

Ensembles: Understanding the Instantiation of Activities

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Abstract

This paper introduces the notion of *ensembles* to understand the way object-related activities are instantiated in practice. An ensemble is an intermediate unit of work between action and activity in the hierarchical framework proposed by classical activity theory. Ensembles are the midlevel of activity, offering more flexibility than objects, but more purposeful structure than actions. We discuss the value of the notion of ensembles to close a conceptual gulf not adequately addressed in activity theory, and to understand the practical aspects of the instantiation of objects over time. Emerging from the analysis of the practices of professional information workers in two different companies, we illustrate the relevance of the notion of ensembles for activity theory and suggest some benefits of this conceptualization for analyzing human work in areas such as human-computer interaction and computer-supported collaborative work.

1. Introduction

The comprehensive understanding of human work is a central aim of activity theory. The multi-level framework of operations, actions, and activities that constitute work has been a fundamental component in the set of concepts and ideas proposed by this theoretical approach since its inception (Leontiev, 1978; 1979; Wertsch, 1981). Within the hierarchical framework, activity theory conceptualizes the “total flow of activity that forms human life” (Leontiev, 1979) to consolidate an analytical perspective encompassing the motives, conscious goals, and actual conditions faced by people as they go about their work. In this paper we argue that in spite of its holistic perspective, the hierarchical framework is missing an important component needed to describe in a complete way the practical instantiation of activities.

In previous work, we distinguished between *constructing* and *instantiating* objects (Nardi, 2005; Kaptelinin and Nardi, 2006). Constructing an object means formulating it, figuring out what the object should be. Instantiating an object is the work of actually realizing it. These concepts bridge Leontiev’s (1974) ideas which emphasize the selection of an object motivating an activity and Engeström’s work (1987; 1990) emphasizing the production of an outcome in an activity.

As we analyzed the instantiation of objects in the empirical research reported in this paper, we found what appears to be a gulf between the action and activity levels in the activity hierarchy. Thus we propose the addition of a new level in the hierarchy between the activity and action. We call this level *ensembles*. Ensembles are sets of thematically related actions defined by a purpose. They are an intermediate form in the hierarchy, neither Leontiev’s final “need or a desire, to which [the activity] always answers” nor discrete actions.

Evidence for the need for a concept of ensembles comes from several sources. First, in our empirical research, we discovered ensembles, finding many ways in which they structured activity. Second, we believe there are hints from Leontiev’s work that suggest the need for such a component in the activity hierarchy. And third, in consulting the literatures of human-computer interaction (HCI) and computer-supported collaborative work (CSCW), we found researchers struggling to define concepts that we believe are captured by a notion of ensembles.

From the beginning, activity theory scholars emphasized actions as the fundamental processes by which human activity is materialized. The emphatic declaration of Leontiev made it clear: “Human activity does not exist except in the form of action or a chain of actions” (Leontiev, 1979). Actions are described as intermediate results, often derived from the division of labor required to realize collective activities (Leontiev, 1978). Within this line of reasoning, the notion of action is used to describe conscious goal-oriented processes, enacted by individuals, and usually achieved within short temporal frames. For example, Kuutti (1996) provided examples of actions such as “arranging a meeting,” “writing a report,” or “transporting merchandise.” The more one understands *actions* as describing the short-term, goal-directed efforts by which an activity is instantiated, the easier it is to perceive a conceptual gulf between the notion of action and the notion of activity.

As proposed by Leontiev (1978), the object represents the “true motive” behind activity, the “ultimate reason” or “sensemaker” of work (Kaptelinin, 2005). Objects guide and define the “horizon of possible actions” (Engeström, 1995; Kuutti, 1998). Activity theory assumes that as activities are instantiated, individuals will be aware of and be able to identify how the partial results of their *actions* connect with the motives of their *activities*. But there is no intermediate notion to describe a unit of effort between the levels of actions and activities. From an analytical perspective it is possible to conceptualize work in this simple way, but we argue that the practical instantiation of activities is a complex phenomenon that demands aggregation of work efforts beyond mere actions, yet below complete activities.

The need for an intermediate concept has been particularly clear in studies exploring the instantiation of activities within disciplines such as HCI and CSCW. While applying the notions of activity theory to understand empirical results, researchers have found it challenging to establish adequate borders for the notions of action and activity as proposed by the hierarchical framework:

The flexibility of the basic [activity theory] concepts makes them useful in describing developmental processes. On the other hand, it also means that it is impossible to make a general classification of what an activity is, what an action is, and so forth because the definition is totally dependent on what the subject or object in a particular real situation is. (Kuutti, 1996, p. 32)

Without questioning that a certain flexibility is afforded by the hierarchical framework, we believe that the original notions of activity and action cannot be arbitrarily expanded without the risk of losing their meaning. This risk can be seen in analyses guided by activity theory that have tended to lose the emphasis on the ultimate motives and object-orientation of activity and to instead use the idea of activity to describe work efforts closer to, but not necessarily equivalent to, goal-oriented actions.

For example, while analyzing the practices of hospital workers, Bardram (1997) referred to efforts such as “diagnosing a patient” and “preparing a patient for surgery” as *activities*. The level of actions was used to describe things such as “checking blood sugar level” or “requesting x-rays” (Bardram, 1997). But what Bardram called *activities* appear to correspond to lower-level efforts if we contrast them with a more fundamental activity such as “providing health care for the patient.” We argue that the problem of assigning lower level efforts to the activity level results not from a lack of understanding of the concepts proposed by activity theory, but from an attempt to work without an intermediate notion which is currently missing within the hierarchical framework.

We propose the notion of *ensembles* to account for the way individuals in practice conceptualize, delimit, and represent those practical intermediate units of work that allow them to instantiate their activities through sets of thematically connected actions. From an empirical investigation in the domain of information work, we found that *ensembles are sets of actions thematically connected, oriented towards a particular purpose, and framed within a particular object-related activity*. We analyze the way ensembles were used to define a contextual frame for actions, to establish workload and the scope of work, and to facilitate collaboration with others.

2. Empirical work

Our interest in understanding how activities are instantiated in practice was part of an effort to investigate the ways information workers manage multiple activities (González and Mark, 2004; González and Mark, 2005; Mark et al., 2005; González, 2006). Previous research indicated an increasing demand for professional workers to attend to multiple and varied activities, due, among other factors, to the flattening of organizational hierarchies, changes in operative structures of work, and relaxation of the formalization of job roles (Gallie et al., 1998; DiMaggio, 2001; Nardi et al., 2002). To understand the phenomenon of

managing multiple activities, it was clear that we had to devote special attention to defining the practical and concrete units of work that people manage on a daily basis.

