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A Stick with a Handle at Each End: Socially Implicated Work Objects for Design of Collaborative Systems

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Abstract. We propose an analytic approach – Socially Implicated Work Objects (SIWOs) – to describe and unify diverse shared virtual objects and work practices in organizations. SIWOs are virtual objects that connect two or more people. SIWOs provide support to coordinate work, especially across distances. Examples of relevant types of work include collaborative scheduling through calendars, collaborative task management, collaborative request management, and co-authoring of documents. Beginning with familiar features from calendars, we build the more general case for SIWOs as a *strong concept* describing an under-supported class of coordinative artifacts in organizations. With a theoretical background combining Schmidt’s work on coordinative practices with Bjørn’s and Chistensen’s concept of relation work, we explore how work practices and work virtual objects could be configured and interrelated through a common and extensible abstraction.

Introduction

When people work collaboratively, their sharing needs may be complex. Usually, they share some kind of content, in the form of text (Holtzblatt et al., 2012), documents (Rader, 2009; Shami et al., 2001), images (Thom-Santelli and Millen, 2009), or media (Rotman, 2009). They also often share two types of relationship information: (a) relationship among persons and groups (Bjørn and Christensen,

2011; Malone et al., 1995), and (b) relationship to the shared content (Churchill et al., 2000; Lai et al., 1988; Winograd and Flores, 1886). Finally, they frequently share status with regard to the content and/or the relationships (Churchill et al., 2000; King and Lyons, 2011; Muller et al., 2004, 2017).

In this exploratory paper, we describe an abstraction that may help us to design for these kinds of collaborative artifacts, and that may help us to unify our treatments of work, data, and designs across different types of content and work practices. This kind of abstraction could provide a uniform data structure for analysis and comparison of diverse working practices over time or over distances. We call this abstraction a Socially Implicated Work Object (SIWO) (Muller et al., 2017).

Socially Implicated Work Objects – Preliminary Definition

We begin with a brief core definition of an SIWO, followed by a development of the concept. An SIWO is, minimally,

1. A virtual object (suitable for computation and analysis),
2. used to represent and support ordinary work, which is
3. accessible by two or more people (members)
4. who have a shared understanding of the referent of the virtual object,
5. and who can discern the status of the work through the virtual object;
6. and furthermore, the SIWO has social implications on one or more members.

In the first set of examples, we will develop the idea of an SIWO as a representation of (a) a meeting; (b) an assigned task; (c) a request; and (d) a collaboratively-written paper.

But first, we want to frame the scope of the objects under discussion. We think that the idea of an SIWO may occupy a middle-space between an empirical report of a workplace practice or a problem topic (on the one hand), and a formal theory

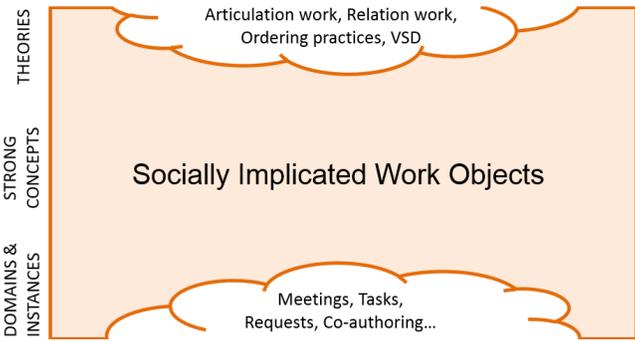


Figure 1. Strong concepts propose intermediate-level knowledge between theories and design instances or domains. We discuss SIWOs as one type of strong concept. This figure takes inspiration from Figure 1 in Höök and Löwgren (2012).

(on the other hand). In the design disciplines, Höök and Löwgren (2012) proposed a contribution-type that they called a *strong concept* (Figure 1). In their proposal, a strong concept is “more abstracted than particular instances, yet does not aspire to the generality of a theory” – similar in status to a pattern, guideline, tool, or bridging concept (Dalsgaard and Dindler, 2014). Nonetheless, a strong concept “cut[s] across particular design use scenarios and even application domains” with an abstraction of a “core design idea” that addresses “use practice and behavior over time” (Höök and Löwgren, 2012).

