

TASK ANALYSIS

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Defining Task Analysis	923	Deciding on an Appropriate Level of Granularity	927
Task Analysis = The Entire Front-End, Predesign Process	923	Deciding Where to Start	927
Task Analysis = One Element of the Front-End Process	923	Gathering Reusable Data	928
Task Analysis = Many Techniques That Come Into Play at Different Times During the Design and Development Process	923	Going to Different Users at Different Times	928
Task Analysis = One Element of the Postdesign Process ..	923	Collecting Task Analysis Data	928
Task Analysis in This Chapter	923	A Bit of History	928
Considering Four Principles That Underlie Our View of Task Analysis	924	Preparing Philosophically to Work With Users	928
Task Analysis Is an Integral Part of a Broader Analysis	924	Selecting Users and Environments	929
Task Analysis Includes Understanding Users' Goals	924	Conducting Site Visits	929
Task Analysis Is Relevant at All Stages of the Process	925	Bringing Users to You (Field Studies in the Lab)	930
Practical Reality Impinges on What We Actually Do	925	Analyzing and Presenting the Data	931
Planning for a Task Analysis (Issues to Consider)	926	Analyzing the Data	931
Getting Into the Project Plan	926	Presenting the Data	931
Getting Sign-Off and Meeting Schedules	926	Considering Task Analysis at Different Stages	935
Providing Useful and Usable Data	926	Strategic Planning and Predesign Stages	935
Deciding What the Project Team Needs	927	Information Architecture and Concept Design Stages	938
		Interface Design and Early Prototypes Stages	939
		Conclusions	939
		References	939

Successful design comes from a marriage of users' goals and (usually) new technologies. Successful design does not necessarily perpetuate users' current ways of working or playing, but it is built on a deep understanding of those ways and of how a new design will change them.

In this chapter, we explore modern interpretations and uses of task analysis.

The first two sections are background:

1. Defining task analysis
2. Considering four principles that underlie our view of task analysis

The next three sections are a practical guide:

3. Planning for a task analysis (issues to consider)
4. Collecting task analysis data
5. Analyzing and presenting the data

In the final section, we present specific ideas for planning a task analysis and for collecting and analyzing task analysis data at different stages of the design and development process.

DEFINING TASK ANALYSIS

Task analysis has different meanings to different authors.

Task Analysis = The Entire Front-End, Pre-design Process

Rubenstein and Hersh (1984) have a section in their book with the heading, "Task Analysis." They are referring, not to a specific method, but to doing what it takes to understand "who the people are, what they do now, and what the new system is expected to do for them" (1984, p. 25). They go on to say, "The procedures for task analysis are not yet standardized, but every task analysis should address [these] questions." Their list of 10 questions for a task analysis starts with "Who is the user?" and "What tasks does the user now perform?" Rubenstein and Hersh are using task analysis for the entire pre-design process of understanding users and their work.

Task Analysis = One Element of the Front-End Process

Olson and Moran (1996), on the other hand, call the front-end process "defining the problem." The goal of defining the problem in Olson and Moran's process is to understand the users' tasks, but they reserve the name task analysis for one set of methods. Thus, they contrast task analysis with other methods, such as naturalistic observations, interviews, and scenarios or use cases, all of which Rubenstein and Hersh would consider to be part of a task analysis. To Olson and Moran, task analysis is one way to represent the information from observations and interviews. Many of the other techniques used by Rubenstein

and Hersh are also part of Olson and Moran's toolkit of usability activities. They just have names other than task analysis in Olson and Moran's list.

Task Analysis = Many Techniques That Come Into Play at Different Times During the Design and Development Process

Kirwan and Ainsworth (1992) list 41 techniques for task analysis and describe 25 in some detail. Some of the 41, especially *observations* and *charting*, are themselves categories that comprise several techniques. These 41 techniques span the development process from what Kirwan and Ainsworth call the concept stage to what they call the stage of operation and maintenance. Thus, Kirwan and Ainsworth take a broader view of the place of task analysis in the entire design and development process than either Rubenstein and Hersh or Olson and Moran, but they confine task analysis to specific techniques for gathering and presenting information about work. Their focus, also, is on safety critical work, such as nuclear power plants.

Task Analysis = One Element of the Post-design Process

Other authors (e.g., Card, Moran, & Newell, 1983; Payne & Green, 1989) focus on detailed task analyses for evaluating existing designs. Payne and Green offer TAG (Task Analysis Grammar) as a way to predict the cognitive complexity of an existing design by assessing the number of rules that are embedded in a user's understanding of a design's fundamental operations. Card et al.'s GOMS (goals, operators, methods, and selection) is a method for doing an extremely detailed analysis of how a user would do a task in a specific design.

In contrast to Rubenstein and Hersh's view of task analysis as looking in depth at the user's world before design, these techniques apply to already-designed products and focus only on efficiency of action.

We might note that any technique for evaluating an existing design can be used at the front-end of a new design process as long as there is a previous product to evaluate. In that way, these detailed, efficiency-oriented task analyses could be used before designing a new version of a product.

Task Analysis in This Chapter

Our view (Hackos & Redish, 1998; Whiteside, Bennett, & Holtzblatt, 1988; Wixon, Holtzblatt, & Knox, 1990) fits between Rubenstein and Hersh and Olson and Moran. Task analysis means understanding users' work or play.

Thus, task analysis encompasses all sorts of techniques, including naturalistic observations and interviews, shadowing users or doing "a day in the life of" studies, conducting contextual inquiries, and observing and listening to users doing specific tasks. It includes gathering information that leads to insights about users' life at work or play, to scenarios and use

cases, and sometimes to detailed flowcharts of work processes or specific procedures.

In our view, a major emphasis of task analysis is predesign, and three types of analysis—user, task, and environmental—are necessary input to designing any product. Task analysis is, therefore, an integral part of a triangle that covers users, tasks, and environments. As described in more detail, task analysis goes hand-in-hand with understanding users (user analysis) and understanding the users' physical, technological, cultural, social, and political environments (environmental analysis).

Users are absolutely critical to all three types of analysis. In our view, task analysis requires watching, listening to, and talking with users. Other people, such as managers and supervisors, and other information sources, such as print or online documentation, are useful only secondarily for a task analysis. Relying on them may lead to a false understanding.

Like Kirwan and Ainsworth, we also believe that task analysis does not stop with design. Task analysis continues to be critical at every stage of the design and development process. Task analysis is the major input to use cases and design specifications. Task analysis helps us understand how the emerging product affects users. It is the key to evaluating designs, as scenarios for heuristic evaluations and for usability testing. Task analysis must be the organizing principle for documentation and training.

We recognize that efficiency-oriented, detailed task analyses, such as TAG and GOMS, have a place in evaluating some products, especially those for which efficiency on the order of seconds saved is important (see, for example, Gray, John, & Atwood, 1993). However, that type of task analysis is not the focus of this chapter. The focus here is a broad understanding of the world in which the new product will be used.

CONSIDERING FOUR PRINCIPLES THAT UNDERLIE OUR VIEW OF TASK ANALYSIS

The practical advice for doing task analysis later in this chapter is based on these four principles:

1. Task analysis is an integral part of a broader analysis that also includes understanding users and their environments.
2. Task analysis includes understanding users' goals.
3. Task analysis is relevant at all stages of the design and development process, although the focus, methods, granularity, and presentation of information may differ at different times.
4. The practical reality is that what you do as a task analysis at a given time for a given project depends on many factors.

Task Analysis Is an Integral Part of a Broader Analysis

The first principle is that task analysis by itself is not enough to give you the understanding that you need to design or evaluate a product. The methodology you need here is triangulation—bringing together information about three interwoven elements: users, tasks, and environments.

Figure 48.1 shows how all three of these analyses must come together as you triangulate what you learn to gain the

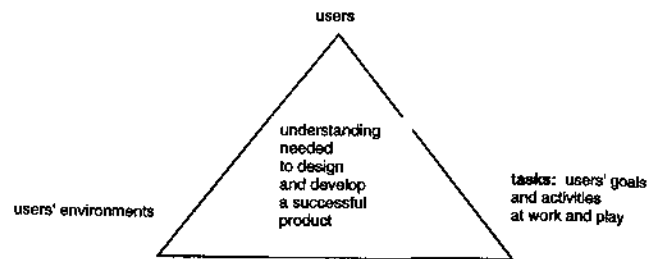


FIGURE 48.1. Triangulating information about users, tasks, and users' environments.

understanding you need. Task analysis is one corner of the triangle of understanding that you need. The other two are:

- Users
 - Who are they?
 - What characteristics are relevant to what you are designing?
 - What do they know about the technology?
 - What do they know about the domain?
 - How motivated are they?
 - What mental models do they have of the activities your product covers?
- Users' environments
 - Physical situation in which the work or play occurs.
 - Technology available to the user (what you might need to find out about could range from what modem speed users have to how often power is interrupted to the cost of upgrading equipment to finding an opportunity for your product because the users' environment favors low technology).
 - Social, cultural, language considerations—what will make the new product acceptable in the users' world? How will the new product change the users' world? How will you help the users make the transition from the old world to the new world?

