

Activity: Analysis, Design, and Management

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ABSTRACT

Activity is a foundational issue in interaction design. We view activity not as an analytic concept for designing artifacts, but as an object itself to be designed for. People think of their work lives as organized into activities – they not only carry out activities, but also they *manage* them – they plan, prioritize, schedule, interrupt, resume, delegate, report on, etc. We are exploring the design of computational support for activity management.

A case study of a complex activity is presented. It shows that subactivities vary from the formal, scheduled, and sequential to the informal, opportunistic, and parallel. The activity was explicitly represented; and this representation was reused to refine the activity in subsequent years and to hand the activity off to another person. From a series of ethnographic interviews we found that people put a lot of effort into planning their activities. People occasionally plan for the long-term: lay out goals, milestones, resources, etc. But every day people juggle what they planned to do with unanticipated daily demands. There is great variability in people's planning practices.

The basic hypothesis of our work is that a platform for explicitly representing activities as personal and social activity structures will provide many benefits, from personal productivity to interpersonal coordination to organizational learning and adaptation. Beginning our investigations with personal activity management tools, we present a series of design studies of an Activity Tableau, a freeform space for jotting down, monitoring, and organizing activities. This flexible kind of tool supports both the planning and the emergence and incremental articulation of activities.

The concept of activity is so fundamental that activity representations can be used for many different functions. In addition to planning, we aim to support the *carrying out* of activities, which involves handling resources: people, email, documents, tools, etc. Activity structures can link to resources so that they are at hand. We also aim to provide lightweight coordination by sharing activity structures among people. Activity sharers have access to viewing and changing activity structures, and these changes are synchronized between people. The flexibility of this scheme supports both ad hoc collaborations and semi-structured activities. We are also exploring connecting these activity structures to workflow systems, where shared activity

structures are the interface between people and formal workflow processes. Finally, we are exploring the notion of reusing and refining activity structures to provide a basis for end users to design activities.

1. Activity in Interaction Design

The notion of *activity* is a foundational concept in interaction design. Interaction design is about creating artifacts, which are usually computationally empowered to provide interactive capability. The artifacts are designed to be used (or experienced) by people. Let us call this the use *activity* (or “experience activity”) that surrounds the artifact, where the artifact is a resource for carrying out the activity. This is the narrowest sense of activity, where the focus is on the interaction between the person and the artifact. The concern here is for such issues as the usability of the artifact, with minimal regard for the context of the use activity.

A broader notion of activity includes the larger context of the many different activities in the organizational and social setting. Let us call these the *context activities*. The focus here is the relationship between the different activities and people. Here we are concerned with such issues as the usefulness and the role of the use activity in the activity context.

Various user-centered design methodologies in human-computer interaction provide techniques for studying use activity (e.g., Preece et al., 1994). Various perspectives provided by the behavioral and social sciences, such as distributed cognition (e.g., Hutchins, 1995), activity theory (e.g., Engestrom et al., 1999), or ethnography (e.g., Suchman, 1987), provide perspectives and methods to study the context activities and methods for designing for context (e.g., Beyer & Holtzblatt, 1998). While there a broad array of theories and perspectives (e.g., Carroll, 2003), in all of these activity is treated as an object of analysis for the purpose of designing an artifact, and well as redesigning some of the activity context of the artifact. This is how we usually regard of the concept of activity in design.

