1

Introduction

This book is about developing activity theory as an approach to the investigation of information technologies in the context of human practice. *Acting with technology* is a phrase to position our relationship to technology as one in which people act intentionally in specific ways with technology—ways that we can study and for which we can produce effective designs.

Activity theory was introduced to an international audience in the late 1970s and early 1980s through two publications: the English translation of Leontiev's *Activity, Consciousness, and Personality* (1978), and a collection of papers by Leontiev and other activity theorists edited by James Wertsch with an excellent introduction by Wertsch (1981).

But until the 1990s, activity theory was effectively standing in Vygotsky's shadow. Vygotsky's approach had become popular in the West, having a substantial impact on a wide range of research in psychology and cognitive science (Cole and Scribner 1974; Wertsch 1985; Hutchins 1995), education (Lave and Wenger 1991), and computer support for collaborative learning (O'Malley 1995; Koschmann 1996a). International interest in activity theory increased dramatically during the 1990s, judging from the frequency of citation of key works in activity theory (Roth 2004). A number of papers and books published during that time (e.g., Engeström 1990; Bødker 1991; Nardi 1996a; Wertsch 1998; Engeström, Miettinen, and Punamäki 1999) contributed to the increased awareness of the ideas and potential of the approach. According to Roth (2004), part of the credit for the uptake of activity theory should be given to Yrjö Engeström, who "through his publications and presentations in a variety of disciplines spread the word...."

The aim of *Acting with Technology* is to provide a thorough understanding of activity theory through a systematic presentation of its principles, history, relationship to other approaches, and application in interaction design. A decade ago, *Context and Consciousness: Activity Theory and Human–Computer Interaction*, a volume edited by one of us, and to which both of us contributed chapters, was published by the MIT Press (Nardi 1996a). *Context and Consciousness* presented a variety of positions and arguments unified by the common objective of making the case for activity theory as a potential theoretical foundation for human–computer interaction. *Context and Consciousness* contributed to the turn to contextual approaches in HCI, foregrounding an understanding of activity as central to the concerns of specialists in human–computer interaction.

The present book has different ambitions. *Acting with Technology* addresses three questions:

1. What impact has activity theory had on interaction design? We present and discuss key results of interaction design research based on activity theory.
2. How does activity theory relate to other theoretical approaches in the field? We contextualize activity theory in the ever-changing theoretical landscape of interaction design by way of a comparative analysis of current approaches.
3. What does "activity theory" really mean? Activity theory is sometimes considered an "esoteric" approach (Engeström 1999a) because systematic introductions to its main principles, intended for general audiences, rather than enthusiasts, are nonexistent. In this book we make an attempt to put together a primer in activity theory, to deliver activity theory "in a nutshell."

The domain of the book is *interaction design*, understood in a broad sense. The term has been used in the human–computer interaction (HCI) and computer-supported collaborative work (CSCW) communities (Winograd 1996; Preece, Rogers, and Sharp 2002; Bannon 2005; Pirhonen et al. 2005), and by those in the field of digital design who see their work as related to but distinct from human–computer interaction (Wroblewski 1991; Gaver, Beaver, and Benford 2003; Löwgren and Stolterman 2004). Löwgren and Stolterman (2004) defined interaction design as "the process that is arranged within existing resource con-

straints to create, shape, and decide all use-oriented qualities (structural, functional, ethical, and aesthetic) of a digital artifact for one or many clients." This definition reveals some reasons for the shift to the term "interaction design": it is not only computers, but digital artifacts of all kinds that interest us, and not only the computational abilities of such artifacts, but the totality of their potentials.

Winograd (1996) defined interaction design as "the design of spaces for human communication and interaction." This definition is similar in spirit to that of Löwgren and Stolterman, but more general. While Löwgren and Stolterman suggested a context of design in workaday settings, invoking clients and resource constraints, Winograd's definition can be construed as covering a wide range of issues, from empirical studies with design implications to work in hands-on design settings.