2.1 Background: The quest for defining practical units of work

Previous studies in HCI and CSCW have been inconclusive as to the specific nature of the units of work that people manage in practice. However, studies persistently point to a thematic aggregation among actions. For instance, inspired by early studies conducted to understand how users organize digital activities, many systems have been designed to support easy switching among different collections of digital artifacts. Starting with Rooms (Henderson and Card, 1986), these systems helped users organize thematically connected digital artifacts such as email messages, text documents, and spreadsheets. Collections of digital artifacts were associated with particular “working contexts” (MacIntyre et al., 2001), “higher-level tasks” (Kaptelinin, 2003), “personal projects” (Jones et al., 2006), or “context structures” (Rattenbury and Canny, 2007). The systems assume that beyond the goals of particular actions, people need to create collections of documents to support long-term tasks or projects. However, exactly what the longer-term units of work are is either implicitly assumed as in “a higher-level task (or project)” (Kaptelinin, 2003), or stated in very general terms as in “A [personal] project is made-up of any number of tasks or sub-projects” (Jones et al., 2006). For example, MacIntyre et al. (2001) said, “working contexts [are] coherent sets of tasks typically involving the use of multiple documents, tools, and communication with others.” Norman (1998) proposed adding the level of “tasks” to the activity hierarchy, although the exact nature of tasks was not defined. González and Mark proposed the notion of “working spheres” which is similar to ensembles. However, it is a standalone concept, not placed in the larger theoretical framing of the activity hierarchy (see Mark and Poltrock, 2003; González and Mark, 2004; Mark and Poltrock, 2004; Mark et al. 2005, González and Mark, 2005, Gonzalez, 2006).

In a similar way, some empirical studies have revealed characteristics of such units of work, but have not aimed to produce a detailed understanding of them. For instance, the studies conducted by Bellotti and her colleagues (2003) explored the use of email to support task management. They found that workers managed threads of messages that were thematically connected around particular tasks or topics such as preparing a paper for submission to a conference. The existence of threads (or *thrasks* as Bellotti et. al. called them) often resulted in the need for people to create mailboxes or folders to store each thread and facilitate their organization. The authors used these ideas to envision a system designed around thrasks as “threaded task-centric collections.” They observed that thrasks would serve to cluster sets of actions but did not further elaborate conceptual understanding of the clusters of actions.

Czerwinski and her colleagues analyzed the relationship between interruptions and task-switching to capture “users’ personal descriptions of their work” and to define the particular tasks involved in multi-tasking (Czerwinski et al., 2004). Using a diary collection technique, they asked a group of information workers to keep a record of tasks they did during their work day. The description of each task, together with the time it took to complete and other details, were annotated in a spreadsheet. The analysis of the data collected in the diaries suggested that people tended to organize actions around higher-level tasks that are comprised of individual actions. The informants’ diaries mentioned things such as working on an “annual performance review,” “work on PPT slides” or “create/edit web pages” that encompassed a number of actions extending over time. The authors used a coding scheme that placed project or routine tasks on the same level with lower level actions such as writing email or placing telephone calls. This scheme made it difficult to assess how many of the actions were related to higher level units of work and to develop a more detailed means of understanding the organization of the users’ work.

In the field of managerial research, Barry and his colleagues (1997) studied managers’ agendas. They found that managers grouped agenda items that were thematically or temporarily related into higher units. Such grouping made it easier to organize agendas and use them for optimal planning and prioritization. Maintaining different levels of articulation allowed managers to use the agendas as mediating mechanisms bridging the gap between long-term goals and plans and the changing circumstances they faced in a moment-to-moment basis. They report that managers observed kept items with more specific and immediate goals such as “*Meet with company that wishes to put our product under its label*” with more general and temporally undefined goals such as “*Evaluate all product lines.*”

Little (1983), a psychologist, proposed a unit of analysis and methodology for the assessment of personal projects. He defined a personal project as “*a set of interrelated acts extending over time, which is intended to maintain or attain a state of affairs foreseen by the individual.*” His work helps personality psychology researchers understand the temporal and spatial contexts shaping the evolution of personalities.

Examples of these personal projects include practical chores such as “*Making a birthday present for my friend*” or “*Completing my English essay*,” generally requiring extended plans of action.

From an activity theory perspective, the common factor among concepts such as “contextual structures,” “working spheres,” “working contexts,” “projects,” “tasks,” and “thrasks,” is that they describe work efforts that encompass actions, but, at the same time, lack the definitive object-related nature of an activity. Consequently, we were motivated to reveal the characteristics of those intermediate units of work that previous studies have detected but not completely defined.

2.2 Ethnographic studies of information workers

From February 2003 to March 2005, we conducted ethnographic studies in two companies, IT-Services and Med-Admin, using a grounded theory approach (Strauss and Corbin, 1998).¹ IT-Services is a branch of a major institutional outsourcer providing information technology and administrative services to financial management companies. At the time of the observation, IT-Services operated with 200+ employees that provided services to a single client, Atlantic Investments, a major bond financial manager in Southern California. Our study focused on the activities of the Trading and the Operations teams that designed and supported the main software systems used by the financial brokers. Work at IT-Services revolved around monthly software releases mixed with other “initiatives,” as employees called them, without fixed schedules, as well as requests at different levels of urgency such as elaboration of reports, consultation of databases, and other demands from clients at Atlantic Investments. Given the high monetary value of the operations supported, workers at IT-Services were very conscious of minimizing mistakes and providing quick responses to clients’ requests.

The other study was conducted at Med-Admin², a small company that specializes in providing administrative and consulting services to small and medium-size medical practices. Med-Admin served hundreds of medical practices in different parts of the country. The company used a proprietary software solution designed to support billing, prescriptions, and other administrative medical processes. Daily operations at Med-Admin were characterized by the constant flow of phone calls and emails from the clients requesting elaboration of reports and upgrades, asking questions about the system, and reporting errors. The requests were mixed with ongoing efforts to identify new clients and expand services. Coming from a drastic period of downsizing that left the company with a small base of 65 employees, workers at Med-Admin were likely to be involved in many different requests from clients, in various projects and committees, as well as efforts to coordinate work processes and to assume pending projects formerly handled by employees who had recently left the company.