Task Analysis Includes Understanding Users' Goals

The second principle is that a task is what someone does to achieve a goal.

Considering Norman's Entire Action Cycle as Task Analysis. As Donald Norman explains (1988, p. 46), "to get something done, you have to start with some notion of what is wanted—the goal that is to be achieved." It is true, as he also says (1988, p. 49), that we cannot always articulate our goals clearly. However, in general, we do start with goals, such as,

- making the family happy by getting dinner on the table
- getting a draft of a paper to a co-author in a different city

Norman also describes how we go about trying to meet our goals, that is, how we act. He gives us the seven-stage cycle shown in Fig. 48.2.

The Action Cycle

1. Forming the goal
2. Forming the intention
3. Specifying an action
4. Executing the action
5. Perceiving the state of the world
6. Interpreting the state of the world
7. Evaluating the outcome

FIGURE 48.2. Donald Norman's view of how people get things done (1998, p. 48).

Task analysis is concerned with all the stages of the action cycle.

We can think of forming the intention as deciding what tasks to do to meet a goal. We can think of specifying an action as figuring out what steps and decisions to take to carry out the task. Executing the action would then be actually doing the steps and carrying out the decisions that we have decided are the way to complete the task.

We can think of perceiving the state of the world as seeing the results of the steps and decisions that we took and interpreting the state of the world as relating the results to our understanding of how to carry out the task. Evaluating the outcome would then be judging whether we have successfully met the original goal.

Starting With Task Analysis as Independent of Any Specific Device. An argument within the human-computer interaction (HCI) community has been whether task analysis can be *device independent* (Benyon, 1992; Diaper & Addison, 1992). The problem is one of definition, of which levels you accept as being part of a task analysis.

Benyon calls the goal level (Norman's first stage), the external task, and he would exclude it from the actual task analysis. He would start the task analysis with what he calls the internal task, which begins only after the user has *formed the intention* in Norman's terms. Thus, Preece et al. (1994, p. 411, italics added) define a "task (or internal task) as the activities required, used, or believed to be necessary to achieve a goal *using a particular device*." They thus separate task analysis from work analysis.

However, if we start at Norman's second stage, we are missing a very important part of how users work. If we call Stage 1, work analysis, and the rest, task analysis, we are missing the essential connection between the two. In HCI, if you are designing

a product that you want users to find useful and usable; you must take into account the users' goals, and the entire social context in which those goals are embedded. Part of the design process is to understand what the device must do to help users achieve their goals in ways that give greater value to the user than any available alternative, that is, to understand how to make users want to *form the intention* to use your product.

If we start task analysis only with Norman's second stage, we run the risk of being device-driven in the design rather than being user-centered. Even if the device is predetermined, for example, if we know the solution has to be a software program on a particular platform, working from users' goals is necessary.

Moreover, as Barbara Mirel (1996, 1998) points out, for many users, the issues of usefulness and usability are at a higher level than how to do a specific procedure with a specific device. The problem these users have is that they cannot see the relationship between their problem (their goals) and the solutions (resources, intentions) that are available. They cannot figure out how to form intentions that will lead to tasks that will support their needs. Mirel is talking primarily about managers who have to draw on a variety of information sources to complete tasks "embodying choices, problem-solving, or conditional steps" (1996, p. 16). An example of a user's goal (1996, pp. 16-17) is "to retrieve, relate, and report financial, production, and personnel data in order to persuade [a] manager to allocate effort and resources differently." HCI specialists need to be able to use task analysis to develop solutions for these complex situations, as well as for the more easily decomposable tasks that are traditionally thought of as task analysis.

Therefore, to us, task analysis starts at a device-independent stage and begins by focusing on users' goals.

Task Analysis Is Relevant at All Stages of the Process

Our third principle is that task analysis belongs everywhere in the process of planning, designing, developing, and evaluating a product. Task analysis, like so much else in the user-centered design process, should be done iteratively. The focus, methods, granularity, and presentation may change over time as different questions and different types and levels of information become more or less relevant.

Table 48.1 shows the types of questions that task analysis might help answer at different times in the product life cycle.

Practical Reality Impinges on What We Actually Do

Our fourth principle is that in the fast-paced world of software and web design, in reality, what we can do for a task analysis (or any other aspect of user-centered design) depends on many factors. These factors include:

- time
- budget
- people
- availability of users to observe and talk to
- travel restrictions.

TABLE 48.1. Task Analysis Questions at Different Times

Stage	Examples of Questions That Task Analysis Should Be Used to Answer
Strategic planning	<p>Why would someone or some organization choose to use this product?</p> <p>What goals in their world would this product help to meet?</p> <p>What benefits are most meaningful and valuable to users?</p>
Predesign	<p>What are the alternatives currently available and technologically possible that would address the "why" listed above?</p> <p>How do users achieve relevant goals today?</p> <p>How could our product make that easier?</p>
Information architecture	<p>What do users know and what are their environments?</p> <p>How do users organize their world?</p> <p>What vocabulary do users use today for their goals and tasks?</p> <p>How can we incorporate that vocabulary?</p>
Concept design	<p>What metaphors are familiar to users?</p>
Interface design	<p>What do users know about interface conventions?</p> <p>How does the task flow of the new product match users' expectations from their current work?</p> <p>If we are changing users' task flows, how can we build in help for transitions?</p>
Early prototypes	<p>What tasks should we provide to "heuristic reviewers" and usability testers?</p>
Development	<p>What does the user know that would address the problems we have uncovered?</p> <p>What changes should we make to the interface and information to better match users' expectations for work or play?</p>
Postrelease	<p>How well does this release match the user/business needs that we uncovered in the original strategic planning phase?</p> <p>Are users now better able to achieve their goals than they were before they had this product?</p>

This chapter is meant to help you decide on the best approaches to consider for whatever situation you are in.

In the next part of this chapter, we consider issues and methods for planning a task analysis, collecting task analysis data, and analyzing and presenting that data.

PLANNING FOR A TASK ANALYSIS (ISSUES TO CONSIDER)

Getting Into the Project Plan

A critical aspect of being able to do task analysis throughout a project is getting this and all other usability activities into the

project plan. The extent to which this can happen depends, of course, on other factors, such as whether a project plan exists and in how much detail it is specified. The more strongly a project team uses a formal project plan, the more critical it is to get usability activities, such as task analysis, into the plan. Time, resources, and respect from managers and developers for the information may be dependent on being part of the formal plan.

Another approach that many usability specialists follow is to create a usability project plan that parallels the system design and development project plan. That is fine if the system people understand and respect the parallelism of the plans.

Getting Sign-Off and Meeting Schedules

Whether the usability plan is part of the overall project plan or a parallel track, it is important to get sign-off from the rest of the design and development team with respect to

- activities that the usability team will do
- resources needed for those activities
- information that will be brought back from those activities
- deliverables (formal or informal) that will come from that information
- dates for those deliverables.

As usability specialists, we must acknowledge that, at least in the United States, most software and web development projects are schedule-driven. Task analysis and other usability activities must deliver information in a timely fashion at the right moments in the project schedule.

Getting into the project plan early can help set schedules that allow time and resources to do task analysis and other usability activities. Another way that some usability specialists accomplish this is to take responsibility for elements of the project plan, such as the user interface specification, and use that as the way to integrate usability data into product design and development.

Providing Useful and Usable Data

As usability specialists, we help project teams only if we provide useful and usable data when they need it. Therefore, staying closely aligned with a project team to know the plan and schedule (and when and how that plan and schedule change) is critical.

What else, besides timeliness, makes data useful and usable?

- Data the project team needs—As usability specialists, we should approach any project looking for where the team needs data about users (whether they know it or not) and plan to collect, interpret, and present that data in a way that the team can directly use.
- Data that is credible—Time pressures and limited resources often curtail the extent of any usability activity, including task analysis. In general, we follow the maxim that some data about users and their work is better than no data. Practical

experience tells us that is true, as long as the data are accurate and representative. Limited data can still be good data. Good data is collected in a systematic, careful, rigorous way from appropriate users.