Interaction design is a broad term inflected in different ways in different communities. To us, interaction design comprises all efforts to understand human engagement with digital technology and all efforts to use that knowledge to design more useful and pleasing artifacts. Within this arena, the main audiences for this book are those who conduct work in the fields of human–computer interaction, computer-supported collaborative work, computer-supported collaborative learning, digital design, cognitive ergonomics, informatics, information systems, and human factors.[1]

Activity theory fits the general trend in interaction design toward moving out from the computer as the focus of interest to understanding technology as part of the larger scope of human activities. HCI began with the notion of a "user." Researchers developed a set of core concepts that advanced the field, such as "user-centered design," "the user experience," "usability," "usefulness," and "user empowerment" (Norman and Draper 1986; Thomas and Kellogg 1989; Cooper and Bowers 1995). Expanding these notions, Bannon (1991) coined the memorable phrase "from human factors to human actors" to emphasize actors in social contexts, consonant with the concerns of CSCW. More recently, attempts to incorporate human activity in interaction design have led to ideas of "activity-based," "activity-centered," or "activity-centric" computing (Norman 1998; Christensen and Bardram 2002; Geyer, Cheng and Muller 2003; Harrison 2004; Muller et al. 2004; Millen et al. 2005)

and "activity management" (Moran 2003). These efforts seek to provide a richer framing for interaction design that more closely matches how people actually use technology at work and play.

While it is helpful that such notions of activity-based computing acknowledge the general importance of the meaningful context of interaction between subjects and the world, it is crucial to move to concrete understanding of what activities are. Activity theory can help bridge the gap between insights about the need for broader perspectives and the need for specific tools for thought. As we attempt to study human activities "in the world" (Bannon 2005), we will encounter issues long of interest to activity theory. We believe that activity theory fits a niche opened by the emerging sensibility that studying interaction and activity is essential to the development of interaction design. The basic principles of activity theory underwrite the emphasis in interaction design on the social, emotional, cultural, and creative dimensions of human actors in shared contexts.

Today activity theory is an approach that has transcended both international and disciplinary borders. It is used not only in Russia, where it originated, but also in Australia, Belgium, Brazil, Canada, Denmark, Finland, France, Germany, Italy, Japan, Norway, South Africa, Sweden, Switzerland, the UK, the United States, and other countries. It is applied in psychology, education, work research, and other fields. In this book, we discuss activity theory in the context of interaction design, but in appendix B the interested reader can find information and web links to international conferences, journals, and discussion forums devoted to research based on activity theory from a variety of perspectives.

The book consists of three parts. In part I we give an overview of the basic concepts of activity theory and how they have been used in interaction design research. We discuss the need for theory in interaction design in chapter 2. We explicate the fundamentals of activity theory in chapter 3. We describe applications of activity theory to practical problems of interaction design in chapter 4. We provide a detailed example of an application developed with activity theory in chapter 5.

In part II we turn to more advanced issues. We discuss the notion of the object of activity in chapter 6, describe the use of this notion in an empirical study in chapter 7, and review the history of activity theory,

with a focus on key debates that shaped the development of the approach, in chapter 8.

In part III we draw on the discussions in parts I and II to outline current issues and future theoretical development in activity theory. In chapter 9, we compare activity theory with its leading contenders in interaction design—distributed cognition, actor-network theory, and phenomenologically inspired approaches. In chapter 10, we delve more deeply into issues regarding agency and asymmetry raised in chapter 9. We conclude in chapter 11 with some reflections on the future of activity theory.