A total of thirty-six information workers were closely observed and interviewed in the two companies. At IT-Services, fourteen informants worked with the Trading team and ten with the Operations team. At Med-Admin, we observed twelve informants from different teams. The set of informants covered personnel in varied positions within the organizational hierarchy and with different job roles including eleven managers, three project leaders, nine financial-business analysts, eight software developers, three support engineers, and two sales executives. Table 1 shows the distribution of informants by role and by study.

In each company the study started with a period of ten days of preliminary general observation that included attending meetings, and interviewing and spending time with employees to become familiar with the main projects, the style of work, and the organizational structure of the company. This work was followed by presentation sessions where employees were informed about the goals of the study and its methods, and then asked to participate in the study.

Study	Role						Total
	Analyst	Developer	Engineer	Leader	Sales	Manager	
IT-Services (Trading)	6	4				4	14
IT-Services (Operations)	1	4		2		3	10
Med-Admin	2		3	1	2	4	12

¹ All names used in reference to field sites, companies, persons, and products are pseudonyms.

² In previous publications (Mark, et al. 2005, and González and Mark, 2005) we referred to Med-Admin as Venture, which was also a pseudonym.

Total	9	8	3	3	2	11	36
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Table 1. Distribution of informants by study and role

Each informant was observed using a shadowing technique (see Mintzberg, 1973; Sproull, 1984). For a minimum period of three working days, the informant was observed by a researcher who sat in their cubicle or office. Observation lasted from the time the informant arrived in the morning to the time they left the office at the evening. As the employee worked, the researcher, using a clip-board, pen, and sheets of paper, documented the work by recording the actions performed, the tools used, interactions with others, and partial contents of conversations or comments. The notes were used to produce detailed observational reports. Follow-up interviews were conducted some weeks after the observation for clarifications, to inquire about the evolution of the activities observed, to learn about new activities that were being undertaken, and to track other changes in informants' jobs. In total, the inquiry comprised more than 920 hours of systematic observation with an average of 26 hours per informant, 100+ hours of interviews, 132 observation reports, and the collection of hundreds of documents including catalogs, brochures, email printouts, photocopies, and pictures.

3. The emergence of the notion of ensembles in our data

From the beginning of our inquiry, we noticed that in general, when workers referred to the specific actions they performed, they usually mentioned not only the action but also the immediate goal they were pursuing. For example, a worker would not just say: *"I made a phone call,"* but would mention the specific goal they were pursuing, e.g., *"I made a phone call to talk with David."* In some cases, a higher-level purpose framing the action was revealed. For example, after hanging up the phone, John, a manager at IT-Services, said to a teammate sitting in an adjacent cubicle, *"I was calling to ask about the license server for the Rational software plan."* The action of *having a phone conversation* was framed within a larger effort to implement an application to support software development based on a product called Rational ClearQuest. John was in charge of acquiring the licenses and making sure that servers were set up to run that product. We noticed that John often framed other actions around this purpose as when he wrote an email message to a co-worker: *"Have you talked with the IT guys about the Rational stuff?"* While observing other informants we found similar references to higher-level purposes. For instance, Jennifer, a sales executive at Med-Admin was involved in a collaboration with co-workers and an external consultant in designing a new website for Med-Admin. The effort required the creation of new content and modification of the site's organization to respond to a new business orientation of the company. As part of this effort, Jennifer attended some meetings. Right before she went to one of those meetings, she said to a co-worker, *"This is a meeting for the new website project."* The action of *having a meeting* with the goal of providing initial feedback was framed within the ensemble of renovating the website. As we observed that day, and on subsequent days, this ensemble also involved other related actions that Jennifer performed such as sending email messages, preparing documents for the website, and additional informal conversations with the consultant outside the meeting.

Consequently, our analysis was oriented to understanding how the actions a worker took, such as composing an email, setting up a meeting, or having a phone call, were related to other actions that were alluded to in phrases such as "the Rational plan" or "the website project." These phrases seemed to denote themes communicating the purpose of the actions. They suggested that the action in question was part of a larger set of related actions that together formed a set. It was through the ensemble of a set of goal-oriented actions that a higher-level purpose could be achieved. At the same time, it was clear that the thematic references were not in themselves activities. The notion of activity, pointing to the object-related motives and ultimate *whys*, seemed far away from the units of work we were hearing about. In spite of the fact that they represented work efforts beyond actions, they were more limited in scope than activities. This led us to engage in a deeper analysis to clarify the properties of this emerging intermediate unit of work from which to inform our understanding of the phenomena under study.

4. An empirical look at ensembles

In this section we look more closely at the empirical basis of our argument for proposing a concept of ensembles for the activity hierarchy. Four sources of study data were used in the analysis. First, informants knew that we wanted to identify the different things they were working on each day and some verbalized some of their work as they conducted it. Sometimes during the day they pointed out the purpose of the

things they were doing. This information was important in understanding what workers thought at the time of instantiating their activities. A second source of data was comments made by informants while interacting with co-workers. While talking to others, informants referred to the things they were doing at the moment: "As soon as I'm done with the ATRACK stuff I will move over to the R6 spec," or, "I cannot take [the call] right now, I am attending to Jim's production issue." In the first case, "the ATRACK stuff" referred to a computer system implemented at IT-Services used to track time employees devoted to different projects. Such tracking was a mandatory everyday routine action. "The R6 spec" referred to a major software release IT-Services was planning to deliver in the following months. A third source of data came from brief informal interviews conducted with informants at the end of each day. These interviews served to clarify events and interactions. Twenty-two informants filled out a paper form at the end of the day listing the things they had worked on. Figure 1 shows an example of one of those forms as completed by "Peter." Informants were asked to list as many things as they liked and to describe them in a way that was meaningful to them. Finally, a fourth source of data came from post-observation interviews in which we inquired about activities conducted during the period of observation. These four primary data sources were complemented with analysis of documents gathered during the research.

4.1 Conceptualization of ensembles: an illustrative case

Peter was a mid-level manager leading a team responsible for the development and maintenance of information systems supporting financial transactions at IT-Services. He supervised twelve people including software developers and financial analysts. He reported to the general transaction systems manager and the chief information officer (CIO). Peter worked in an office but his door was always open. Most of his interactions were spontaneous and based on informal meetings either at his office or in employee cubicles. Figure 1 shows Peter's work as he conceptualized it during the first day of observation. His descriptions point to different kinds of ensembles involving things such as discussions, requests, meetings, and solo work. For example, there was an item listed as "Arrangements for Boston TRIP" which referred to a set of actions that Peter performed to organize a trip to the IT-Services headquarters in Boston. On the morning of 2/19/2004, his boss told him about the visit and asked him to prepare quickly as Peter would be flying to Boston the following week. His boss gave him few details about the purpose of the trip but mentioned that it was connected with a new project. Peter booked an air ticket on-line, phoned the human resources office to get a company credit card, and walked over to the IT staff office to request a laptop to take with him.