Deciding What the Project Team Needs

The task analysis that you want to do will depend in part on the type of product or Web site that you are working on. Consider at least these four factors as you think about the project for which you are planning task analyses and other usability activities.

Where Is the Product in Its Overall Life Cycle? For example, is the team

- upgrading an existing product without changing the medium (a new software release; a revision of the Web site)?
- changing business processes or medium (going from a “legacy”—DOS-based or green-screen product—to a graphical user interface or to the web)?
- developing something totally new?

How Broad or Specialized Is the User Population for the Product? Is the product for a

- very broad public market?
- niche business market where you can easily define the user population and access to them is through account executives (or similar)?
- special audience? (children? the elderly? persons with disabilities?)

How Widespread Geographically, Culturally, and Linguistically Is the User Population for the Product? Is the product

- Global? How far? How many countries? Cultures? Languages?
- Local? (some products are still used only in a particular country, but even within one country, you are likely to find differences in culture and vocabulary).

How Detailed Must We Specify the Tasks? Is the product

- safety-critical where tasks are very specific and must be done in specified ways? Do users receive training until they prove their competence in completing the tasks accurately and efficiently?
- used by many different types of people for different tasks that they may do in different ways?

Is This a Special Type of Product for Which Traditional Task Analysis May Not Be Useful? Some applications do not fit the traditional approach for task analysis. These are primarily applications that the user does for fun (e.g., games).

Traditional task analysis would not aid much in the design and development of these applications. Games (both technology-based and real-world games) present players with a defined goal

and a set of constraints. The fun is in achieving the goal without violating the constraints. The fun is more in the process than the actual outcome. The outcome exists to motivate the process.

The more interesting the game, the less amenable it seems to be to task analysis. Interesting games have a large number of possible ways to win and present a complex set of constraints. These make the application of task analysis extremely difficult.

Game designers do not typically do task analysis. They are more interested in mood, theme, story, drama, progression, surprise, pacing, and the physical correlates of these experiences. The conceptual space in which they operate and their way of thinking about how to create a fun experience is fundamentally different, perhaps even antithetical to, the analytic approach that is typical of task analysis. (Also see chapter 46 in this handbook, *User-Centered Design in Games*.)

Deciding on an Appropriate Level of Granularity

Another aspect to consider as you plan a task analysis is the types of analysis to do. Understanding users' goals and their work or play can be done at several different levels. You might be interested in one or more of these types of analysis:

- Analysis of a person's typical day or week (“a day in the life of” or “an evening at home with”)—This is probably most needed for the early stages of strategic planning and predesign.
- Job analysis (all the goals and tasks that someone does in a specific role—daily, monthly, or over longer periods)—Again, this is probably most needed for the early stages of strategic planning and predesign.
- Workflow analysis (process analysis, cross-user analysis, how work moves from person to person)—This may be useful in strategic planning and predesign, especially if you have ways of improving workflow among users. It is also needed in concept design and interface design.
- High-level task analysis (the work needed to accomplish a large goal broken down into subgoals and major tasks)—This is needed in information architecture, concept design, and interface design.
- Procedural analysis (the specific steps and decisions the user takes to accomplish a task)—This is needed at the interface design stage and beyond.

Deciding Where to Start

You must first understand how far along in the process the project is.

Unfortunately, by the time usability specialists know about the project, the strategic planning and predesign stages may already be considered closed. The project may be at considerable risk if the strategic planning and predesign questions were never answered or were answered based on speculation or internal discussions without users. However, it may be unproductive for usability specialists to spend time and effort collecting data that speaks to those questions if no one is willing to listen to the answers they bring back. A more productive use of the limited

time and resources for task analysis and other usability activities would be to understand where the project is and how to influence it from that point forward.

Gathering Reusable Data

Time, resources, and costs are likely to limit the number of times you can return to users for task analysis. Also, users do not think in terms of the information needs of a project team or the different stages of design and development of products they might use in the future.

One good approach might be to collect extensive data about users' work in a relatively holistic way, capturing that data on video, audio, or in extensive notes so that you can return to the data—rather than to the users—with different questions in mind at different times.

To do this, an open-ended field study method combined with detailed information gathering is best (Wixon, 1995). Also, having a relatively detailed log of the raw data is necessary (videotape, audiotape, or verbatim transcripts).

Going to Different Users at Different Times

Although the number of times you may go out to users is likely to be limited, we have also said that you are likely to want to do site visits at different times for different questions. Even if you gather extensive data holistically on early site visits and return to the data, you may not have the information that you need. In that case, go out again, and go to different users.

You can use each set of site visits not only to answer the specific immediate issues and questions, but also to enrich the team's general understanding of users, their work, and their environments. Although your immediate focus may be a specific why or what or how question, always drill down so that you are, in fact, seeing the why behind the what or the what and how behind the why.

COLLECTING TASK ANALYSIS DATA

Now that we have considered some issues in planning to do a task analysis, let us discuss ways to work with users to do a task analysis.

A Bit of History

Traditional task analysis had its roots in time and motion studies (Taylor, 1911; see Preece et al., 1994). Observers with stop watches timed workers on assembly lines to find more efficient ways to accomplish the work. The workers were just another part of a system that was part mechanical and part human.

Modern Roots in Ethnography. Modern task analysis, on the contrary, relies more on ethnography and cognitive psychology than on time and motion studies. As Redish writes, "user and task analysis, like ethnography, is about developing as rich understanding as possible" (Hackos & Redish, 1998, p. 14).

Task analysis today relies primarily on qualitative methods of data collection and analysis. You may report frequency of activities (how many people do the task this way), and at some points in the design and development process, timed studies of tasks may be relevant (how fast users are able to do a task in their current environment). However, the primary methods today are ethnographic—observing, listening, and talking with users in their own environments as they do their own work. These methods were brought into HCI by a group at Digital Equipment Corporation in the late 1980s and early 1990s (Whiteside et al., 1990; Wixon & Comstock, 1994). (Also, see chapter 50 in this handbook, *The Ethnographic Approach to Design*.)

Of course, a typical user and task analysis is not really ethnography. Redish explains the difference this way:

Ethnography usually means spending a year or two immersed in a different environment. Half a day with each user and a few weeks for the entire visiting time isn't the same. Ethnography, moreover, is usually only about describing the culture. A user and task analysis has a goal that goes beyond description. The point of a user and task analysis is to design a product that may in fact change the culture being observed. . . . [W]e aren't really doing an ethnographic study . . . when we do user and task analysis. But we are making practical use of ethnographic philosophy and techniques, adapted to the goals of designing products and the constraints of product schedules and budgets (Hackos & Redish, 1998, p. 15).

Modern Roots in Cognitive Psychology. The other source of philosophy and techniques in modern task analysis is cognitive psychology, the study of how people think and learn. Work is not only about action; it is about decisions on when and how to act. The decisions are made by people, and, therefore, people are active parts of any system.

We do user and task analysis because, in fact, it is often the users who are much less predictable and less well understood than the technology. As we now know,

[u]sers come to any new product with preconceived ideas based on their prior experiences. They interpret what they see in an interface and draw their own conclusions about how it works that may be very different from the designers' intentions—and then they act on their conclusions, not on the designers' intentions. Cognitive psychology shows us that we must accept the users as reality because it is they and not the designers (nor their supervisors) who will in the end determine how the product is used (or not used) (Hackos & Redish, 1998, p. 15).

From cognitive psychology, we understand that we must focus on what is happening in users' heads as well as with their hands, and we adapt the technique of think-aloud protocols (having users talk out loud as they work).

Preparing Philosophically to Work With Users

From ethnography and cognitive psychology, we also take our ideas of how to work with users when we are doing a task analysis. Anyone who works with users to gather data for a task analysis should abide by these five principles (inspired by and adapted from the work of Beyer & Holtzblatt, 1995; Holtzblatt & Beyer, 1993; Whiteside et al., 1988; Wixon et al., 1990; Wixon & Jones, 1996; Wixon & Ramey, 1996).

... user with respect.
 ... here to understand who users are, what they do and
 ... do it, and what they value. No matter how differ-
 ... do their work (or play) from what we expected,
 ... respect them, their culture, their actions, and their

... and that we are visitors (guests) in the users' envi-
 ...
 ... there to learn about their reality, not to bring our
 ... to them.