If we have any advice to our readers, it is to be alert to the coherent whole that is activity theory. As we have explored other theories and empirical research, we sometimes have the sense of seeing a piece of activity theory developed independently. For example, early in his career, Herb Simon discussed the way people conserve "mental effort by withdrawing from the area of conscious thought those aspects of the situation that are repetitive" (Simon 1945). This sounds very much like the operational level of the activity hierarchy in activity theory. Without in any way critiquing Simon (who was not developing a psychological theory but rather describing organizational behavior), we can point to the way such insights crop up as "one-offs" across the theoretical landscape. In activity theory, the operational level is one of three linked levels in the activity hierarchy, not an isolated insight. Another example closer to home is that of GOMS models, which resemble the activity hierarchy but lack an activity level and the possibility of dynamic changes between levels that are part of activity theory. We hope to encourage a holistic reading of activity theory and a cognizance of the way concepts weave together into a patterned whole. Some of the power of activity theory lies in the way it ties insights into larger wholes to provide a clarifying framework for the bigger picture.

In this book we advocate and evaluate the continued development of activity theory as a basis for understanding how people act with technology. We hope to use theory to stimulate great design—the design of digital technologies that address the needs and desires of specific individuals and groups. We also want to understand the fundamentals of our human relationship with technology. These designs and understandings will

include the usual activities that we know as the practice of interaction design, but may also stretch to less familiar projects involving how we act with technology, such as analyzing the impact of technologies on the environment or understanding the role of technology in viewing our spiritual relation to the cosmos. Though such projects may appear beyond the scope of interaction design, the technologies we design inevitably have major impacts in these arenas. If we are to continue to deepen our understanding of what it means to act with technology, such concerns will impinge on, and sometimes become central to, our labors.

Activity theory seeks to understand the unity of consciousness and activity. It is a social theory of human consciousness, construing consciousness as the product of an individual's interactions with *people* and *artifacts* in the context of everyday practical activity. Consciousness is constituted as the enactment of our capacity for attention, intention, memory, learning, reasoning, speech, reflection, and imagination. It is through the exercise of these capacities in everyday activities that we develop; indeed this is the basis of our very existence.

This social approach rooted in practical activity contrasts with, for example, biological explanations of consciousness that focus on genetically coded capabilities, or neuroscientific views that situate explanation at the level of nerve tissue, or the Jungian view positing universal archetypes accessible through dreams. Traditional cognitive science attends to representations, casting them as entities that can be modeled equally well for computers as humans. Freudian explanations focus on a small set of early social relations with parents and family. Activity theory proposes that consciousness is realized by *what we do* in everyday practical activity.

To take a simple example, let's consider how an activity theorist might analyze a young child learning arithmetic. Activity theory looks for key people in the child's universe and useful artifacts. In many cultures, children learn math from their teacher who explains numbers and arithmetic operations to them, and encourages and motivates them. The children may also consult more experienced peers. Children initially perform calculations on their own bodies, counting on their fingers silently until they have internalized addition and subtraction. The fingers come into play as a useful "artifact," appropriated by the child as a marking device to aid in counting. Once the child has mastered the facts of arithmetic, the cal-

culation shifts to what activity theorists call the internal plane of actions, and the math is done in the head.

Part of what is distinctive about this formulation is that it goes beyond the representation of the arithmetic problem, beyond the bare bones of the arithmetical processes, out to the environment where the teacher, the friends, and the fingers are. These aspects of the child's universe are essential to our understanding of how the child learns arithmetic. Most theories miss these aspects, or see only one—perhaps the teacher, or the way the problem is represented on paper. In activity theory it is the *doing* of the activity in a rich social matrix of *people and artifacts* that grounds analysis.

This insight was expressed thousands of years ago in Eastern thought. In speaking to Vasettha, Buddha described the primacy of activity in human life:

> One is not a brahmin by birth,
> Nor by birth a non-brahmin.
> By action is one a brahmin,
> By action is one a non-brahmin.
> So that is how the truly wise
> See action as it really is.
> Seers of dependent origination,
> Skilled in actions and its results.
> Action makes the world go round
> Action makes this generation turn.
> Living beings are bound by action
> Like the chariot wheel by the pin.[2]

It is striking that the central image of this poem is a technical one, the chariot wheel with its pin. Here the poet intimates the close link between human action and the technologies that support it. Activity theory has developed the insights of the poets in a scientific idiom, delineating a set of core principles that frame the study of all human activity (see Zinchenko 1996).