We borrow that concept for this paper, proposing SIWOs as intermediate concepts between

- multiple design instances in diverse domains, on the one hand, and
- Formalizations such as articulation work (Schmidt and Bannon, 1992), ordering practices (Schmidt and Wagner (2005), relation work (Bjørn and Christensen, 2011), Value Sensitive Design (Friedman et al., 2008), and awareness (Bjørn and Christensen, 2011; Gutwin et al., 1996; Vieweg et al., 2010), on the other hand.

In this list, we made brief reference to these theories to help position SIWOs as a strong concept. We defer a detailed discussion of theories until we have developed the concept of an SIWO.

Common Work Practices and their Artifacts

We begin with a concrete example, that of a calendar object (a meeting) as a shared virtual object (e.g., Palen. 1999). Next, we extend our abstraction to other familiar aspects of working life that have less formal support than calendars, and we use each extension to critique the preceding cases. Often, these are *transient* aspects of work and work practices, rather than routinized workflows, and are thus more difficult to track and to remember. We show how the concept of SIWO can be used to integrate common attributes of these four common work activities, and we use emerging understandings of SIWOs to critique some of the limitations in current work-practice support practices and technologies. We conclude with a retrospective view of SIWO as a strong concept, and we propose implications and future research.

Meetings as SIWOs

Calendars and meetings serve multiple purposes in organizations, including the “what” and the “when” of events (Masli et al., 2011). They support finding a time and a (physical or virtual) place that is mutually convenient for some form of collaborative activity (Palen, 1999). Meetings are important, and breakdowns in meetings can be burdensome (Neustaedter et al., 2009). Calendars support the coordination of important relationships (Dittmar and Dardar, 2014; Thayer et al.,

2012) and states of relations (Tomitsch et al., 2006). Therefore, people prefer to be able to inspect the information about their meetings, including both formal aspects (time, place) and informal aspects (implied relationships). Their meetings are thus an important component of their on-going work processes, work relationships, and work resources – what Mark et al. referred to as their “working spheres” (Mark et al., 2004). Meetings are one type of site where work is planned, done, and understood; we could also say that meetings are one type of site where relationships are formed, deepened, and appreciated. Knowing the status of a meeting, and of the people who agreed to meet, can be important to work and to each worker (Chen et al., 2012; Palen, 1999; Geyer et al., 2011). Meetings often occur in a series, to support the work of a team or a project (Quesada and Darses, 2008), and thus the aggregated information about a series of meetings can be valuable for project histories and governance (Pongolini et al., 2011).

Considered in these terms, the representation of a meeting becomes a shared virtual object that places social responsibilities on the people who will be meeting (the *members* of the meeting). Members generally agree on the “who,” “what,” “when” and “where” of a meeting, including online meetings, conference calls, etc., even if their expectations and emotions about the underlying “why” of a meeting may differ. To coordinate a meeting of two people, we can envision a stick with a handle at each end (Figure 2). Either party can jiggle her/his handle (as it were), and the vibration may be sensed by the other party. Thus, the virtual calendar object (the meeting object) serves multiple purposes, including interpersonal coordination of work (e.g., Schmidt, 2011) by having a shared object to represent that work (the stick), and the ability to signal changes in the plan or status of the meeting (jiggling the stick), including a very rough kind of progress of the meeting plans (e.g., proposed, accepted, confirmed...). In the concrete example of a meeting, we also see that the action of jiggling the stick can be somewhat differentiated: A meeting organizer’s jiggle may indicate a *decision* to reschedule, whereas a meeting participant’s jiggle may indicate an inability to attend, or a *request* to reschedule.

If the meeting serves an important purpose, then the virtual object also places social implications on the members. As we suggested above, people plan and enact both work and relationships in meetings, making and fulfilling commitments to one another. In these ways, the representation of a meeting offers the attributes listed, above, for an SIWO: It is a virtual object; it is used to support some form of collaborative work; it is visible to the people who are concerned with it (the members of the meeting); it is agreed among the members to be a meeting (with agreed expectations about what a meeting is); and it has social consequences upon the members.