... learning mode.
 ... not there to train or teach or demonstrate or sell
 ... product. (This part is often difficult for engineers,
 ... specialists, marketing specialists, and others when
 ... first start doing site visits. They are used to going to
 ... partners for these other reasons. Before going out on a task
 ... analysis site visit, they must understand the difference in the
 ... reasons for the visit and they must become comfortable with
 ... appropriate frame of mind and behavior.)

... the user be a mentor.

... we are there to learn, we must watch and listen more than
 ... we act or talk. Especially in work contexts, one way to do this
 ... is to suggest to the user a relationship of mentor and trainee—

... user as mentor, site visit observer as trainee. Users are often
 ... unsure of how to deal with the strangers in their midst. They,
 ... too, have more often been visited by people training them or
 ... demonstrating something to them or marketing something to
 ... them. Helping them to get into an appropriate relationship
 ... is useful, and most users are happy to become the trainer or
 ... demonstrator.

5. Be a partner in the task of understanding the user's world.

... Use a site visit to test out your assumptions. Clarify your
 ... understanding of what the user is doing and saying as you
 ... go along. Capture the users' words. Do not translate as you
 ... take notes.

Selecting Users and Environments

Companies have sometimes commissioned large-scale task anal-
 yses as part of their long-term strategic planning; that is, outside
 of the development cycle of a particular product or version (see,
 e.g., Dray & Mrazek, 1996; Redish & James, 1996). That is terri-
 fic when it happens.

However, most task analyses today are small-scale studies,
 especially when they are part of a product-oriented project.
 The rapid pace of design and development often does not leave
 time for site visits to more than a few places. The scale is similar
 to that used in iterative usability testing—six to eight users per
 study. As with usability testing, it is better to do a few site visits
 each time for different purposes at different times in the project
 than to do many up front and then not have resources to go out
 for other reasons later. Also, as with iterative usability testing,
 even though each study is small, over the course of the project,
 you may see many different sites and users.

Make a Convenience Sample as Representative as Possible. A task analysis study almost always uses a convenience
 sample. However, care should be taken to make the sample as

representative as possible within the constraints of time and
 budget (see Hackos & Redish, 1998, especially chapters 2 and 7
 on defining your users and then selecting appropriate ones for
 a user and task analysis).

Because it is almost impossible to find one user who truly
 represents the entire spectrum of users, spending some time
 with each of a few users is better than spending all the allotted
 time with just one user. Characteristics on which you might
 want to base representation include:

- Size of the user's company (which may affect task special-
 ization among users, amount of support available to users,
 technology available to users, etc.)
- Experience in the domain and with the medium being con-
 templated for the product
- Gender, age, and background (which may correlate with mo-
 tivation to learn new ways of working and with interests and
 values related to technology)

Do Not Limit Task Analysis to Development Partners.

Many companies today have "development partners" who agree
 to work with them throughout the project. Development part-
 ners are usually major customers who get to influence the new
 product in exchange for allowing their people to participate in
 site visits and usability tests, as well as other activities, such as
 customer focus groups and beta tests.

Working with development partners is a great idea. How-
 ever, in many cases, development partners are at the tail end
 of the distributions for both size and sophistication within the
 company's market. What works for them may not work well for
 the company's many other customers. In most cases, restricting
 site visits to the development partners raises the risk of the
 product failing to meet the needs of other customers.

If the project you are working on has development part-
 ners, but the company also wants the product to be used in
 many smaller and less sophisticated places, push to include
 others in usability activities like user and task analysis. In ad-
 dition to making project managers realize how unrepresenta-
 tive users in the development partners may be, you can also
 often make a cost-benefit argument based on plans for imple-
 menting the product in different environments. The company is
 likely to implement the new product for the development part-
 ners with a lot of hand-holding, but the wider distribution to
 the many more but smaller companies must eventually happen
 without that hand-holding. Getting the product to be usable for
 the broad majority requires doing task analyses (and other us-
 ability activities) with representative users from those smaller
 companies.

Note that you can, of course, set up a situation in which the
 development partners or customer partners are in fact represen-
 tative of the range of customers and users (see Hackos, Elser,
 & Hammar, 1997; Hackos & Redish, pp. 143-144). However, in
 many projects, that is just not the case.

Conducting Site Visits

What happens when you actually meet the users? How should
 you act when working with users?

The two main techniques for collecting task analysis data are observations and interviews. In a typical site visit, you combine both; and, when possible, you do them together—conversing with the user about the work as you observe and listen to the user doing the work.

In certain situations, you cannot converse with the user while the user is working. This may happen when

- the situation is safety-critical (e.g., with air traffic controllers [Means, 1993])
- the user is interacting with a client (e.g., in some situations with retail salespeople or travel agents [Redish & James, 1996])
- the users do not want to be interrupted in their work (e.g., with radiologists [Ramey, Rowberg, & Robinson, 1996])

In those cases, you may be able to talk about the work as soon as the user finishes the task (immediate recall) or at a later time using information from videotape or other artifacts to stimulate recall (cued recall). In situations that depend on the user interacting with a customer, you might have one member of the site visit team act as customer, thus having the user do a real task but giving you the opportunity to talk with the user during the task. (For these and other techniques for task analysis, see Hackos & Redish, 1998, especially chapter 6. For specifics on observing and interviewing during site visits, see chapters 9 and 10 in Hackos & Redish.)

Observing Users. What you take notes on and the level of detail of your notes depend on the stage the project is at and, herefore, the questions and issues you are addressing in this particular study.

In each site visit, you may want to spend all of your time with one user, the person responsible for the tasks you are investigating. You may want to spend time with different users at the same site if several people at the site do the same tasks, especially if they have different levels of domain knowledge, product experience, or technical skill.

You may also want to spend time with different users if you are interested in work analysis or process analysis (how work flows across users who do different parts of a process). You may want to spend time with the people who do each part of the process. If you have already watched them individually and drawn flowcharts of what you see as their process, you may want to bring them together in a conference room to go over your process flow and verify it or discuss it or get answers to questions you have about it.

If you want to get details of steps and decisions to flowchart a procedure, you may want to slow the user down and discuss each step and decision, asking questions about other situations and how they might change the steps or decisions and about the frequency of different situations.

In all cases, as you observe and listen, you must remember the five points we made earlier in the section on preparing philosophically to work with users as well as these four:

1. Be friendly but neutral.
Be aware of how you give messages with your body, as well as with your words.

2. Be aware of assumptions that you brought with you.
As you watch and listen, you are verifying those assumptions or changing your understanding of the user's reality.
3. Ask questions to clarify.
Restate what you think you heard. Your goal must be to bring back the user's understanding of the work. It is very easy to think that you understand when you are in fact filtering what you see and hear through your own view of the work.
4. Note the user's words.
One goal of a task analysis is to understand the user's vocabulary for objects and actions. Again, it is very easy to translate what you hear into the development team's words without realizing that you are doing it—if you are not attuned to the need to capture the user's words.

Interviewing Users. Most of the talking in a task analysis should be in the context of a conversation with the user about the work during the work. However, there may be more general questions that you want to ask.

In general, interviewing after you have observed is better than before. You will have the context of what you have seen and heard as a frame for the other questions.

The two most important guidelines for successful interviewing are:

1. Ask questions in a neutral manner.
Do not lead the user. Try to put the questions in a behavioral context rather than as a simple matter of like or dislike. If you say, "We are thinking of adding [feature] to the product. Would you like that?" you are suggesting that the user say, "Yes, I'd like that." If you say, instead, "If the product had [feature], would you use it?" and follow that up with "When and how would you use it?" you are likely to get a more informative answer.
2. Listen far more than you speak.
You can keep a conversation going with prompts and probes that send the message that you are listening and want the user to talk more. (See Hackos & Redish, 1998, chapter 10, especially pp. 279–291 for more on interviewing and listening skills for user and task analysis.)

Whenever possible, make an interview behavioral rather than attitudinal. For example, if you have brought along prototype screens of the new product to show as part of your site visit, do not just show them and ask what users think. Make that part of the site visit into a mini-usability test even if it is in a conference room and not at the user's desk. Ask the user to walk through the screens doing a realistic scenario.

With interviews, as with observations, clarify what you are hearing, restate so that you know you are getting the user's understanding, try not to filter through your preconceived notions, and do not translate the user's words into your company or product jargon.