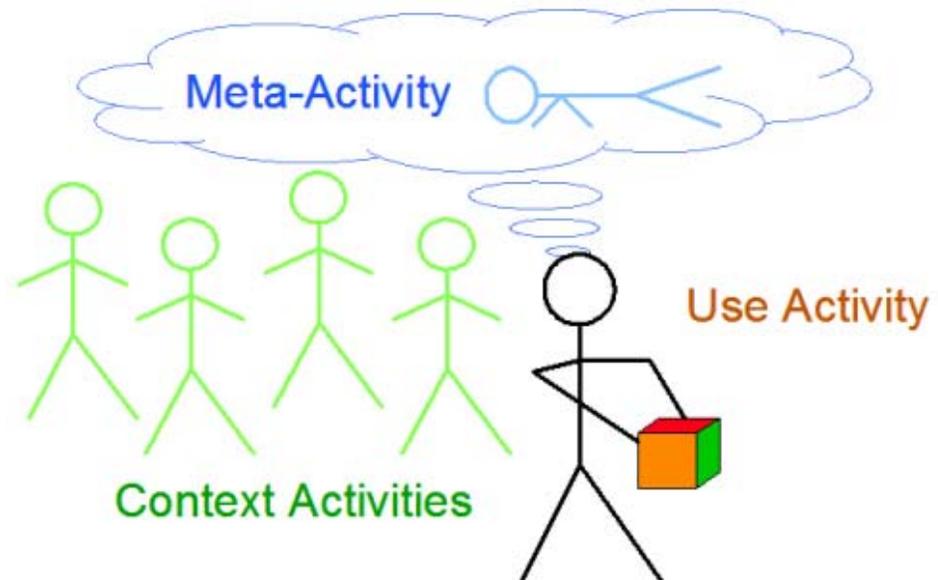


Figure 1. Various Senses of Activity.

2. Activity Management as Meta-Activity

Let us step back and consider activities more generically, not from the perspective of the analyst or designer who is concerned with designing artifacts, but from the perspective of the person carrying them out. Imagine a person reflecting (looking down from above, as in Figure 1) on the multitude of activities that he is involved in. In order to carry out the various activities, the person has to *manage them*, e.g. to plan and prioritize them. Activity management consists of generic *meta-activities* that act on different specific activities. Such meta-activity is an inherent part of any activity.

People carry out activities to accomplish specific objectives, from the serious (running a business meeting) to the playful (doing a crossword puzzle). The actions that accomplish the specific objective are the “real work” of the activity. We can call these “real work” actions the **execution** of the activity. The management meta-activities support the execution:

- Before one can execute an activity, it must be **set up** (e.g. assembling the resources to be ready to use).
- Before one can execute an activity, one must **remember**, or be reminded or alerted, or seize an opportunity to do it.
- When one is doing one activity, he must often peripherally **monitor** his other activities to be aware if they are in need of attention.
- One must **respond to the unanticipated** activities that require attention.
- When another activity needs attention, the one must **context switch** from the current activity to the other activity.
- When one has many activities, one must **plan, organize, and prioritize** them and **set up to be reminded** of them at the appropriate time or in the appropriate context.
- When one has many activities, it is often beneficial to have an **overview** of the state of the various activities.
- Finally, one must often **account** for activities by reporting or documenting them.

We are exploring the idea of providing generic support for these kinds of activity management meta-activities. Given this broad definition, many different computer tools address activity management, but they do it in a localized and ad hoc way. Personal information management (PIM) tools provide to-do list facilities to help the individual keep track of tasks. Groupware tools provide shared repositories that include shared task-list tools for coordinating group efforts. Project management applications provide tools for scheduling and synchronizing the activities of project teams. Workflow systems provide facilities for developing and running business processes, thus “choreographing” the activities of people across an organization. While

these tools are all in use, people have problems with them. The personal and group tools tend to be tedious to use. The project and workflow tools tend to be overly formal, overly rigid, and/or coercive (Abbott & Sarin, 1996). Perhaps the biggest problem is that all these tools take a limited view of activity, each focusing on particular meta-activities. From a user's perspective, activities cut across all these tools; and having to deal with many tools makes activity management more difficult.

3. What is an Activity?

Let me start by offering a partial definition of activity considered generically, for purposes of capturing what people mean by activity and providing a basis for systems to represent it.

An activity is a set of (mental or physical) actions carried out by people.