End of the Day Session Sheet

Informant Code:

Date: 2/19/2004

Issues or things that I worked on today

1. ARRANGEMENTS FOR BOSTON TRIP
2. ARRANGE CELL PHONE REQUEST FOR
3. MANAGEMENT REPORT
4. PROMOTION RECOMMENDATION LETTER
5. TAPS TEAM MEETING
6. TROUBLESHOOT USER CREATION PROCESS
7. DISCUSS USER PROFILE APPLICATION ISSUES
8. CASE TRACKER REVIEW / ~~UPDATE~~ UPDATE

Notes: 9. TOUCH BASE WITH ALL DEVELOPERS ON PROJECT

Figure 1. An example of an “End of the Day Session Sheet”
used to capture an informant’s work.

On the same day, Peter arranged to get a cell phone for Ronald, one of his subordinates. He noted this on the session form as “Arrange Cell phone request for Ronald.” Ronald had explained to Peter that he would be covering a major server update and would like to be available at any time in case of problems. Peter suggested a company cell phone so that Ronald would not have to pay for the calls himself. Peter annotated the request in his electronic agenda (Microsoft Outlook) and the next day made a couple of phone calls and talked to Ronald again about the arrangements.

The third item on the session form, “Management Report,” referred to an ensemble that Peter worked on over the course of three consecutive days. Peter was asked to report to his boss on the status of certain projects and to prepare a spreadsheet with the information. A less time consuming but no less important activity was the elaboration of a “Promotion Recommendation Letter.” Peter and the CIO had talked about the promotion of employees from other teams. Peter suggested considering Susan, one of his subordinates, as a person deserving of promotion. The CIO asked Peter to write a recommendation letter and send it to him so that Susan could be included in the promotion process.

The first four items on the session form were non-routine. Item 5, the “TAPS team meeting” was regularly scheduled for each week. The meeting was held so that people collaborating in the TAPS project could discuss the status of the monthly release, report problems, and define plans. Similarly, the “Case Tracker Review” was a regular meeting that Peter scheduled with the developer of a system called Case Tracker.

Other issues arose as problems to be solved and were characterized as urgent. The “Troubleshoot user creation process” item referred to a problem that was reported by phone to Peter just before lunch. People at the accounting office were having problems accessing an application and requested immediate attention so they could continue their work. After receiving the phone call and trying to clarify the issue, Peter talked with Susan and together they worked out a solution. Then Susan walked over to the accounting office to help the users reconnect to the system. Later on, they met again to discuss the problem and found that the user creation process was not working properly. They defined some changes in the configuration of the servers so that the problem would not appear again.

4.2 The practical value of ensembles as conceptualizations of work

Our analysis shows that ensembles were useful in at least two related ways. First, they served to provide a frame of reference for workers’ actions. Ensembles make actions meaningful beyond the scope of short-term goals and help people map actions onto higher-level practical purposes. We noticed this mapping emerge as workers reflected about their actions. Sometimes the reflections occurred while the informant was alone with the researcher, but they were also expressed during interactions with co-workers while stating and clarifying how a particular action related to a higher-level purpose. For instance, David and Joe, two managers at Med-Admin, discussed the way to produce a particular report in a spreadsheet. David brought the issue up with Joe to tap Joe’s expertise on generating reports with spreadsheets. At the beginning of the discussion, Joe was not aware of the purpose of the report. For some time, the discussion centered on the *goal* of formatting the report in certain way. However, when David proceeded to ask Joe to work on the spreadsheet and help him generate the entire report, David referred to the ensemble of which the request was a part, saying, “*I’m doing this to project October revenue, the revenue monthly summary.*” When asking for help beyond just formatting, David brought into play the purpose of the ensemble—the October revenue summary.

A second way that ensembles were useful was in serving to envision and define workloads. Informants used ensembles to establish goals, then to define the particular actions to be taken. Ensembles were commonly represented in physical or digital artifacts. Some informants constructed and displayed lists of their ensembles and kept them handy to be consulted along the day as they progressed with their work. James, a project leader at IT-Services, kept a list of ensembles on a whiteboard in his cubicle. Referring to the things written there, James explained: “*Those are like my bigger projects and the things I have to do.*” He also had a notebook where he kept track of the specific actions for each ensemble. He took the notebook with him whenever he moved around the office to interact with others. This artifact supported his daily actions. As he explained: “[This is] *my notebook with the day to day stuff... Just to keep me straight and make sure I don’t forget anything.*” Figure 2 shows the detail of a section of James’s whiteboard and a typical sheet from the notebook. We can see that although the main use of the whiteboard was to represent

ensembles, some particular actions, such as “email to DAG group,” were also represented, but always framed within an ensemble, e.g., “Daily Cash Balance Upload.”

At both IT-Services and Med-Admin, we attended meetings where people presented their work to others in terms of ensembles, enumerating for each ensemble the effort required, the temporal frame, people involved, and expected outcomes. During those meetings, people discussed dependencies among co-workers’ actions and they negotiated schemes to optimize their efforts in the light of the involvement of others. For instance, John, an analyst at IT-Services, explained that it was during his team’s weekly meetings that he would start to define his scheme of work priorities. Because his work was mainly oriented to supporting developers, he defined many of his ensembles based on their needs: “So whatever they need support on, that’s kind of a priority, whether it’s writing a document and then doing testing...finding requirements, et cetera, and that’s defined in our Monday meetings.”