Bringing Users to You (Field Studies in the Lab)

The best task analysis, of course, is done in the users' context. However, time constraints, travel restrictions, or security restrictions may make it impossible for you to go to the users.

still do task analysis. Have the users bring their tasks to

ough you will not get a true environmental analysis (see users work or play in their own settings), you still get data about users and tasks. Butler and Tahir (1996), for example, conducted what they called "usability roundtables," in which users (individually or with colleagues from their work) brought their own artifacts and walked and talked the usability specialists through their tasks.

For a detailed procedural task analysis (getting down the steps and decisions in completing a specific task), the lab may be the best environment. If you want to capture details, you probably want a videotape record. It is easier to videotape in the lab than to transport equipment to users' sites, set it up, and take it down, although we do recommend videotaping for most task analysis site visits.

If you want quantitative measures, such as time to complete a task under ideal conditions, the lab may again be the best place to do the study. Someone might ask, in that case, whether you are doing a field study or a usability test, but in fact the line between the two techniques is quite blurry. Both can be done in the field or in the lab. Both can be done on old products or new prototypes. Both can be done qualitatively or quantitatively. Both can be done on the user's own work or on scenarios given to the user. Task analysis is a major part of both field studies and usability testing.

ANALYZING AND PRESENTING THE DATA

Once you have collected the data, of course, you need to analyze it and present it. Data is of no value if you do not communicate what you have learned to the people who need the information. To make the data useful, you must bring the data together, think about what you have learned, and draw out implications.

Analyzing the Data

Consider these four principles as you plan how to analyze the data:

1. Involve the design team.

Making the effort to involve the rest of team pays off handsomely. Involving other team members ensures that they have a stake in the results. It also allows them to work with the raw data, which helps them internalize the "work of the user" more completely, even if they did not get to participate in the site visits. When you involve the team in the analysis, you build a shared understanding of what was seen and heard at the customer or user sites. It also ensures that the questions the team has get answered. Often teams refine and redirect their thinking as they go through an analysis. They may drill down more deeply into the data. They may completely change the questions they have of the data. They may change their thinking about the direction they had planned for the product.

2. Make it traceable.

Any analysis should include references back to the raw data. There are many advantages. First and foremost, keeping the

link ensures the integrity of the analysis. It is important to be able to say to those who were not involved in collecting and analyzing the data that all conclusions are traceable back to statements by users or direct observation of their behavior. Second, as we noted in discussing the first principle, interpretations may change as analysis progresses. During that process, it is important to be able to revisit the data and recall the context of the behavior or the comments. If you set up ways of tracking the data through analysis, the extra time and effort need not be substantial.

3. Make it visible and accessible.

The analysis may be complex and detailed, but a report laden with text will almost certainly go unread. There is not time in the rush of a project for people to read. Therefore, many teams choose to display their analysis on a wall or in a "war room," where team members can review and add comments to the display (see, e.g., Simpson, 1998). An alternative is a hyperlinked document in which higher level conclusions are linked to more specific analyses. Often, the analysis is graphical so that designers can stand back and see patterns in the data. Some people create multilevel documents with a one-page summary, supported by a three-page overview, which in turn is supported by a 50-page report.

4. Match the form to the questions, the stage, the team's needs.

The cardinal rule of all documentation is to give users what they need in the form they need it when they need it. That's why most technical communicators have moved from writing extensive tomes that people do not open to helping teams bring communication into the interface. The same principle applies to the internal working of any project team. The best form in which to represent the data depends on many factors, including the questions that were asked, the stage in the project's life cycle (i.e., how the information will be used), the time in which the information is needed, and the team and company culture.

Usability specialists should keep in mind the essential purpose of any analysis. Analysis provides an anchor from which designs can be generated and against which they can be evaluated. The analysis is not an end in itself, and the specialist must always keep in mind the need to keep the design team engaged with the analysis and with the representations of the analysis. In the next section, we describe a few of the possible representations.

Presenting the Data

Here are eight ways to present task analysis data (also, see Hackos & Redish, especially chapter 11. Miles & Huberman [1994] also describe the rich variety of ways to organize qualitative data for interpretation).

Affinity Diagrams. Affinity diagrams are hierarchical pictures of user data. They are produced inductively by grouping similar data elements together into categories and then grouping the categories together. Figure 48.3 is an abstract illustration of an affinity diagram in progress.

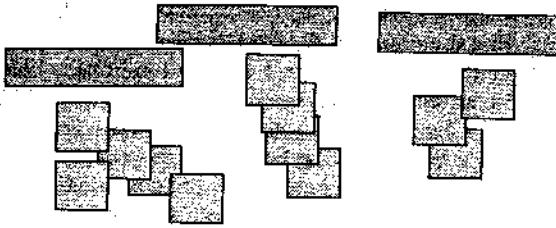


FIGURE 48.3. An abstract illustration of an affinity diagram in progress.

Affinity diagrams derive much of their value from the process that produces them (i.e., a deep engagement with the data combined with recurring reflections on the generalization that best captures a number of data elements). Also, teams often produce “collateral” elements while creating an affinity, such as design ideas and additional questions, that are captured and then used in design or further data gathering (see Beyer & Holtzblatt, 1998, for more on the process).

Figure 48.4 is an example of a small part of the result of doing an affinity diagram. Note how the team has kept the reference to the data with each bullet point (i.e., each note in the affinity diagram).

1. I must FIND, MAINTAIN, and COMMUNICATE with customers, and sometimes others.

1.1. I need to keep in touch with clients, colleagues, and family.

1.1.1. I must make sure my landline is forwarded—can't miss calls while I'm out.

- P 622 SW 6.2 Seq (Getting ready to leave): Turns off the phone so that the answering machine goes online.
- P 508 SW 5 Seq NOTE: He has a landline, but has forwarded it to his mobile phone so that he always can get calls when he's away from the office and also so that he doesn't forget to forward the phone when he leaves the office.

1.1.2. My cell phone is essential during the business day—it must be within easy reach.

- P 349 US 3 Notes He docks his phone on the dash where he can reach it easily.
- P 442 SW 4 Flow NOTE: The phone is everywhere in this flow diagram—as much as he is hitting the pavement, he is also hitting the wire.
- P 552 SW 5 Notes If I leave my phone at home, I've ruined my day. I usually have at least 1 visit, and I need the phone [to help if I get lost, to confirm the visit, and to keep track of other business when I'm traveling].
- P 628 SW 6.1 Seq 6.1 has her bag back there in the trunk too, but her mobile phone is in her hand. (Can't tell if earphone is on; it's not by the time we get out of the car in any case.)
- P 834 SW 8 Seq In the car he puts the mobile phone between his legs, resting on the seat. BREAKDOWN: I normally have the mobile phone put away in my pocket (or somewhere) and an earpiece in my ear so I don't have to mess with it while I drive. (ASSUME: There's usually a switch next to the hanging microphone to let you answer calls.) But this borrowed phone doesn't have an earpiece.

FIGURE 48.4. A partial example of results from an affinity diagram.

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rence
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FIGURE 48.5. Ellen's appointment book as an example of an artifact.

Artifacts. Some types of tasks are deeply intertwined with their artifacts. For example, the task of making appointments is necessarily interwoven with calendars that show dates and times. As a result, it is often best to begin with existing artifacts (e.g., Ellen's appointment book) and to organize data around that representation.

The team may or may not decide that the representation is in fact the best metaphor to bring into the new product. Even if they do not, the artifacts and representation are often the best way to get an initial understanding for a task analysis. Figure 48.5 shows an example of an artifact that you might want to collect if you were creating a program to help people keep track of time, dates, meetings, tasks, etc.

Flow Diagrams. Flow diagrams answer questions about how information or artifacts flow through a system (process analysis). They illustrate the dependency between system elements or states of the system and what needs to be transferred or moved from one part to another. They also show how roles are divided within an organization as data moves from one person or department to another or between the organization and outsiders.

Figure 48.6 is a small part of a flow diagram. The different patterns on the underlying circles represent different people (managers, nonmanagerial professionals, consumers, etc.) who are involved in this flow. Note once again that the references to the raw data are kept with the flow diagram so that the team can return to the data to understand more about the user and the context for each data point.