- The actions do not have to be contiguous in time, but they do have to have coherence in order to be considered an activity. There are at least two kinds of coherence. An activity is *conceptually coherent* if the actions are directed to the same goal, such as a project. The actions may be diverse, but they are coherent because of they support the same goal. An activity is *contextually coherent* if the actions share a context, such as a meeting where many conceptually-distinct issues may be discussed. The coherence is of a different kind; the convenience of the shared context gives coherence, at least temporarily.
- Activities are related to other activities. The most important relation is *composition*. An activity can have subactivities, which can have sub-subactivities, and so on. It is a practical matter how far we want to articulate the decomposition. An activity provides a context for its subactivities. Also, an activity can have multiple parents (super-activities), because of the different kinds of coherence (e.g., a discussion activity can be a subactivity of a meeting activity as well as of a project activity).
- Thus it follows that activities can be at *different time scales* – months, days, minutes. Again, it is a practical matter (of activity management) as to which of these are worth articulating.
- An activity utilizes a set of *resources* – people, tools, objects, information – in order to carry out the activity. Accessing and organizing the resources is a large part of managing an activity. (See Kaptelinin, 2003, who proposes a scheme for automatically linking resources to activities by monitoring user actions.)
- Another relationship among activities is that they *share resources*. In particular, different activities must be carried out by the same person. This, for the person, is the activity management problem – how to share his limited time and attention among the various activities.

Note that this definition of activity is from a *person-centered*, from the viewpoint of a single individual. This does not imply that activities are not social. A social or collaborative activity is characterized from the perspective of each of the individuals involved. A socially activity involves the interrelation of activities of individuals. Often the interrelations can be characterized by the notion of different roles that the individuals play.

4. Example of an Activity

To better understand the concept of an activity, consider a concrete example of a fairly complex activity – chairing an awards committee for the ACM SIGCHI (Special Interest Group for Computer-Human Interaction). This was a real activity which I carried out during the last two years. The activity described here occurred over a period of four months in 2003. The analysis presented here was derived from the various materials that I created *during* the activity. Most of the work was done via email (plus two phone conferences). The activity involved several people – committee members, SIGCHI officers and administrators, CHI conference officers, and an assistant.

Figure 2 shows a data display of the activity. The shaded items on the left represent the activity-subactivity structure in outline format, derived from my email folder structure. One subactivity, “decision process,” is expanded in the middle of the figure. To the right of these subactivity items is a table showing the resources for each subactivity. The first column shows the number of emails involved in each subactivity. The second column gives icons for the people I had to contact or work with in each subactivity. The third column lists the key documents created and used in each subactivity.

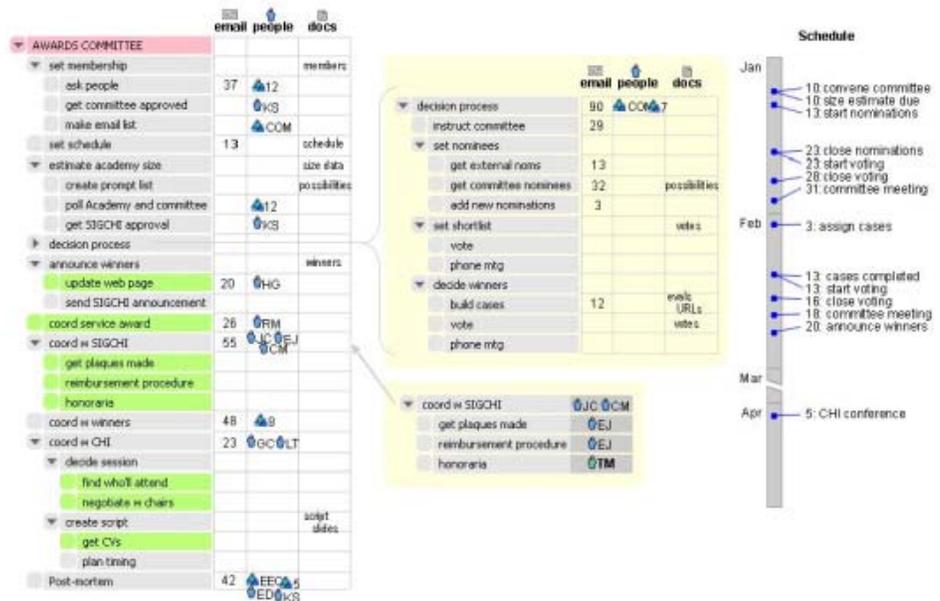


Figure 2. A Complex Activity: Chairing an Awards Committee.