We have found the principles of activity theory to be of help as we consider our own chariot wheels and how we design and use them. For several years we have advocated activity theory as a framework for thinking about human activity as it is expressed in the use of technology (Nardi 1992, 1993, 1996a; Kaptelinin 1992; Kaptelinin, Nardi, and Macaulay 1999; Bannon and Kaptelinin 2002). We have observed a

steady and growing uptake in the adoption of activity theory among those who find a theoretical framework useful for negotiating the thickets of users and their needs, and technologies and their possibilities. We have been drawn to activity theory because of certain of its tenets that are encapsulated in the notion of people acting with technology. These tenets are:

- an emphasis on human intentionality;
- the asymmetry of people and things;
- the importance of human development; and
- the idea of culture and society as shaping human activity.

Let us first consider intentionality. We live in an ever increasingly designed world, furnished with technologies at every turn. Despite the clearly intentional nature of the act of design—behind every design there is an intention—many of our theories lack a concept of intentionality. In acting with technology, people deliberately commit certain acts with certain technologies. Such a mild statement, seemingly devoid of theoretical freight, is in fact at odds with theories such as actor-network theory and distributed cognition. These approaches posit a sociotechnical network whose generalized nodes are actors that can be either human or artifact. Such actors represent states that move through a system—whether the actor be a pencil or a person. Intentionality is not a property of these generalized nodes. Activity theory distinguishes between people and things, allowing for a discussion of human intentionality.

More broadly speaking, activity theory posits an asymmetry between humans and things—our special abilities to cognize through interactions with people and artifacts are distinctive from any sort of agency we could sensibly ascribe to artifacts. In activity theory, it is essential to be able to theorize intention, imagination, and reflection as core human cognitive processes. Accounts in which people and artifacts are the same deflect such theorizing.

In activity theory *people* act *with* technology; technologies are both designed and used in the context of people with intentions and desires. People act as *subjects* in the world, constructing and instantiating their intentions and desires as *objects*. Activity theory casts the relationship between people and tools as one of *mediation*; tools mediate between people and the world.

Another principle of activity theory is the notion of *development.* Activity theory shares the commitment of the cultural-historical school of psychology because of its commitment to understanding how human activity unfolds over time in a historical frame. Activity theory takes the long view: we cannot understand activity if we do not watch it cycle, grow, change. It would be desirable to establish a practice of design in which the development of users—their ability to grow and change with technology—is of paramount importance. In activity theory, development is a sociocultural process, but the individual is not reduced to society or culture. The dialogical nature of processes of internalization–externalization makes it possible for individuals to transform culture through their activity. As a psychological theory, activity theory has always had a strong notion of the individual, while at the same time understanding and emphasizing the importance of the sociocultural matrix within which individuals develop. As we will discuss in chapter 9, the individual is an important theoretical concept because of the need to account for the interrelated processes of creativity, resistance, and reflexivity. These processes take place in part within individuals as people have the capacity to radically restructure cultural conceptions, transcending culture in unpredictable ways.

Technological creativity is rooted in our primate past. Nonhuman primates can "think out of the box," developing and sharing simple tools to transform their activity. For example, capuchin monkeys have been observed using sticks to reach food (Beck 1980). The great apes, especially chimpanzees, have more sophisticated tool capabilities. In the wild, chimps may use assemblages of anvils and hammers to crack tough nuts (Mercader, Panger, and Boesch 2002). An individual animal in its own well-known environment can suddenly recognize a solution to a problem, and come to see an object as a tool for some useful purpose. As with humans, nonhuman primate development is cultural; tool use among higher primates is specific to distinct animal locales, with local tools and cultural practices providing knowledge of how to use the tools.