Of course, meetings are already supported through virtual objects in conventional office applications and popular websites (Reinecke et al., 2013). An analysis that applied only to calendars and meetings would not be very interesting.

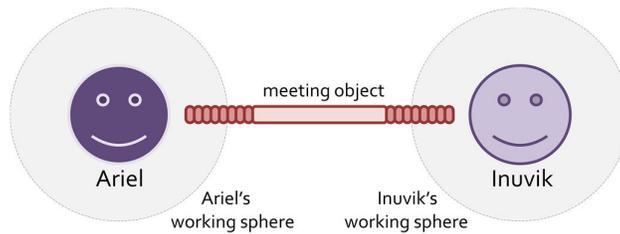


Figure 2. A simple dyadic presentation of a meeting object in a calendar system – a first example of a Socially Implicated Work Object (SIWO).

We now extend our analysis to other, less-well-supported organizational artifacts and the relationships that they support.

Tasks as SIWOs

Some tasks may also be represented as shared virtual objects. In *THE COORDINATOR*, Winograd and Flores described a formal vocabulary and representation for managing tasks as negotiated commitments between people (Winograd and Flores, 1986). There are many versions of software to achieve efficiencies in individual task management (Karger, 2011), even though the operational overhead of using those systems seems to defeat their adoption (Bellotti et al., 2004). A particularly strong case of operational overhead occurs in project management systems, which typically require the entry not only of “who”, “what”, and “when” information, but also dependencies and costs (e.g., Bozhikova et al., 2009; Maretti et al., 2016).

In these terms, the online representation of an interpersonal task object has many of the same attributes as a meeting object. It is a shared virtual object that supports workplace activities; it is visible to at least two members, who generally understand the work-practice and relational implications of the task; and the consequences of doing or not-doing the task can be significant for one or both parties (Bjørn and Christensen, 2011; Schmidt, 2011; Schmidt and Bannon, 1992; Schmidt and Wagner, 2005). Over time, organizations may want to analyze patterns of tasks, and the people who perform them. Thus, a shared task, like a meeting, is an example of an SIWO: We could replace the “meeting object” of Figure 2 with a “task object.”

An assigned task can help us to see additional optional attributes of an SIWO. A shared meeting might be planned by mutual consent. By contrast, an assigned task has well-defined roles: one member assigns, and the other member agrees to carry out the task (Winograd and Flores, 1986). Thus, an SIWO may have explicit roles, and so we add optional attributes to the definition of an SIWO:

7. The members of an SIWO may have distinct social roles.
8. These roles may involve different permissions on SIWO representations.

Using Task Management for a Conceptual Critique of Meeting Management

In this way, we use the framework of a task SIWO to critique one common implementation for the meeting class of SIWOs (including the iCalendar industry standard – Z Content, n.d.). Our recognition of the necessarily role-based definition of an assigned-task object (per Winograd and Flores, 1986) helps us to see that some meetings have a defined convener (e.g., a status-reporting meeting), but other meetings do not have a defined convener (e.g., a lunch date). And yet, most systems¹ require that each meeting have an “owner” – i.e., the convener.

The imposition of ownership upon a mutually-agreed meeting between peers may distort the peer relationship. In practical terms, it means that one of the members has to do more work than the other member, to set up the lunch date. Furthermore, it means that only one member has the authority to change the meeting time or place – i.e., the “owner” of the lunch date. In social terms, it requires that one member is operationally subordinate to the other member. Suchman criticized the language/action approach adopted by Winograd and Flores (1986) as “carr[ying] with it an agenda of discipline and control over organization members’ actions” (Suchman, 1993). The owner-participant structure of a meeting may present an analogous problem, i.e., of putting a disciplinary structure upon on a less structured and more egalitarian relationship, and enactments of aspects of that relationship. We may want to re-think the implications of collaborative software that imposes a hierarchical power structure on a social relationship that may not, in fact, be structured in that way.