This activity was basically composed of four subactivities:

Chair awards committee

- 1. Set up the committee**
- 2. Decide on the award winners**
- 3. Announce, coordinate, present, ...**
- 4. Handoff chairmanship to next chair**

These subactivities were logically sequential – for example, I could not announce the winners until the committee’s decision process was complete – although there were minor overlaps. Each subactivity had a distinctly different character:

1. *Setup*. First I had to set up the committee by recruiting people for the committee and, in parallel, working out a fair and efficient decision process for the committee. This process was a refinement of the process I had used the previous year. The materials from the previous year were used as a sort of checklist for defining the current process.
2. *Decision Process*. I had to manage the sequential decision process itself, which was fairly formal and had to be run on a tight schedule (shown on the right of Figure 2). Committee members were assigned specific research and voting activities during the process. Their work was communicated by email and collated into a few key documents. This was used to structure two phone meetings for discussing and finalizing the decisions on the award winners.
3. *Announcements, etc.* There were several post-decision subactivities, which were run mostly in parallel with each other. These involved making announcements, working with SIGCHI on award plaques and reimbursements, negotiating with CHI Conference officers for an award presentation slot, creating the presentation, and finally presenting the awards at the CHI Conference.
4. *Handoff*. A couple months after the presentation I handed off the job to the newly-appointed committee chair. This was important for continuity of the awards process. The handoff involved giving him the key documents and key contacts, and thoroughly discussing the various subactivities, the key issues and problems, and possible revisions in the process.

Running the awards committee required considerable effort to do my parts of the work, which came in bursts of activity. But my main effort was the activity management that required continual attention to keep the activity progressing. From a personal point of view, the committee activity was only part of my activity management. I had to interleave the committee activity with my job and home activities during this period. Thus, this is a typical activity management situation for most knowledge workers.

5. Studies of Activity Management

When we started this project a year ago, we were focused on personal time management and calendaring. We conducted three ethnographic

studies, consisting of over 30 interviews of people inside and outside of IBM. From these, we identified a dozen time management issues, and we decided to focus on the issue of planning – how people cope with mostly *unscheduled* tasks.

The interviews revealed that people put a lot of effort into planning. Planning ranges between two extremes. At one end, people engage in long-term planning, laying out goals and subgoals, milestones, budget, people, resources, risks, etc. Long-range planning is a considerable task in itself. People only do this occasionally – yearly planning, creating proposals, project startups, etc. At the other extreme, every day people juggle what they planned to do with unanticipated daily demands. This hardly seems to be planning, but more like continuous adaptation. Some people step back every week or so to look at the intermediate term. There is great variability in people's planning practices.

People use a multiplicity of tools, both electronic and physical, for planning. Electronic tools – from standard calendar and to-do tools to quirky ad hoc customizations – are generally problematic. The electronic tools are not coordinated with each other, and they are available only when people are at their computers with particular applications open. Physical tools – from paper to-do lists to post-its stuck on computer displays to plans written on whiteboards on walls to paper piles on desks – seem to be more satisfactory, or at least more comfortable. To-do items function mainly as reminders and are thus distributed in the natural flow of work, in both the physical and electronic world, which is a prospective memory heuristic (Brandimonte et al., 1996). A task list on a whiteboard is seen every day, often by several people, which helps with awareness and coordination.

Many people use their email inboxes to manage their activities. It is interesting to consider why:

- Email is the place where new activities are initiated, such as requests in incoming email.
- Many activities are carried out through email. That is, email serves as the main resource for many activities.
- Email headers serve as a reminder of the current state of various activities conducted through email.
- Email is where many people spend much of their online time; it is their "habitat" (Ducheneaut & Bellotti, 2001). Thus the representation of activity is usually "at hand."