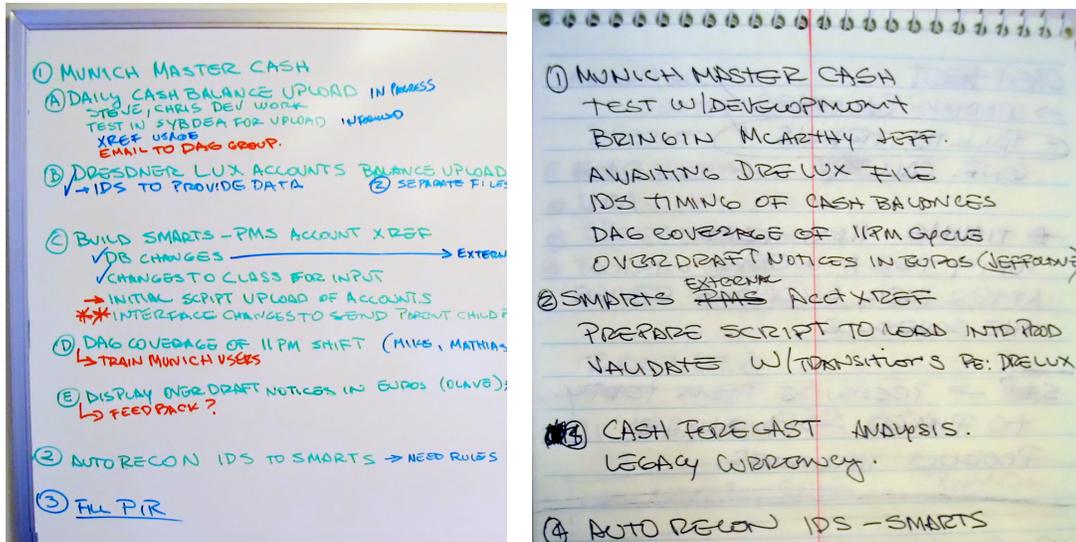


Figure 2. Detail of artifacts used to represent ensembles and actions.

It was often at the level of ensembles that people understood the work of others and evaluated it, as in this conversation between Jim and Bryan, two financial analysts at IT-Services. Jim and Bryan were talking about Andrew’s ensemble defining the specification for a software release for Atlantic Investments to support a special kind of financial transaction called “pair-offs.” In a pair-off transaction, analysts apply a special set of complex rules to validate operations. Andrew worked for many weeks to define the specification of the pair-off process:

Jim - Is Andrew around?

Bryan - Yeah, I think so, but he is working on the specs for pair-offs. Hiding, getting some work done (laughs).

By naming ensembles and referring to them as specific units of work, informants were able to distinguish and characterize the efforts in which they were involved and to establish shared notions defining the context of their collaborations. The mention of “specs for pair-offs” explained why Andrew would be “hiding”; the specs were a significant chunk of work that required his attention and the need to work privately. It would have been unlikely for Bryan to have said, “Andrew is hiding so he can write an email.” But reference to the “specs for pair-offs” made sense of Andrew’s need to remove himself from co-workers for a time. This ensemble was more than a simple action, yet not an activity.

5. A modified hierarchy of human activity

Based on this analysis, we see ensembles as a distinct level of activity that thematically connects sets of actions oriented toward the achievement of purposes that are broader than the goals of individual actions or simple chains. An ensemble can refer to efforts of limited duration such as implementing a fix for a

software component, routine work such as daily maintenance of equipment, events such as a training session, or long-term projects such as implementing a new operational procedure for a client.

In Figure 3, we present a proposal for a modified activity hierarchy for understanding the practical instantiation of activities.

Within this framework we aim to preserve the original definition of actions as proposed by Leontiev and to understand them as related to goal-directed processes which produce intermediate partial results generally enacted by single individuals (Leontiev, 1978). The goals of actions are achieved through operations that are adjusted to the specific circumstances and conditions of the enactment (Leontiev, 1978). Thus, for actions we understand the specific interactions that people have with artifacts and other people, for instance, interactions such as talking on the phone, writing an email message, or attending a meeting. However, we want to circumscribe the notion of action as a unit of work to describe the achievement of a particular goal. We distinguish individual actions from *sets* of actions that are thematically connected as the goals of each action accumulate towards a purpose. These actions may be ordered or unordered unlike Leontiev’s notion of a “chain of actions” by which he seemed to imply a string of actions to be carried out in linear order. Enacting a set of actions, enables the instantiation of purposes such as “design and implement a software component,” “define a contract for a client,” or “train employees in time-management skills.”

Activities	→	Objects
Ensembles	→	Purposes
Actions	→	Goals
Operations	→	Conditions

Figure 3 – A modified hierarchy of human activity

Our notion of ensemble identifies sets of actions thematically connected, oriented towards a particular purpose, and framed within an object-oriented activity. The partial results of realizing the goals of the actions are accumulated until finally a purpose is achieved. Ensembles differ from a simple chain of actions in doing the work of carrying purpose and meaning crucial for personal and collaborative human activity.

As with actions, people are consciously aware of ensembles. They may represent them on whiteboards, for example, and otherwise make them visible in personal workspaces. They talk about them to other people. In fact, it is our observation that people talk about ensembles much more than they do objects which are often unstated, assumed as background shaping of activity, or unconscious (Leontiev, 1978). As such, ensembles are an important means of structuring collaborative work as workers explain to others what they are doing. People need a way to communicate about work above the level of actions which are too low level, too divorced from that which immediately energizes work activity.

Ensembles are connected to objects motivating activity. The object serves as a guiding scheme directing the work needed to instantiate the object through specific ensembles. In the companies we studied, we found that ensembles were related to people’s objects in key ways through their job responsibilities. In interviews, many informants described their job in terms of the main responsibilities they were assigned. For example, Andy at IT-Services said, “*I am basically a programmer analyst. I write code, do analysis.*” “What are the main things you do?” we asked David at Med-Admin. “*The summary of that is I’m responsible for everything related to customers and internal employees after we make a sale,*” he said. Similarly, Chris, a manager from IT-Services, said, “*My main responsibilities are to make sure that all the road blocks are removed from my teammates, and that we move forward on the ongoing goals we set for Atlantic [Investments], and provide excellent quality support for people at Atlantic because it’s our client.*” These higher level objects expressed by informants reflected workplace responsibilities they took very seriously. We argue that objects such as creating software products, facilitating the work of others, supporting clients, and giving continuity to operations, represented not just a guide to define the “horizon of possible actions,” but also a guide to the horizon of possible ensembles needed to instantiate objects.

To illustrate this point, we analyze a party held at IT-Services. Bob was a manager of the Trading team, supervising four other managers, with a total head count of twenty-five employees. He threw a party for all the members of his team and their families. They gathered at a nearby beach, had a barbeque, played volleyball, and socialized. In the invitation email that Bob sent out, he mentioned that the purpose of the event was “*to celebrate the outstanding effort of [the] team this year*” (see Figure 4). During casual

conversation before the party, Bob commented to the researcher that he wanted to have the party as a way to motivate his people and increase communication among them. In a later interview, Bob referred to one of his most important job responsibilities as keeping the team working together and motivated. Thus, the *motive* of the event was primarily to enhance the well being of the team, with the specific *purpose* of celebrating the team's efforts for that particular year. Notice that Bob did not express the motive of his object in the email invitation, but rather the *purpose* of the ensemble. We believe that such purposes are important means by which people make collective activity sensible and meaningful and by which they engage shared purpose. Ensembles are grounded in localized purposes rather than the grander motivations that orient activity. Referring to the celebration of "outstanding efforts," and packaging the celebration as a collective ensemble, was a meaningful way to instantiate Bob's object in a way that made sense to workers and was congenial with their work practice.