Requests as SIWOs

Some assigned tasks take on additional attributes through their workplace importance. Muller et al. (2017) discussed the class of requests in organizations, and described the personal and organizational challenges of request management. Requests might be relatively simple (e.g., find some information), or they might be of major importance to the organization and members (e.g., prepare a crucial presentation to a potential customer). In the Muller et al. analysis, requests are similar to assigned tasks (Bellotti et al., 2004; Karger, 2011; Mark et al., 2005; Winograd and Flores, 1986), but they may become more complex, and also more contextualized. Many requests are assigned “down” an organizational hierarchy, from a superior to a subordinate. The subordinate may decompose the request into sub-requests, and may then delegate each sub-request to a different one of her/his own team-members, subordinates, or peers. Each subordinate reports the completion of her/his task (including both status and content) back “up” the hierarchy, and these reports (and especially their contents) become aggregated and integrated by each delegator. The patterns of decomposition, delegation,

¹ As a matter of legal policy, IBM does not publish critical descriptions of other companies’ products in research papers.

aggregation, and integration, add several attributes to the analysis of task management described above:

- The number of assigned components becomes larger.
- The number of members of the aggregate collection of requests and sub-requests becomes larger.
- Failure of any assignee to make a timely contribution may lead to the real or perceived failure of the entire group of request-respondents.
- The number and diversity of stakeholders of the overall request may expand.

In the preceding list of attributes, we introduced the word “stakeholders.” This usage is based on the Value Sensitive Design (VSD) analysis of direct stakeholders and indirect stakeholders in a design or a policy (Friedman et al. 2008). In the conceptual part of a VSD investigation, a principal aim is to understand who is affected by the system or policy – i.e., who contributes to its design, and who has a stake in its outcome. Our work with request management showed us that the stakeholders for an organizational request may be conceived in concentric circles (Muller et al., 2017). The closest circle to the request itself includes the assigner and assignee. The next circle out may include a manager or executive who made a more complex request to the assigner (who is her/him-self the assignee of the complex request). Less visible are the clients of the manager or executive, who may be thought of as occupying a place in a more distant circle. Other stakeholders may include marketers, sellers, developers, testers, and so on. A request may directly involve two people in the inner circle, but it may indirectly involve many other people who have something to contribute, or something to risk.

The analysis involved in request management is consistent with the prior analyses of tasks as SIWOs. However, the case of request management adds more optional aspects to the definition of an SIWO:

9. The virtual object of an SIWO may be decomposed into sub-objects.
10. Different sub-objects may be associated with different members.

In this way, we find that the “stick with a handle at each end” may be more of a branch than a simple stick, and may have more than two handles.

The organizational importance of requests also makes clear an aspect of SIWOs that was implied in task management, namely, the importance of the *content* of the shared object. Thus, the “stick” becomes more of a “*container* with set of handles,” one for each stakeholder. The revised abstraction is shown diagrammatically in Figure 3.

Using Request Management for a Conceptual Critique of Task Management and of Meeting Management

As above, we can use the evolving framework of an SIWO to critique representations of tasks and meetings in conventional software. Without

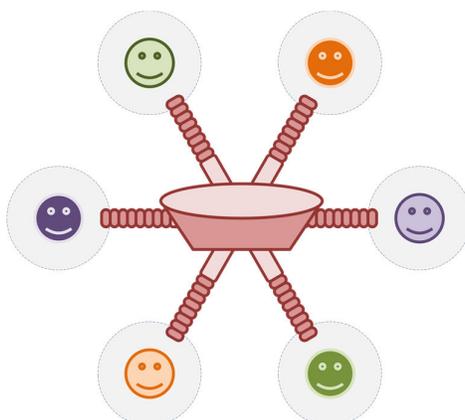


Figure 3. A more complete abstraction of a Socially Implicated Work Object.

criticizing a particular commercial entity (see footnote 1, above), we summarize a typical task assignment structure as follows. A task is characterized by an owner, the owner's organization, the due-date, the status, and two text fields that respectively name and describe the task. The assigner of the task may or may not be included in the specification. This formal structure is roughly similar to that described by Winograd and Flores (1986), and does not allow the expression of sub-tasks or other organizational stakeholders. In our previous critique of calendar objects and standards, we showed that the concept of an SIWO could be used to enrich a calendar representation in the realistic and pragmatic social and organizational context. Similarly, we note here that the evolving description of an SIWO could also be used to enrich an assigned-task representation in the realistic and pragmatic social and organization context.