That is to say, email provides baseline support for many of the meta-activities involved in activity management. See Bellotti et al. (2003) for a proposed redesign of email to more directly support task management.

We can illustrate some of the important temporal properties of activities that emerged from our studies by laying out a timeline, as shown in Figure 3. An activity comes into being when a **need** to do

something arises. If a person cannot do it immediately, then he may **plan** to do it some time later. Often this takes the form of a *planning interval*, during which the person intends to do it. The planning interval is not a scheduled time to do it, but a fuzzy time interval (“do it next week sometime”). The planning interval should be distinguished from a **deadline**, which is an externally-set time for the activity to be completed. Later, the person must **remember** to do the activity. This can be purely a memory recall, or the person can be reminded by some sort of to-do artifact, as discussed above. Now the person can **execute** the activity. Often an activity cannot be completed in one “sitting.” The execution must be accomplished by intermittent bursts of work on it. An activity often has to be accounted for, such as a **report** on it, which can be done long after the execution.

Most people are engaged in multiple activities at any point in time, illustrated in Figure 4 as parallel, overlapping activities. Multiple activities are complex to manage. This is why the execution of a given activity is intermittent – one is switching between activities to keep them all going at once. This presents the issue of dealing with multiple activity contexts. Also, when one is focused on a particular task, there is the need to peripherally monitor the other activities to know when they need attention.



Figure 3. Lifecycle of an activity.

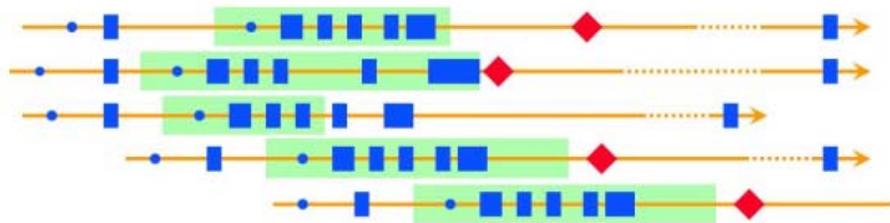


Figure 4. Multiple Overlapping Activities.

6. Representing Activities

Our goal is to provide generic support activity management. To do this we claim that activities have to be explicitly represented electronically. Call a representation of an activity an *activity structure*, which at minimum consists of:

- An informal *description* of the activity,
- a hierarchy of *subactivities* (also allowing for multiple parentage),
- a collection of *resources* (people, tools, documents, etc), and
- properties for *process semantics* (planning times, deadline, status, dependencies, etc.).

(There are many other important generic properties of activities, but we will just consider these in this paper.)

Activity structures vary from informal to formal and from simple to complex. An example of the simplest activity structure is "buy wine." Jotting down these two words (with an appropriate tool) creates a full-fledged activity structure. This simple activity structure functions as a reminder to stop at a store. This activity structure could be elaborated slightly by a pointer to a recent article recommending wines, which serves as a resource for the buying activity. An example of a complex activity structure is the one representing the awards committee activity described in Figure 2. Activity structures typically evolve and become more elaborated as the activities progress. For example, I had the simple item "awards committee" in my to-do list for months to remind me that I had to get the committee work going. Once started, the activity structure (or rather, the set of artifacts I used in place of an explicit activity structure) expanded quickly.

It is important to be clear on the relationship between an activity and its activity structure. An activity structure is not meant to be a description of the activity – an analytic product, such as an ethnographic account of the activity. It is a resource for managing the activity (cf. Suchman, 1987). People will not do more work than they have to, and they will describe the activity only to the extent that descriptive accuracy helps them manage the activity. Ease-of-use is one issue. A fluid and flexible tool for jotting and organizing activity structures will lower the barrier of creating them. Some situations naturally call for more elaborate activity structures. For example, if an activity structure is shared among several people in order to coordinate their efforts, then more descriptive accuracy is useful to make clear their respective roles.