Personas or Archetypes. Personas or archetypes (user profiles) often describe the user's activities, knowledge, and tasks in some depth. Thus, personas or archetypes may integrate the two elements of users and tasks from the triangle presented

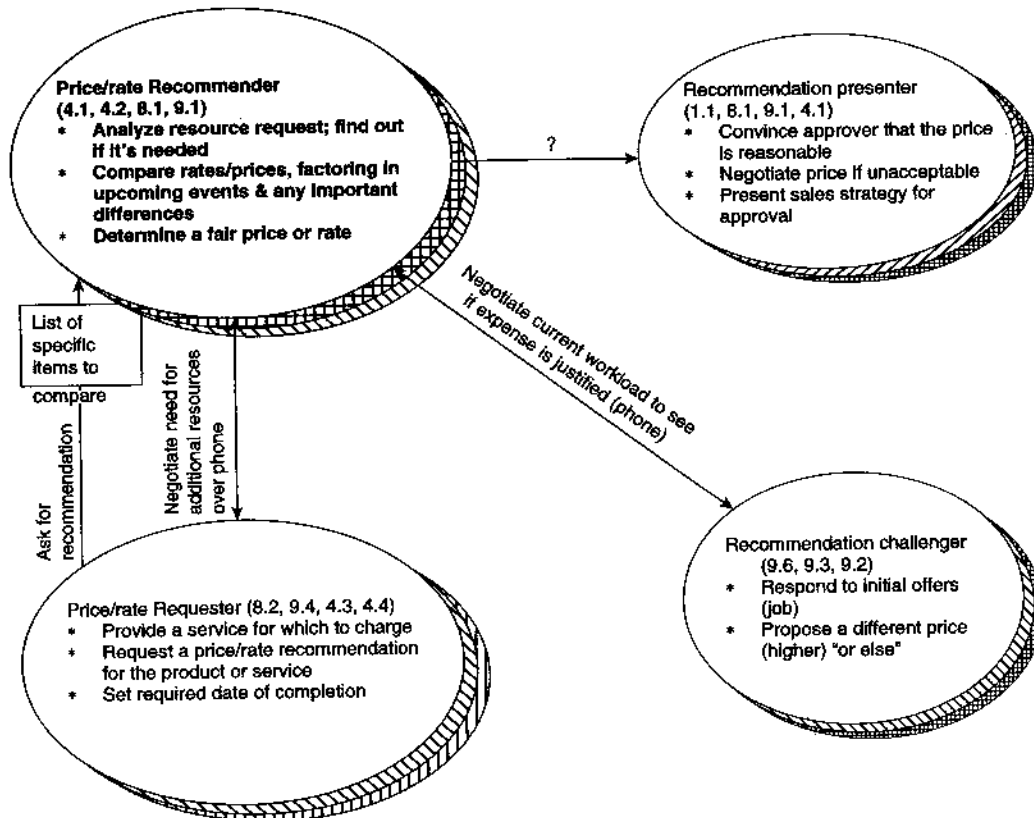


FIGURE 48.6. Part of a flow diagram to present task analysis data.

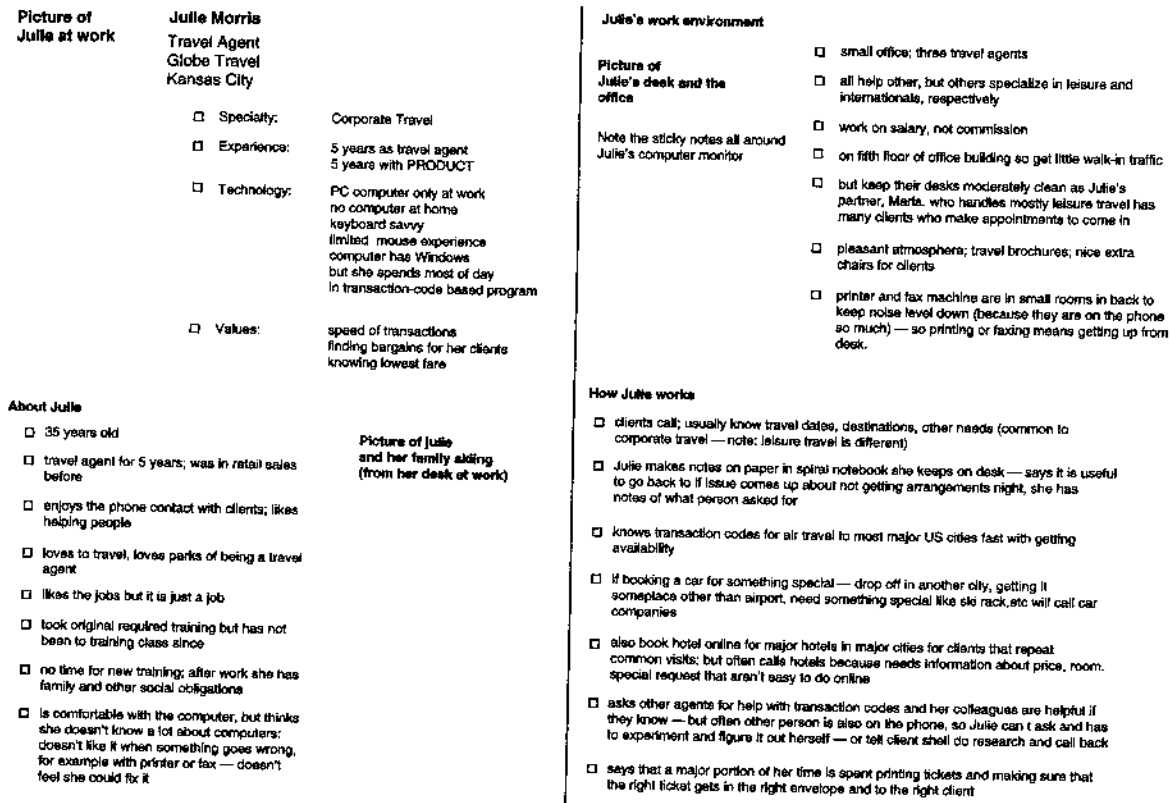


FIGURE 48.7. An example of one type of persona (user profile).

in Fig. 48.1 of this chapter. Some people, in fact, also include information about the user's environments (physical, social, cultural, technological) in the description of personas, thus capturing all the triangulated data that we discussed at the beginning of the chapter.

Rich persona descriptions that encompass user, task, and environment information are particularly useful for commercial products, which often begin with market segmentation that classifies and describes potential customers. The task analysis builds on this data by characterizing these users more precisely (Lee & Mikkelsen, 2000).

Because personas describe people, they tend to be memorable. Designers can ask "How would X respond to this design that I have just created" (see, also, Cooper, 1999).

Figure 48.7 is one of many ways of showing a persona. The real example would include photographs or sketches where indicated.

Scenarios. A scenario is a short story of a specific situation that is real and relevant to a user. A scenario gives the team the user's goal and specific needs. It often also gives the team the user's names for objects and attributes of those objects. It may give the team information on what the user values. (Is price more important than choice in renting a car, for example.)

Each situation that you observe on a site visit is a scenario. You can also collect scenarios by interviewing users through critical incident technique (Flanagan, 1954) in which you

ask users to recall a specific incident and then to tell you about it.

Figure 48.8 is an example of a scenario from a study of travel agents (Redish & James, 1996). (See, also, chapter 53 in this handbook on Scenario-based Design.)

You can elaborate a scenario with the sequence diagram (flowchart) of the procedure the user went through to accomplish the scenario. If accomplishing the scenario is difficult, and the scenario is important, creating a more efficient procedure could become a requirement for the new product.

Sequence Diagrams. Flow diagrams track work through a system or across people. Sequence diagrams use time to track the actions and decisions that a user takes. Sequence diagrams (procedural analysis) show what users do and when and how they do it. This type and level of information is critical for interface architecture and design because it gives us the functions, objects, and attributes of a system (e.g., menu items and dialogue box design) and the navigation for a Web site.

Client calls the travel agent. Client wants to go to Phoenix for a weekend to see her friend, but she is very concerned about the price. She would like to go sometime this month. She can be flexible about when to go and come back. She wants to know what the best fare is, if it is available this month, and what flights she can get for that fare.

FIGURE 48.8. An example of a scenario.

By laying out the sequence diagram that represents what users do today, you can often see ways to make the product more efficient and effective. Thus, the sequence diagram of the reality of what you find in predesign observations is often elaborate and messy. It may be important for the team to see that reality as they work toward a more useful product.

Figure 48.9 is an example of part of a sequence diagram.

Tables. Tables are an excellent way to show comparisons and so are useful for presenting many types of analysis. Technical communicators, for example, have traditionally used a user/task matrix to understand which tasks are done by which types of users. The user/task matrix becomes a major input to a communication plan—to answer the question of what tasks to include in documentation for people in different roles (e.g., system administrators, end users). Tables can be used to show the relationships between any two (or more) classes of data. (See Table 48.4 later in this chapter for an example of a table with three classes of data.)