The addition of content to Figure 3 also allows us to extend our critique of conventional meeting management. Suppose that one of the members in Figure 3 calls a meeting, and is therefore the owner of the meeting object. That person can post an agenda as the contents of the meeting container. However, the usual access-permission rules of calendaring systems preclude others from writing on the agenda. Because of that restriction, a member who was previously requested to bring a report to the meeting, *cannot* attach that report to the agenda item that calls for that report, because the meeting object does not allow her/him to update the agenda document. Indeed, s/he cannot even add status information to say that the report is done. In the preceding critique based on Tasks as SIWOs, we noted that the conventional meeting structure may distort a relationship, such as one member of a lunch date being required to "own" the lunch date in the calendar software. In the current critique, based on request management, we extend our earlier concerns to note that content-oriented actions that are desired by both parties (i.e., updates to a document that is intended to be shared) are rendered impossible by the distorted relationship imposed by the meeting structure.

Attribute 5 of an SIWO (visibility of status) is severely limited by the meeting ownership model.

There are, of course, solutions to this problem, but they involve scattering documents into other repositories. For example, the meeting object could contain a link to an agenda wiki page, and members of the meeting could take turns editing that wiki page. However, the meeting object would not provide awareness of updates to the wiki page, and any member of the meeting who needed to check for updates would have to access the meeting object, and then navigate to the wiki page, repeatedly, until s/he could find the updated information. As we found in our earlier critique, the simple model of a single-owner of a meeting has the unintended consequence of interfering with collaboration about the meeting.

Shared Documents as SIWOs

Following on the preceding critique, we consider documents themselves. Organizations care deeply about their collections of documents, and their ability to compute over those documents, as shown by both the importance of the EUSSET and ACM Digital Libraries (see also Rader, 2009; Shami et al., 2011). Documents present major challenges while they are being co-authored. Co-authoring a document involves a mix of individual and group (or group-aware) activities (Raikundalia and Zhang, 2005; Ringel et al., 2004; Scheliga, 2015). Except for purpose-built online services, co-authoring environments for documents usually involve large amounts of coordination efforts by people (Cohen et al., 2000; McDonald et al., 2004; Veer et al., 2011). Even in online environments designed to support sharing and coordination of other artifacts, collaborative writing can involve complex “stewardship” activities (Longo and Kelley, 2015).

Teams of authors adopt sometimes-complex protocols for avoiding edit-collisions (Raikundalia and Zhang, 2005; Scheliga, 2015). These protocols may require careful crafting of edit-messages to minimize tensions and conflicts (Birnholtz and Ibara, 2012). Most environments do not signal when a change has been made, which can lead to issues if the contents have political aspects (Tam and Greenberg, 2006), or if the co-authors include conflicting or adversarial people or roles (Cohen et al., 2000; Kriplean et al., 2007). Under some circumstances, co-authors have invented additional codes to signal changes and intentions to one another (Chi et al., 2010).

We propose that a shared document may be represented as an SIWO and as the contents of an SIWO. The awareness attributes (“jiggling the stick”) are certainly relevant (Cohen et al., 2000; Kriplean et al., 2007; McDonald et al., 2004). In the preceding section, we wrote about decomposition and delegation of requests. It seems that a similar pattern of decomposition and delegation may occur with tasks during co-authoring (e.g., Chi et al., 2010; Raikundalia and Zhang, 2005; Ringel et al., 2004; Scheliga, 2015). In the case of conflicted or adversarial work, the

knowledge of the broader social and organizational context – of direct and indirect stakeholders – could be crucial (Cohen et al., 2000; Kriplean et al., 2007; Tam and Greenberg, 2006). Veer et al. (2011) argue for a complex task model to represent collaborative writing. An SIWO structure could provide part or all of a simpler form of support.