██████ Systems Team Party

The management team is looking forward to our team party tomorrow to celebrate the outstanding effort of team this year. We are looking forward to getting together with friends and family. The forecast is cloudy tomorrow, but we are going ahead with the party as planned. Below is a summary of the RSVPs for the party. Everyone is welcome whether you have RSVPd or not.

We would like everyone to bring something to the party to help out. I have made assignments summarized below. Please let me know if you will not be able to bring what you have been assigned.

Please come in early tomorrow if possible to offset some of the time we will be out of the office

██████ will arrive at the beach around 2 PM to begin setting up. From 2:30 PM to 5 PM we will have snacks and drinks and just hang out. We will start cooking dinner around 5 PM, probably eat between 5:30 and 6 PM. The volleyball team's game will start around 5:30 PM. The games are always a source of good humor for all.

Directions: From PCH in Corona Del Mar turn on Marguerite towards the coast. Marguerite ends overlooking Big Corona Beach. You can park up top for free or drive down to parking on the sand. Parking costs \$6 per car.

Please don't discuss the party with people outside our team. Please be careful about leaving this print out on the printer for all to read. Please change down at the beach rather than here at the office. This will help avoid the publicity that ████████ Systems is having a beach party while the other groups will be working through the end of the day. There is a bathroom down at the beach where you can change.

Coverage

STP coverage – PK through 5 PM or completion of STP trading (between 4 and 5:30 PM typically)– direct STP calls to cell phone after 5 PM

ACE coverage – ████████ through 5 PM

STP recon – ████████ following the party to ensure all BB trades were published to SMARTS

Figure 4 – The invitation to the Beach Party

The discovery of ensembles suggests that there is something more than objects needed to direct actions. In everyday activity, people instantiate objects not just from motives such as "motivate my workers" but also from intermediate ensembles that are closer to the actions that must be taken such as having the party. As Bob's party indicates, there may be multiple reasons why ensembles are useful.

6. Discussion

In this section we discuss how the notion of ensembles can aid our understanding of the dynamics of activity instantiation. In particular we are interested in how people decide what to do next given multiple responsibilities, how they move up and down the activity hierarchy, and the transformations that activities undergo over time.

6.1 The guiding power of ensembles: knowing what to do next

How can people choose from among the many actions that could be taken at a given time? While workers managing multiple activities in modern corporate settings are perhaps an extreme case of the need to make such choices, it is not hard to find a similar need if we consider, for example, a mother managing childcare, housework, and craftwork, a farmer attending to plants, animals, and hired help, or a building contractor overseeing the construction of a new building involving recruiting and supervising workers of different trades, ordering materials, and cooperating with architects and building inspectors. Given multiple activities, how does anyone know what to do next? We believe that people are attentive to the guiding purposes of ensembles and that the purposes framing sets of actions provide important information about what to do next.

Our finding was anticipated by Leontiev. He observed that “[A]ny kind of well developed activity presupposes attainment of a series of concrete goals, some of which are rigidly ordered” (1979). Leontiev saw the need to consider sets of related goals, even some with well-defined ordering. He appears to have felt as we do that the means by which people know “what to do next” was not explained in activity theory and had scarcely been studied:

One question which now arises is that of goal formation. This is a big psychological question because the range of objectively adequate goals depends upon the motive of activity. Almost unstudied is the process by which a goal is picked out and discerned objectively, i.e., by which one becomes conscious of the most immediate result to be obtained if the whole activity is to be realized, which can satisfy the desire objectified in the motive. (Leontiev, 1979)

Leontiev went on to note that in experimental research the goal is pre-specified, so the means by which goals take shape cannot be observed. Goals are not simply “an act of will,” said Leontiev; they are “given in objective circumstances.” This is consistent with the idea that ensembles respond to the particulars of the circumstances in which people work as they fulfill requests, follow project timelines, and so forth. Leontiev spoke of the “discernment of goals” as requiring an “object-type ‘flushing out.’” The purpose behind ensembles might be something like the “object-type” working out of goal formation Leontiev sketched.

In Leontiev’s (1978) discussion of “the general structure of activity” he used the word purpose and connected it with action: “[J]ust as the concept of motive is related to the concept of activity, the concept of purpose is related to the concept of action.” However, later he spoke of “goal directed actions,” so we might think that he used purpose and goal synonymously. However, still later he provided an example we might consider an ensemble and connected it to a purpose: “The purpose of a given individual may be preparing equipment for fishing; regardless of whether he himself will use the equipment he has prepared in the future or give it to others and obtain part of the total catch.” (Leontiev 1978). If we assume that “preparing equipment for fishing” was composed of a set of actions, and, if we assume that this was done for a particular group of fishermen with whom the individual collaborated, we might argue that this example points to our notion of ensembles. Interestingly, Leontiev connected a purpose—not purposes—to a set of actions

Leontiev (1979) argued that actions are not immediately motivated by objects because of the division of labor. In his famous example of the primitive hunters, he pointed out that those beating the bushes were motivated by the need to obtain food, but the actions of scaring the animals away—actions apparently the opposite of obtaining food!—only made sense with respect to the larger activity with its division of labor in which hunters were waiting to kill the animals the beaters flushed out. With this story, Leontiev provided an analysis that revealed a gap between action and object. What we observed in our research is that this gap is, at least in some cases, structured by ensembles. The dissociation between goal and activity resulting from the division of labor observed by Leontiev does not appear to us to characterize all collective activity. We found that people direct actions according to explicit purposes expressed in ensembles. They do not simply refer back to the highest level motives of an activity. Indeed we cannot see how such general objects as “motivate my workers” could help a person figure out which action, or set of actions, to take at a particular time “in objective circumstances.”