User Needs Tables. Kujala, Kauppinen, and Rekola (2001) have recently developed what they call a “user needs table” as a way to present a current task sequence along with the problems and possibilities that the designers should think about for each step in the sequence. They hypothesized that it would be easier to use findings about users’ needs in design if the findings were connected to the task sequence that forms the basis of use cases. In their studies, designers found this type of presentation very useful in moving from data to requirements. They also found that writing use cases from this type of presentation keeps the use case in the user’s language and keeps the use case focused on the user’s point of view. Table 48.2 shows an example of a user needs table.

CONSIDERING TASK ANALYSIS AT DIFFERENT STAGES

In this section, we look in some detail at doing task analysis for different stages of the process. Remember that even if you come in after the first stage, you can still do task analysis. Just as it is relevant at all stages, task analysis is relevant at any stage. The questions, the methods, and the deliverables may vary, but the underlying principles are the same (see Table 48.3).

Strategic Planning and Predesign Stages

Prerequisites for a Task Analysis at This Stage

- **Users:** You must know or postulate who is likely to want or need to use the product.
- **Purpose:** You must have at least a broadly conceived understanding of what the promise of this product is.

For example, the product may be aimed at small and medium businesses and provide a systematic way of combining

geographic data (maps) with financial information (sales). This is enough information for a usability specialist to begin doing user analysis, task analysis, and site visits with potential customers.

Questions for a Task Analysis at This Stage. For a task analysis during strategic planning and predesign, you probably want to answer questions like these:

- How do users currently meet the goals and do the tasks that would be fulfilled by this new product?
- How many different ways are there for meeting these goals and doing these tasks in the users’ world today?
- Are there any common elements in the way these tasks are done? What are they?
- What are the strengths (from the users’ perspective) of the current methods?
- What are the weaknesses (from the users’ perspective) of the current methods?
- How connected are these tasks with other user activities?

At the same time, you also want to understand the users themselves (user analysis): who they are, what jobs they have, what matters do them, etc. You also want to understand the contexts in which they would use your product (environmental analysis—physical, technological, social, cultural, political).

Use of the Data From Strategic Planning and Predesign Task Analysis. The answers to these questions will determine the viability of the initial market definition and product concept. They will also suggest general directions for the product.

Two specific uses of this data might be:

- Assessing the variability in activities related to task performance. This gives the design team some idea of how flexible the design must be. If all users do the tasks in the same way, a “wizard”-like approach may be best. If both the sequence and types of activities are highly variable, a more “toolkit”-oriented approach may be best.
- Deciding the difficult issue of which functions to include in the product.

Presentation of Data From Strategic Planning and Predesign Task Analysis. At these early stages, the goal is to provide the design and development team with as rich and detailed an understanding of users and their work as possible.

One way to do this is to have other team members go with the usability specialists on site visits. Team members who go on site visits should have at least minimal training in the methods being used so that they observe and listen neutrally, do not become defensive, hear what users say in users’ words, and do not take the visit as an opportunity to train or demonstrate. Team members who go with usability specialists on site visits should participate in summarizing, interpreting, and presenting the data—both because their input is valuable and to clarify any differences in interpretation about users and their work.

In addition to actually taking other team members when you are gathering the data, other ways of getting information to designers and developers include:

Triggers, Steps, and Strategies

Identify new potential customers and get their contact information

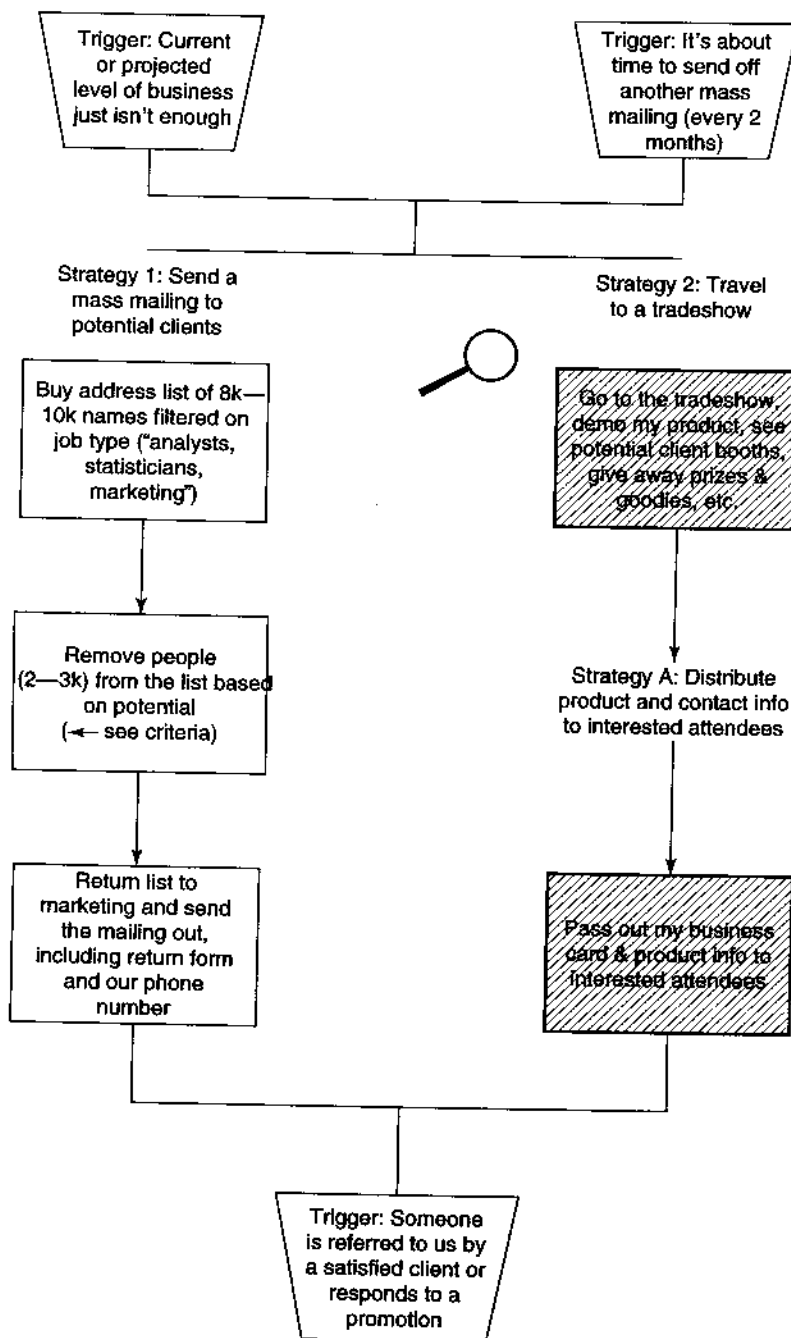


FIGURE 48.9. Part of a sequence diagram.

TABLE 48.2. Example of a User Needs Table

Sequence	Problems and Possibilities
When trapped in an elevator, passenger makes an emergency alarm call.	<ul style="list-style-type: none"> • Passengers want to get out of the elevator as soon as possible. • All kinds of passengers must be able to make an alarm call (blind, foreigners, etc.). • Sometimes passengers may make false alarms unintentionally. • Passengers may be in panic. • Passengers need instant confirmation that they have created a connection to the service centre operator and that they are going to get help.
Step 2: Unoccupied service centre operator receives the emergency alarm call and asks for information (description of the failure).	<ul style="list-style-type: none"> • Different versions and types of remote monitoring systems. • Passenger is the only information source. • Service centre operator does not notice the emergency alarm call.
Step 3: Service centre operator completes transmission of information to the system and sends it to the area serviceman.	<ul style="list-style-type: none"> • Laborious phase for the service centre operator. • Simultaneous calls must be differentiated. • Serviceman cannot see all the information. • Inadequate information from a site system. • Possibility: Instructions as to how to operate the system. • Possibility: Possibility to open phone line from Call Centre to the elevator.
Step 4: Service centre operator calls the serviceman and reads the description of the failure.	<ul style="list-style-type: none"> • Extra work for the service centre operator.

Note: From "Bridging the Gap Between User Needs and User Requirements," by S. Kujala, M. Kauppinen, and S. Rekola, 2001, *Proceedings of the PC-HCI 2001 Conference*, Patras, Greece, December 7-9. Copyright 2001. Reprinted with permission of University of Patras.