Using Shared Documents for a Conceptual Critique of Meeting Management and Task Management

As we wrote, above, certain work practices related to meetings are prevented by the ownership model of a calendar object, especially with regard to agenda documents. Similarly, co-authors frequently include suggestions, comments, and requests to one another within their shared documents. Each of these within-document actions might be considered an assigned task, or perhaps a micro-task. In this way, there is a potential hierarchy of SIWOs: The macro-level SIWO of the shared document may contain micro-level author-to-author-request SIWOs within it. Within this nested structure, we recall the interests of organizations to summarize or aggregate SIWO data in various ways. Applied to the shared document as a domain of work, one co-author of the shared document may want to query, “have I responded to all of the edit-requests made to me?”, while another co-author may want to query, “are there any unmet requests remaining in the document?” Thus, the SIWO representation for a shared document gives further weight to SIWO attributes 9 and 10, which called for decomposition, with potentially different members in different roles. Similarly, if a meeting object were redefined as an SIWO, then the author of an agenda could represent each agenda item as an assigned task SIWO to the person responsible for that item.

Summary

In these four examples of common office activities and their representations – meetings, assigned tasks, requests, and shared documents -- we developed the concept of an SIWO, building up from work practices to a common set of abstractions about those practices. These abstractions help to make work and relationships more visible to direct and indirect stakeholders, and can thus help people to coordinate the one-off shared practices that can be important to work, workers, organizations, and relationship. Our hope is that the common set of abstractions will help designers to develop more consistent ways of creating, modifying, and visualizing the tasks and objects, and that they will help organizations to connect and compute across these tasks and objects. We now reconsider SIWOs from the perspective of theories of collaborative work.

Theoretical Development

Articulation Processes and Articulation Work

Strauss (1985; Strauss et al., 1985) proposed the principles of articulation processes, used by members of an organization to coordinate work and to repair work processes that were not “on track.” The components of an articulation process might include “the specifics of putting together tasks, task sequences, task clusters – even aligning larger units such as lines of work and subprojects – in the service of work flow” (Strauss, 1988). Articulation work has become an important way to theorize people, tasks, and objects in CSCW (Schmidt 2011; Schmidt and Bannon, 1992; Schmidt et al., 2007; Star and Griesemer, 1989).

In Strauss’s terms, SIWOs might exist as subclasses of articulation processes. SIWOs are collections of people, documents, and tasks; and they also represent configurations and alignments of those components – very much in keeping with Strauss’s theory. However, the focus of Strauss’s work was workflows (1985, 1988; Strauss et al., 1985). By contrast, we have discussed aspects of SIWOs that involve less structured and less routinized workplace activities, such as meeting management and collaborative task management. Requests are often one-off events (Muller, 2017), and therefore do not conform to the more structured and replicable attributes of workflows. Meetings, tasks, requests, and even documents are often improvisational acts rather than components of an over-arching plan (Suchman, 1987, 1993). Our ideas about SIWOs are surely informed by Strauss’s concepts of articulation, but they also address domains of work that are both *less formal* than workflows, and (sometimes) *more consequential* to organizational outcomes and personal reputations, than more quotidian concepts of workflows.

Coordinative Artifacts and Coordinative Mechanisms

Schmidt and Simone further developed concepts from articulation work (Schmidt and Bannon, 1992) into coordinative artifacts and coordinative mechanisms (Schmidt and Simone, 1996; see also Schmidt and Wagner, 2005). Based on Schmidt’s recent integrative account (2011), a coordinative artifact may structure both individual and collective components of shared work, and includes coordinative mechanisms and/or protocols for that structuring. The use of a coordinative artifact is distinct from the actual work that it supports.

Coordinative artifacts support communication and awareness. Schmidt (2011) uses an example task of two people moving a set of furniture together:

“by holding the table in their hands, they are both immediately ‘aware’ of the state of the table: its location in space (altitude, pitch, and roll), its velocity, its weight... In the act of carrying the table, the two men are causally interrelated.” (p. 8)

In the case of remote or distributed work, the two or more members of the work do not physically hold the same object. We earlier wrote of a “stick,” and Schmidt’s table functions very much like our stick. The mutually-perceptible adjustments of the movers serve awareness functions similar to “jiggling the stick.” The correspondence would be even stronger if the carriers of the table put documents onto the surface of the table.