The basic hypothesis of our work is that providing a platform for representing activities as personal and social activity structures will provide many benefits, from personal productivity to interpersonal coordination to organizational learning and adaptation. This is a tall order. We are beginning by exploring a personal activity management tool.

7. An Activity Management Tool

As mentioned above, we began by considering time management. An early mockup is what we called the "Planning Tableau," shown in Figure 5. In this envisionment, the calendar was the central tool, and it was located in the middle section of the tableau. A space for goals and to-do's was in the left section, and a space for other calendars was in the right section. The theme of the tableau was to lay out a person's *intentions* (goals and to-do's), *commitments* (scheduled events), and *possibilities* (events from other calendars that might be of interest). The idea was to facilitate the easy movement of items across the sections of the tableau, such as events being dragged from other calendars to the central calendar. But we became most intrigued by the relationship between scheduled events and unscheduled, or vaguely scheduled, goals and to-do's, which we have come to call activities. The intentions section of the tableau has a vague two-dimensional spatial semantics. Activities on the left are higher-level

goals that are not very time bound (e.g., an activity for this year). Activities on the right of the section (near the calendar) are more closely related to time. For example, the activities bunched up near the Today section of the calendar are intended to be dealt with today. As an activity is moved leftward, it is less bound to a specific time. Activities can also be linked, as sub/super-activities. An activity can also be linked to a calendar event. For example,

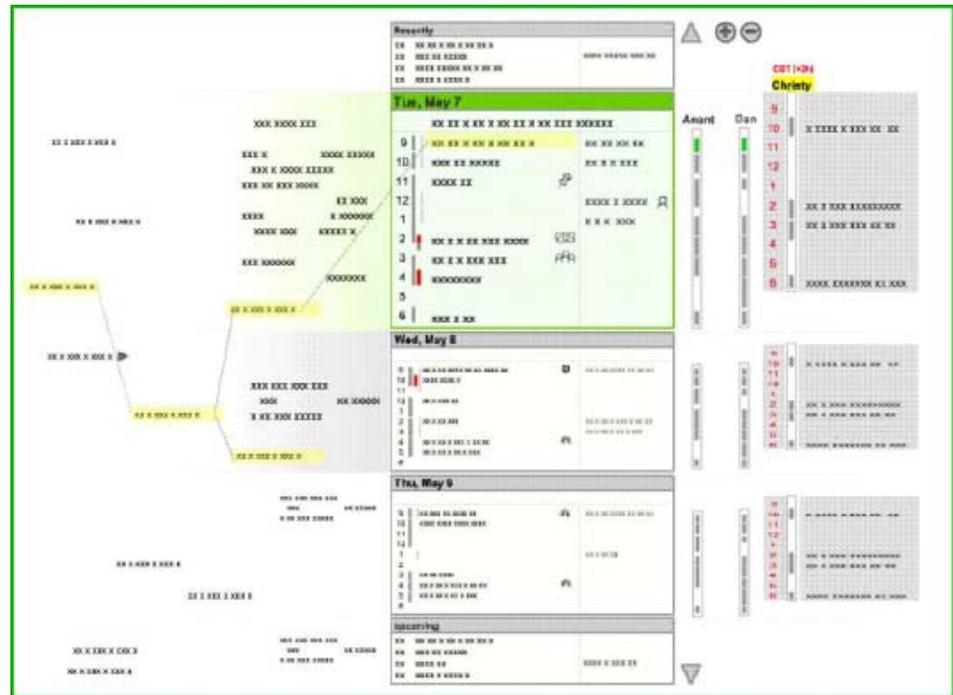


Figure 5. Planning Tableau Interface for Time Management.

the activities to prepare for a meeting are linked to the meeting event as their deadline. Lastly, if a meeting event becomes unscheduled, it can be dragged from the calendar to the intentions section, where it becomes a to-do to reschedule the meeting.

Our work since this mockup has focused on the idea of an activity space for jotting down, monitoring, and organizing activities. An early running prototype of the Activity Tableau is shown in Figure 6.