- Videos that capture essential issues and provide some understanding of the users environment (e.g., you might have brown bag lunches where you show and discuss the videos).
- Relatively simple, written summaries, such as tables of negative and positive elements of current work practice and relevant, related information.

In all likelihood, the usability engineer will revisit the raw data (videotapes, audiotapes, or transcripts) during subsequent stages of product design.

Reuse of Data Gathered at the Strategic Planning and Pre-design Stages. The data that you gather in this early stage is likely to be very rich. You probably will not use it all for the deliverables the team needs now. Keep the deliverables at this stage to ones that meet the team's need for answers to the immediate questions.

At later stages, you may find it useful to go back to the data you gathered in these visits, especially if you have videotape,

audiotape, or extensive notes that speak to the more detailed questions of what or how.

An Example of Using Data From an Early Task Analysis: Deciding on Functionality for the Product. One important use of task analysis data at an early stage may be helping product planners make the difficult decisions of determining the major functionality for a product. Functionality should be based on what will best help users meet their goals or allow users to have goals that meet their needs and values, but that they could not achieve in the world before this product. Functionality that is included only because it is "neat" or "cool" or "possible to include" may hamper the usability and market acceptance of the product.

In most projects, decisions must be made even about functionality that users want and need. Often, time and resources dictate that some functionality must be left out or left to a later release.

Approaches to this problem of choosing which functions should be included in a product vary, but any useful approach must provide a way of

- systematically capturing all users' goals and rating each one in terms of relative importance
- listing all functions under consideration and rating their relative contribution to each user goal
- integrating these two dimensions (users' goals and functions) to make appropriate decisions based on the ratings

A typical approach is to use a matrix with users' goals along one axis and potential product functions along the other axis. Typically, user's goals are scored in terms of their relative

TABLE 48.3. The Different Stages and the Major Thrust of Task Analysis Questions

These Stages	Answer This Type of Question
Strategic planning and pre-design	Why?
Information architecture and concept design	What?
Interface design, early prototypes, and development	How?

TABLE 48.4. Matrix for Weighing Market Size, Users' Tasks, and Potential Product Functions

Users	Relative Market Size		Task Relative Importance				Total (Sum of Products, How Well the Market Is Served by These Features)	
	Hi—3 Med—2 Low—1	High-Level Task	Hi—3 Med—2 Low—1	Tool Bar Customization	Better Drag and Drop	Progress Meters		Interruption Protection
Techno Bob	1	Customize my screen	3	2	1	0	0	9
		Download information	3	0	0	1	2	9
Newbie Ed	1	Customize my screen	1	-1	2	0	0	1
		Download information	3	0	2	3	0	12
Practical Sue	3	Customize my screen	2	2	2	1	0	36
		Download information	2	0	2	1	2	30
Sum				17	35	27	18	

-1—will confuse users
0—users will not use it
1—users mildly positive
2—users strongly positive

importance and potential product functions in terms of their contribution to a specific goal. These results are combined in some way and then summed in either direction with comments (see Table 48.4 for an example).

In Table 48.4, the market size of user groups was rated based on survey data. Customer visits provided data to rate the relative importance of tasks. Each feature was also rated in terms of user reaction. The numbers for market size, importance of task, and anticipated user response are multiplied to form a rating in each cell and then summed across rows and columns. The column totals show how well the feature will serve all the markets. The row totals show how well a given market is served by the features listed.

Matrices like this one provide a way to systematically look at a wide range of features in terms of tasks and market sizes (J. Pruit, person communication, Oct. 2001).

Information Architecture and Concept Design Stages

Prerequisites for a Task Analysis at This Stage. The data analysis from the earlier strategic planning and predesign stages is input to the plans for task analysis at the information architecture and concept design stages. For example, understanding problems that users have with their current tools helps to avoid the trap of designing a system that simply implements the existing work practices with new technology. Although users do not have to learn much to use a new system that mimics the old way of working, there is not much incentive for adopting a new system that has any learning curve and provides no further value.

Many of the critical issues in design revolve around striking the right balance between the way things are done now and

the improvements (as seen by the user) that technology brings. Ehn (1988) refers to this as the trade-off between "tradition" and "transcendence."

Questions for a Task Analysis at This Stage. The focus for this stage is what users know and what metaphors work for them. Relevant questions include:

- What are the primary "objects" that users deal with and what are their attributes and organization?
- What are the operations that are performed on these objects?
- What artifacts do users use in performing these tasks?
- How much variability is there in both objects and artifacts among users?

Use of the Data From Information Architecture and Concept Design Task Analysis. The objects, attributes, and operations that users currently work with suggest possible "data models" for the new product. For example, do users now organize information by time in calendars or charts or do they organize information spatially, suggesting that the metaphor should be a map or diagram?

Sometimes the appropriate metaphor is quite literal. For example, a route planning program will probably have street maps and let users get to additional information from the map interface. Sometimes, the appropriate metaphor is not nearly as literal, and we must be cautious about directly carrying over a metaphor where the new technology will cause users to misinterpret the effect of the metaphor (see Carroll & Rosson, 1987).

A related question is whether users have different metaphors for different parts of the task domain in which the software is applied or, for which the software is meant to help users. For

example, when viewing geographical sales data, one may want to compare a map view with a chart or table.

Presentation of Data From Information Architecture. The information architecture and concept stages broadly define what the system can do. There are a variety of ways to successfully represent this data, including:

- an object hierarchy showing the definition of and the relationship between objects, their types, their attributes, and their features (see Coble, Maffitt, Orland, & Kahn, 1996; Wood, 1996)
- process diagrams showing activities or artifacts and their relationships (see Coble et al., 1996; Graf, 1996)
- diagrams that capture the metaphor that was derived from user data.

Interface Design and Early Prototypes Stages

Prerequisites for a Task Analysis at This Stage. By this point in the product design and development cycle, the team is working on screen layouts, names for menu items, and design elements, such as color and icons. The overall look and feel are largely determined. Now, the usability specialist can contribute most by having specific and detailed data about user work. This detailed information can directly influence designs and prototypes.

Questions for a Task Analysis at This Stage. The focus now shifts from why and what to how. Task analysis questions for these stages include:

- What is the users' workflow?
- What words does the user use for objects, attributes, operations, etc.?
- What computer conventions do users know and feel comfortable using (e.g., right clicking)?
- How long do tasks take users now? What errors do users make? What are users' tolerances for time and errors for specific tasks?

Use of the Data From Interface Design and Early Prototypes Task Analysis. Data from a task analysis at these stages can be used both in design (to generate storyboards and screen sketches) and in evaluation (for heuristic reviews in developing scenarios and metrics and for usability tests).

Presentation of Data From Interface Design and Early Prototypes Task Analysis. Presentation here is less important because the relationship between data and design is changing. In earlier stages, the primary goal of representation was to influence the creation of the design. At these stages, the primary role of data from users is to evaluate the emerging design.

By this point, data about users, their tasks, and their environments should have been incorporated into the design. The discrepancies between the look and feel of the interface and user's tasks and underlying knowledge should be minimal. The results of task analysis should now provide input into heuristic reviews and inspections of user interfaces (Nielsen & Mack, 1994) and into usability testing (Barnum, 2002; Dumas & Redish, 1999; Rubin, 1994).

CONCLUSIONS

Many usability practitioners do task analysis in one form or another, although often they do not recognize it as such, much as Moliere's character found the fact that he had been speaking prose all his life a revelation.

Some may hesitate to plan for task analysis because they think of it as too complex and time consuming to apply in real-world situations in which time is always too short. In this chapter, we have tried to show that task analysis is a family of flexible and scalable processes that can fit well in almost any development environment.

Some may have thought of task analysis only in terms of highly structured ways of capturing minute details of specific procedures relevant to evaluating already created designs or developing training or documentation for already determined systems. In this chapter, we have tried to show that, although such uses of task analysis continue, the more common use today is in developing a very broad understanding of users' work and is of great use from the earliest strategic planning stages through all the phases of predesign. Task analysis as laid out in this chapter continues to be useful throughout the process, at later stages, being used to develop scenarios for user-oriented evaluations, as well as in inspection methods.

Task analysis is a way to involve the entire team in understanding users. It provides ways to organize the mountain of unstructured data that often comes from field studies or site visits. It is an essential part of the process of creating any product (software, hardware, Web site, document) because products are tools for users to accomplish goals; products are all about doing tasks.

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