An SIWO is clearly a type of coordinative artifact: Members inscribe a configuration of people, tasks, and documents into it, and other members should be allowed to read that configuration. Certain coordinative mechanisms are at least implied by that configuration. For example, meetings are called *by someone*, tasks are assigned *to someone*, and a request (if represented as an SIWO) may include the *requester*, the original *assignee* of the request, and also the *delegates* that s/he chooses after decomposing the request into sub-requests.

Interestingly, part of Schmidt’s description (2011) of coordinative practices appears to treat the actual coordinative work in isolation. Writing about the task of two of the table, Schmidt notes that

“In fact, we *do not need* to know the socio-economic roles of the two men: if either or both of them are wage earners and do this for a salary, or if they live there and do it for their own benefit, or if one of them is providing neighborly help... In short, we can focus on and investigate cooperative work and coordinative practices as a distinct domain of practice, while leaving the socio-economic and organizational setting in the background.” (p. 10)

For a meeting, we think that the relationships and dispositions of the members may be important. In request management, the chain of requests may tell much about how the work is to be done, in terms of accuracy, accountability, and urgency, and thus also the social consequences for the organization and for the members. Our current sense of an SIWO emphasizes the importance of the direct and indirect stakeholders in the work that is supported through the SIWO. SIWOs are related to Schmidt’s coordinative mechanisms, but they depend much more on social and organizational context for their configuration of members, tasks and content, and their practices, and their significance.

One possible reason for these contrasts may derive from the broader assumed context: Schmidt is writing, here and elsewhere, about the support of workflows. In his example, the two people who are moving the furniture are employed as movers, and they are doing their quotidian work. They have little personal interest in the table, and they go home at the end of the day to their own tables in their own homes. In contrast, SIWOs often support non-routine work. Meetings may or may not be routine, tasks may be conventional or unique, and requests are more often than not exceptions with organizational urgency driving them. Members live with the *consequences* of SIWO-supported work.

Relation Work

This discussion of the importance of stakeholders leads us to think about Bjørn's and Christensen's concept of relation work (2011). In their view, Schmidt's articulation work is primarily concerned with tasks and their configurations. Bjørn and Christensen argue that relations among geographically-distributed people, and among people and artifacts, must necessarily be worked out *before* an articulation process can begin; relation work is thereby antecedent to articulation work:

“What we suggest is a distinction between, on the one hand, articulation work, referring to “the specifics of putting together tasks, task sequences, task clusters – even aligning larger units such as lines of work and subprojects – in the service of work flow” (Strauss, 1988, p.164) and, on the other hand, relation work, understood as the fundamental efforts of achieving the very basic human and non-human relations that are a prerequisite for multi-site work...” (p. 139)

In the case described by Bjørn and Christensen, there was a single big project shared between two sites. Relation work was described as being *necessitated* by the difficulties of coordination over distance (e.g., Olson and Olson, 2000). The relation work of Bjørn and Christensen was generally conducted by knowledgeable people who knew the people at both their own site and the other site, and who had collectively developed skills to manage the challenges for remote work. There were easily observed differences in how the work progressed, when facilitated by people who were highly knowledgeable about the human-to-human working relationships, as contrasted to people who had less knowledge.

From our exploration of “Meetings as SIWOs,” above, we recall that sharing information through meetings and calendars may be an important part of forming and honoring a relationship (Dittmar and Dardar, 2014; Thayer et al., 2012). An SIWO offers the potential for people to inscribe information about relationships and relation work among its parameters. Some organizational information can be derived from the official reporting structures (i.e., the hierarchical “org chart”). Other information might be computed from online traces of collaborative work, such as person-to-person relationships derived from co-authorship, dependencies among code modules, and (where available) email or social media response relations. Yet other information – especially about indirect stakeholders – might have to be entered by hand. In this way, SIWOs may require less human facilitation than the case in Bjørn and Christensen, and may provide a more personal and mobile form of awareness than what was visible in that case.

Discussion and Conclusion

We proposed a class of abstractions, namely SIWOs, to represent work, workers, and the objects of their work, and we developed a set of ten attributes of SIWOs, as summarized in Table 1. We used four common work activities (meetings, task management, request management, and document co-authoring) as the basis for

Table 1. Summary of SIWO attributes.