What we can see is how someone could know what to do next given the mediation of artifacts organizing ensembles such as James’s whiteboard. The supportive role of ensembles is evident in James’s list of ensembles inscribed on the whiteboard in his cubicle. James usually began his day by looking at the ensembles on the whiteboard, then making some annotations in his notebook about the specific actions to be performed that day. In this way, the ensembles served to guide and plan his daily actions. We noticed that as James went about his work, he used his list of ensembles to maintain focus. Coming back from meetings, or after lunch, he consulted the whiteboard and updated it with information from his notebook, and then continued working. We observed that many other informants used similar strategies where ensembles served to support decisions about what to do next, given particular circumstances.

Leontiev (1979) stressed the importance of the human ability to dissociate object and action in order to accomplish collective objects through the division of labor, as in the hunting example. While such dissociation is certainly important, Leontiev’s example is a didactic one constructed to make a specific point, not to cover all possible instantiations of human activity. We can well imagine the beaters knowing what to do next, keeping in mind the motive of food. But in many real life settings, such as at IT-Services

and Med-Admin, work is not so simple. The gap between action and activity is considerably larger than among the primitive hunters. Because workers undertake multiple ensembles and activities, ensembles must be sensibly aligned. In part, the purpose of an ensemble provides guidance about what to do next through making sense of a particular ensemble with respect to other ensembles. The party invitation, for example, suggested exactly how and when to change clothes in order not to create conflicts with the ensembles of others in the office. Others would be “working through the end of the day” attending to their own ensembles. The purpose of the beach party (to celebrate the year’s efforts) was important enough to warrant holding it even though it involved the risk of others finding out.

This risk was mitigated through the actions of changing clothes at the beach, not in the office. Such actions would not be sensible solely with respect to high level objects such as “provide excellent quality support for [clients].” This object applied to everyone in the office, yet it could not serve as an explanation for the need to change at the beach. If one digs deep enough, there was indeed a connection between changing at the beach and the company’s collective object of supporting clients. But had the manager said, “change at the beach to provide good quality support for our clients,” or referred to a similar object, it would have been nonsensical. Ensembles comprise immediate references to the ongoing flow of work activity, providing important means of sensemaking with respect to local conditions.

6.2 Transformations along the activity hierarchy

As Leontiev specified, levels of activity can transform into one another. Logically, a transformation between action and activity entails quite a gulf. Does it really make sense to speak of a progression from the action of sending an email to the activity of taking on a new life project? It is easier to envision how such transformations might happen with reference to ensembles, that is, how people might go from participating in ensembles to working out new objects. It is also possible to see how motivated activity could shift down into ensemble as an individual’s priorities change, as life circumstances alter.

An example of ensembles transforming into activities comes from Bob, manager of the Trading Team at IT-Services. One of Bob’s ensembles was related to a new quality and optimization program called Sigma. The program was adopted to optimize production lines, human resource management, and software development processes. Bob participated in meetings and exchanged email about Sigma to learn about it. Months later Bob mentioned that he had switched jobs and now was working full-time in the Sigma Program. As this project had evolved and become more relevant for the company, Bob was promoted and assigned a leadership role in the effort to implement Sigma in all departments of IT-Services. As an ensemble, the Sigma project had the purpose of investigating a new methodology and obtaining ideas to improve software development practices. But as the company and Bob became more involved in the philosophy behind Sigma, they embraced it and aimed to achieve a new object: the continual improvement of all work processes at IT-Services through the use of the Sigma system.

6.3 Ensembles transformed into other ensembles

We have discussed connections between actions and ensembles and activities and ensembles. In this section we discuss connections between ensembles, the way an ensemble may be transformed into another ensemble. For instance, because many of the software projects at IT-Services required the development of interdependent software modules, and because it was not possible to work on more than a few for each monthly release, some developers distinguished among each release as a different ensemble. That was the case of the TMS (Trade Management System), a complex project developed through a series of incremental monthly releases. Many of the releases were devoted to the integration of particular functionality (e.g. “pair-offs” or “settlement instructions”), and it was common for developers and analysts to use names such as “the pair-offs release” or “the settlement instructions release” to distinguish among them. In practice, each release was independent as they had different schedules, users and requirements, but due to the interdependencies among the software modules, and the cumulative development of the software (some modules were based on others), these ensembles remained connected, one resulting from the other. The purpose of each ensemble was different as they aimed to implement different functionality, but they were motivated by the same object: provide support to the client. Consequently, each month the object-related activity of providing support to the client remained the same, but the way the object was achieved and instantiated was transformed according to the specific purposes of the ensembles.

We also noticed that ensembles sometimes transformed from one kind to another. For instance, in many cases, a problem, once solved, became another kind of ensemble such as a project. A common practice at IT-Service was to solve problems with the production systems by applying temporary patches to

restore system function as soon as possible. Having provided a solution that let financial brokers continue their work, the systems were monitored for some time (days or weeks). Once the problem was fully identified, it became a project for the database administrator or systems engineer who would work out a permanent solution.

Another example of such a transformation was a request turning into a project. One of Peter's ensembles involved a request from another department to create an inventory of software applications in the company. An employee from the department came to Peter's office for advice. He helped her identify documents in the company's network archive that contained useful information. During an interview with Peter we talked about this request, and he mentioned that a few days later it became a project for his team. He had additional conversations with the employee about the inventory, and they realized that the request would require some programming. Peter decided to make the request a formal project and assigned it to one of his developers.

It is perhaps not surprising to find such lateral transformations from one type of ensemble to another because of ensembles' intermediate placement in the activity hierarchy. Objects are stable, providing long-term orientation; thus they change infrequently (Engeström, 1995). Actions are completed relatively quickly and are more discrete and bounded than activities or ensembles. Ensembles are the "middleware" of activity, offering more flexibility than objects, but more purposeful structure than actions. A goal associated with an action is not laden with meaning and sense the way the purpose of an ensemble is. A goal sets up an action, such as formatting a spreadsheet report, expressing little about the larger meanings of the action. Ensembles introduce purpose and sense, but in a way amenable to transformations such as taking a problem and turning it into a project. Ensembles signify purpose with both the immediacy and vividness of the local, and connection to larger meanings of object-related activity. It is possible that the purpose of an ensemble functions in part as a metonym for its associated object, in the sense of evoking the whole through a local manifestation. Further research is needed to investigate this possibility.

6.4 Adding another level to the activity hierarchy

In proposing another level to the activity hierarchy we must ask, "Is this useful and necessary?" The tri-level activity hierarchy has guided research for decades.