The Activity Tableau is a freeform space containing icons that represent activity structures, which are stored in a database. Icons can be created, arranged, and edited in the freeform space. (Actually, there are many spaces, since the Tableau has multiple pages.) The user can just click and type into an empty spot on the Tableau, and a new icon is created, along with a new activity structure in the database. The user can edit the properties of the activity structure through the icon, e.g., add or change a deadline, planning time, priority, status (e.g., "completed"). The icon can be dragged to any location. When an icon is dragged near another icon, they lock together in an outline structure that represents activity-subactivity relationships.

We noted previously that an activity can have multiple parent activities. This is represented by “cloning” an icon. Icons that are clones of each other point to the same underlying activity structure. When a user changes the label on an icon, this changes the label of the underlying activity structure, which propagates the change to all the clone

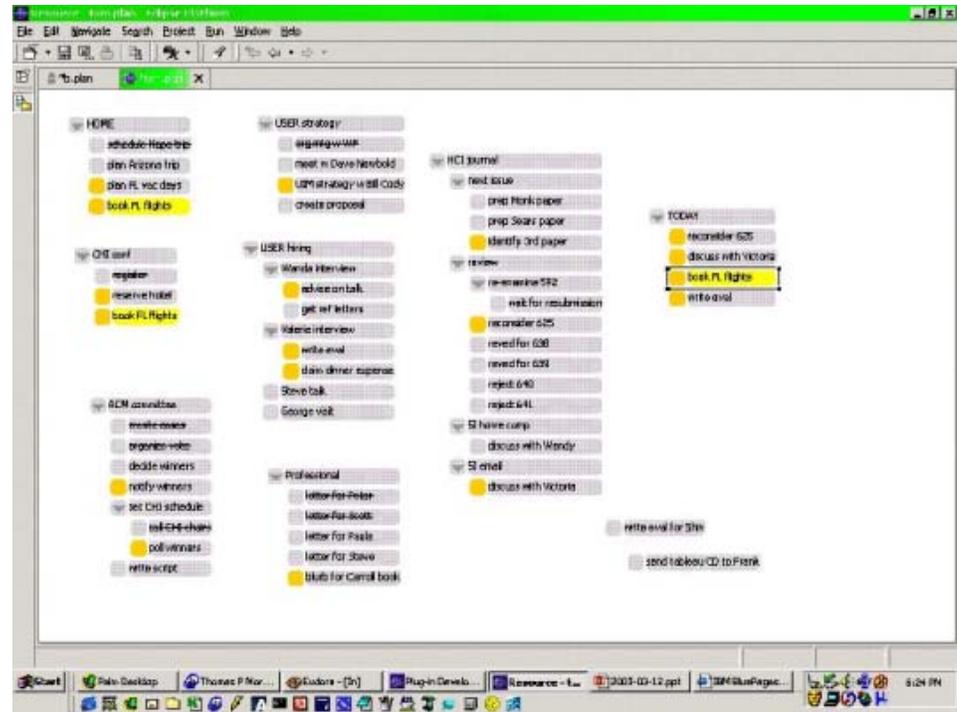


Figure 6. The Freeform Activity Tableau.

icons pointing to the activity structure. Multiple parents are represented by placing icon clones in different outline structures, where each clone has shows a different parent. An example can be seen in Figure 6, which shows three yellow icons. The icon on the right is selected, and it and its clones are highlighted. They all represent the activity “book flights.” This is a subactivity of three different activities – “CHI conference,” “Home,” and “Today” – because the trip being booked is both the conference and for a vacation (a home activity) and the booking is intended to be done today. We are working on other features for the Activity Tableau to better support the temporal aspects of activities, such as a graphical timeline to set and show deadlines and planning times and an automatic “Today” activity that dynamically group activities are planned for the current today.

This flexible kind of interface supports a fundamental property of human activity – *emergence* and *incremental growth*. Sometimes activities can be planned from the top down, first laying down a broad goal (an activity) and then deciding steps to accomplish the goal (subactivities). But often activities emerge from the bottom up. One engages in different activities that seem only vaguely related. These can be represented in the tableau by spatial clustering. Over time, as the relation between various activities becomes apparent, they can be

organized into nested activity structures to represent the emerging coherence.