1.	A virtual object (suitable for computation and analysis),
2.	used to represent and support ordinary work, which is
3.	accessible by two or more people (members)
4.	who have a shared understanding of the referent of the virtual object
5.	and who can discern the status of the work through the virtual object
6.	the SIWO has social implications on one or more members.
7.	The members of an SIWO may have distinct social roles.
8.	These roles may involve different permissions on SIWO representations.
9.	The virtual object of an SIWO may be decomposed into sub-objects.
10.	Different sub-objects may be associated with different members.

this development (derived from Bellotti et al., 2004; Geyer et al., 2011; Heinrich and Maurer, 2000; Karger, 2011; Longo and Kelley, 2015; Muller et al., 2017; Neustaedter et al., 2009; Palen, 1999; Pongolini et al., 2011; Tullio et al., 2002). We think that the common attributes will make it easier for workers to recognize repeating attributes from one class of SIWOs to another, such as signaling (from awareness to status to completion-indicators), containers (from trivial to complex), and types of membership (including both direct and indirect stakeholders). We hope that a common basis in SIWOs will make it easier for workers to take a broad view of their own work, and the work of their colleagues, and their shared tasks and projects over time. We also think that the common attributes will aid organizations in appreciating, comparing, and governing those projects.

We related the concept of SIWO to major theories of collaborative work (Bjørn and Christensen, 2011; Schmidt, 2011; Strauss, 1985, 1988). We believe that researchers may find other domains which can also be usefully treated in this way.

Critique of Common Work Representations

We used the emergent attributes of SIWOs to critique existing representations of common work activities, such as meetings and tasks. These critiques were possible through abstraction of the common attributes of SIWOs (Table 1), which allow comparison and reciprocal informing of ideas. We hope these abstractions will assist other researchers to make similar comparisons, which can lead to both increased consistency of user experiences for these tasks and objects, and further insights into the current limitations in common products, services, and standards.

Review of SIWO as a Strong Concept

In their description of strong concepts as a type of contribution, Höök and Löwgren (2012) borrow evaluation criteria from Booth et al. (2008). We briefly consider SIWOs in terms of their three criteria:

- **Contestable:** A strong concept is contestable if it is novel and not universally shared. We have contrasted SIWOs with concepts of articulation work, coordination work, and relation work, and with conventional representations of work tasks and objects. We believe that the concept of SIWOs provides constructive contrasts with the previous work.
- **Defensible:** A strong concept is defensible if there are criteria for judging its contribution. We have argued for the “fit” of SIWOs to four domains and cases, and we have used the lack of fit of our initial formulation (e.g., attributes 1-6) to motivate our development of additional attributes (7-10).
- **Substantive:** A strong concept is substantive if it contributes new ideas that a community can work with. We have shown that the SIWO concept may help to unify our thinking across multiple work domains and shared objects. In addition, we have proposed ways that workers and organizations may make substantive use of these ideas.

Next Steps

We hope to design systems for organizational work using the SIWO abstraction, beginning with representations of requests and reminders. We hope that others may find this abstraction useful, and may experiment with thinking and designing based on SIWOs. We anticipate that the SIWO concept will change over time if researchers and designers gain experience and criticize this formulation.

In particular, we hope that SIWOs will influence the design of social attributes of future systems for collaborative work. We critiqued existing representations and their assumptions, based on the translation of observations from one domain (e.g., requests) to other domains (e.g., meetings, tasks), through the common conceptual substrate of a potential SIWO abstraction. We hope that we and others can use the abstraction of an SIWO for critical analysis of how assumptions and values about power and ownership find their way into designs (as argued in the more general case by Friedman et al., 2006).

Finally, we look forward to developing a better understanding of the relationship of transient and one-off work practices (Bellotti et al., 2004; Palen, 1999; Muller et al., 2017; Neustaedter et al., 2009) with the relatively routinized work practices that have been the focus of much of theoretical development (Bjørn and Christensen, 2011; Schmidt, 2011; Schmidt and Bannon, 1992). While we need to articulate, order, and coordinate our routine work and relationships, we have similar needs for unusual and non-repeating work activities. We hope that SIWOs can inform a series of representations that can unify these facets of work practices.

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