As we have discussed, it is evident that researchers are struggling to articulate the phenomena we have identified as ensembles (e.g., Bannon et al., 1983; Cypher, 1986; Henderson and Card, 1986; Norman, 1998; MacIntyre et al., 2001; Bellotti et al., 2003; Kaptelinin, 2003; Czerwinski et al., 2004; Bardram, 2005; González and Mark, 2005; Jones et al. 2006; Rattenbury and Canny, 2007). There is a convergence in the literature that this level exists and is not represented theoretically. Kaptelinin (2006) suggested that using activity theory in empirical studies of the human use of technology has pushed the traditional hierarchy to some limits in its application to the complexities of this arena. Much previous application of activity theory has been in classroom settings where focus on teacher-student interactions yields to simpler models. One reason, then, to add the level of ensembles to the hierarchy is the grounded need arising from empirical studies of technology use in many domains spanning over twenty years of research.

Another reason is to focus more clearly on sensemaking (Kaptelinin, 2005). Actions are represented by simple goals. They do not emit the emotional resonance of ensembles. Motivation is essential to human activity and is central to activity theory. At the highest level of activity, motives may be unconscious. They may refer to long-term motives. They do not articulate the sense of everyday activities. They do not allow collaborators to talk about what they are doing in meaningful ways. Our observations, and those of many others, suggest that sensemaking is a fundamental aspect of activity. We need to be able to identify a level of activity in which everyday sensemaking is revealed.

An alternative to adding another level to the activity hierarchy is to differentiate the level of actions. Kaptelinin (2006) suggested this possibility. He observed that "[A] differentiated representation of the level of actions opens up the possibility for developing a flexible, multidimensional structure. Actions can differ along a number of dimensions. Their goals/purposes can be more or less directly related to motives of activities. But actions can also be novel or habitual, collective or individual, mediated by different technologies."

This suggestion underwrites our argument that there is a need to elaborate the overly spare activity hierarchy. It is possible that some combination of these approaches—adding ensembles to the activity hierarchy and differentiating actions—will be fruitful. Making sensemaking more visible through a notion of ensembles as well as differentiating the internal structure of actions may provide the kind of practical help in applying activity theory that seems needed. The goal of this paper has been to suggest the

conceptual work that we believe a concept of ensemble can perform. Deepening understanding of different dimensions of actions as suggested by Kaptelinin (2006) also seems a promising direction.

Such an approach may be required in particular in human-computer interaction and computer-supported collaborative work research. As activity theory itself develops, its application in varying domains and practices is a source of expansion.

7. Conclusion and Future Directions

The development of the notion of ensembles is grounded in the practices of informants observed at IT-Services and Med-Admin, and derived from an interplay between the methods provided by the grounded theory approach (Strauss and Corbin, 1998) and the framework of human work defined by activity theory. Through the comparative analysis of data from different informants, we were able to move from particular cases to more general characteristics defining the notion of ensembles. Then, we used concepts from activity theory as a guide for revealing the essence of the notion of ensemble and to orient the analysis towards the exploration of issues not adequately addressed in studies of human-computer interaction and computer-supported cooperative work. The combination of grounded analysis with the guidance of the activity theory framework provided a way to consolidate results beyond descriptions and to contribute to the further development of the understanding of human work.

As part of the future development of the concept of ensembles, we perceive its potential to connect individual with collective perspectives. All activities are the result of the social nature of work even if not carried out collectively (Leontiev, 1979; Kaptelinin, 2005). In the same spirit, ensembles might be not carried out collectively, but are all social. To conceptualize a work effort as an ensemble, the individual must consider not just what is meaningful for him or her, but what can be meaningful for others. Thus, though names for ensembles such as “Daily Cash Balance Upload” were inscribed on a personal whiteboard, they were also used during meetings to refer to the specific ensemble; they conveyed shared meaning for co-workers. More investigation is required to understand how, from a collective perspective, work efforts were conceptualized as ensembles and the way ensembles were understood by different individuals.

It is possible that ensembles are a way to allow contentious personal objects to co-exist in a work environment by having workers focus on lower level purposes rather than individual objects. Individual objects—such as power, prestige, and money—may destabilize collaboration if workers’ become resentful of others’ attempts to advance personal agendas. Purposes, more closely aligned with the particularities of work and a local setting, may permit a kind of “professionalism” that would be broken by too much attention to personal objects. Further empirical investigation is needed to explore this possibility.³

In Leontiev’s work, the gap between objects and actions is problematic, as discussed. The gap, albeit a smaller one, still remains between objects and purposes. Given a high level object, how do people formulate specific purposes? We believe this will be a difficult question to answer, one requiring careful empirical inquiry.

We believe that the notion of ensembles can be useful for the development of computing infrastructure oriented to more effectively supporting work activities. Designers in HCI and CSCW have already been engaged in efforts to move from application-based to activity-based forms of computing (Christensen and Bardram, 2002; Moran, 2003; Bardram, 2005; Czerwinski and Kaptelinin, 2007; Bailey et al., 2007; Gotz and Zhou, 2008). Some of these efforts have revealed the need to support activity management and to understand the nature of human activity (Moran, 2003; Harrison, 2004). We feel that the notion of ensembles can benefit not only the design of systems to support activity management but also it can be used to design systems and methodologies that can enable a deeper understanding of user behavior. Some technical designers have realized the importance of understanding user behavior at different levels of granularity. Gotz and Zhou (2008) have proposed a model based on Activity Theory that can be applied to study users’ actions and rationale in the course of visual discovery. While Gotz and Zhou have developed a method for identifying what they term “semantic building blocks” that are general and applicable across a variety of domains, the notion of ensembles could be used to gain more insight into distinct forms of work. Thus, evaluating system use in terms of users’ effort in different ensembles can provide substantial benefits in the field of HCI.

³ We are indebted to Tye Rattenbury for this point.

Finally, a notion of ensembles as part of the activity theory hierarchy can help designers in designing systems for user experiences, expanding the focus on particular tasks. It provides designers with a wider set of lenses for understanding user activity. For example, designers can use a top-down approach identifying first the object of a user experience (e.g., “providing optimal care and treatment for patients”), and then focusing down the hierarchy of activity to purpose-based ensembles required to achieve the object. This can lead to the refinement of analytic tools such as the Activity Checklist (Kaptelinin, et al, 1999). The addition of ensembles can also help researchers understand better reasons for technology adoption, i.e. their role in working on ensembles.

Activity theory is an open body of theory, unfinished and in need of continuing enrichment and expansion. As further work is conducted using the notion of ensembles as an analytical tool, we believe we will be able to discover additional benefits of this concept to describe the practical instantiation of activities and to understand human work.

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