Again, it is important to be clear about the loose relationship between human activities and their representation. Any kind of checklist or task list is not a full description of the activities they represent. People will represent activities only to the extent it is useful for managing them. From our studies we see that people only need terse descriptions to remind them. The decomposition of activities into subactivities is often only partial, and thus there are unrepresented subactivities. Sequential dependencies are not articulated. People seem to understand the logical dependencies in a list of activities, and they are opportunistic in the order in which they actually carry them out. Thus, any tool for managing activities must tolerate informal and partial descriptions and must give the users flexibility in carrying the activities. This is an issue in workflow systems (see, e.g., Dourish et al., 1996). (An interestingly related phenomenon observed in our studies is that people sometimes further elaborate their activity descriptions after they are completed, in order to be able to better report on them later.)

8. The Bigger Picture

A facility to capture a richer representation of activities than typical task lists gives us a basis on which to provide many more services.

In addition to planning functions, we want to support the carrying out of activities. Essential to this is handling resources for carrying out activities. Thus, each activity structure can collect various resources. This provides an activity-based “foldering” capability, only more flexible, because activities can have multiple parents and can collect heterogeneous resources. For example, we have implemented a prototype of the tableau that works with email. When the user drags a message from the inbox to the tableau, it is converted to an icon representing an activity with the message as a resource. From this icon, the user can activate the email system to redisplay the message.

We also want to provide lightweight coordination by sharing activity structures among people. When an activity structure is shared, all the sharers have equal access to viewing and changing the activity structure; and these changes are synchronized between people. An example is shown in Figure 7, which shows an activity structure for me that is shared with two others, indicated by the person icons on the right. All three of us can see and edit the activity structure. Each subactivity can be “claimed” by a sharer or be assigned to it by another sharer, or the subactivity can be left unassigned. Any of the sharers can mark activities done or add or delete activities. There is great flexibility in this scheme. For example, I can share different subactivities with different people to delegate them; I can see all the subactivities, whereas each of the sharers only sees the one subactivity they share with me. Or I can decide to share the overall activity with all the people, so that they each have more context for their individually assigned subactivities. Erickson et al. (2004) discuss the social issues of sharing activity information through activity structure icons (which they call “task proxies”).

We are also exploring connecting these activity structures to workflow systems, where a person who plays a role in a process can “share” an activity (representing that role) with the workflow process. Finally, we are exploring the notion of reusing and refining activity structures and creating activity “templates.” For example, standardized tasks can be catalogued as activity structures. When a person wants to do one of the standard tasks, they copy the activity structure or template from the catalog and use it to guide them through the task (similar to the way I used the previous year’s committee work to plan the current year’s committee work).

Perhaps the most powerful aspect of supporting generic activity management is the potential to integrate the many systems dealing with activities around a unified concept of activity and to bridge the perspectives of business process workflows, team collaboration tools, interpersonal coordination tools, and personal productivity tools.

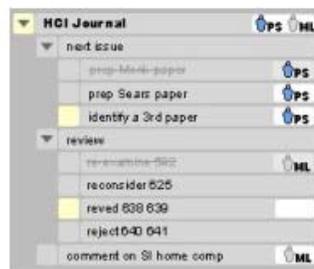


Figure 7. Example of a Shared Activity Structure.

9. Back to Interaction Design

This paper has presented a view of generic human activity from the point of view of the person managing activities and initial explorations into tools to support the meta-activities of activity management. In the beginning of this paper, I argued that the activity management perspective was in contrast to the usual view of activity in interaction design, where the activity surrounding an artifact is analyzed, in order to understand context of an artifact being designed. But of course it turns out that designing tools for activity management is really a case of interaction design. The artifacts we are designing are generic activity representations and activities surrounding these artifacts are the generic meta-activities of activity management. So, in the end, this paper describes an exercise in interaction design.

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