How does grounding our theory in a concept of intentionality and the asymmetry of people and things, as well as a strong notion of development, help us as interaction designers? We believe there are several benefits. First, such a theory can provide a matrix in which to reflect on our

own practice, to arrange what seem to be disparate threads into a coherent framework. For example, the adoption of approaches such as participatory design and contextual design are responses to the larger problem of addressing the gap between the intentions of designers and the intentions of users. The continuing search for techniques of end user programming (Lieberman 2000) speaks to an unfilled need to increase end users' abilities to realize their own intentions so they can grow and develop over time, becoming increasingly adept with their technologies. The design of agent-based user interfaces, which seek to enact high-level intentions while sparing users the details, is one approach to bringing intentions into the user interface. The current state of designing and using information technologies in education also clearly indicates the importance of taking intentionality into consideration. There has been a growing realization that to have a positive impact on education, technologies should be designed to support purposeful actions of the human actors involved in everyday educational practices (Gifford and Enyedy 1999).

A second benefit of a theory grounded in intentionality, asymmetry, and development is that it can frame discussions of users' continuing frustrations. We do not have to go far to find users who are stymied in realizing their intentions because the technologies offered them are neither usable nor useful. And users often feel daunted by the rapid pace of technological change, which makes it ever more difficult to become skilled with a given technology. Only a decade ago, it was possible to write optimistically about "gardeners and gurus" (Gantt and Nardi 1992), those office experts who became especially proficient with the technologies in use in their local settings and could help their less technically inclined colleagues. Today, because technologies change more rapidly and work groups are less stable, we cannot be as sanguine about the role of local experts in the ecology of a given work setting. Activity theory's attention to issues of development commits us to taking such issues seriously.

The third benefit is that of reckoning with the long-term impact of the technologies we design. If a historical developmental perspective frames our view, we cannot merely hope for the adoption of the technologies we intentionally design; we must consider wider impacts. For example, the batteries and components of wireless devices contain arsenic, anti-

mony, beryllium, cadmium, copper, zinc, nickel, lead, and brominated flame retardants—all toxic. Wireless devices, including cell phones, pagers, PDAs, pocket PCs, portable email readers, and mp3 music players, are being manufactured by the billions. Yet we have not designed or implemented adequate means of handling the wastes they release. Toxins leach into groundwater when wireless devices are discarded in landfills, and dioxins are created when they are incinerated. Used cell phones (and computers) are often donated to Third World countries, so the waste reaches its final resting place in the air and water of the poorest countries (see *Waste in the Wireless World: The Challenges of Cell Phones*, 2002). As designers, how do we respond to these realities?

Activity theory is self-reflexive, and we are encouraged to find ways to inform our own development. To mitigate the harmful effects of, say, the wireless devices we design, we might look to the fields of architecture and manufacturing which are working with techniques of "green design," "lifetime design," and life cycle assessment. While such a move might seem an unmanageable increase in the scope of our efforts, other disciplines have adopted these concerns as part of their practice. When our theories reveal intentionality and historical development as visible theoretical constructs, we are more likely to entertain conversations about long-term effects than if our theories conceal them. Miettinen (1999) noted that understanding the historical development of human consciousness is needed to make sense of the relations between humans and their environment. Such an understanding is critical when the aim is to analyze the work of constructing associations between heterogeneous entities and the work of creating "new assemblies of materials and humans" (Miettinen 1999).

Activity theory opens up avenues of discussion concerning human interaction with technology and potentially can be fruitful in encouraging participation in conversations about the larger global concerns that the deployment of our technologies unquestionably affects. If we are *acting with technology*, both possibilities and responsibilities expand. The object of this book is to stimulate further discussion of the theoretical basis for understanding how people act with technology.

2

Do We Need Theory in Interaction Design?

In this chapter we analyze the need for theory by discussing the impact of cognitive theory on interaction design and the challenge mounted against the cognitivist approach by the situated action perspective growing out of ethnomethodology. We suggest practical reasons for developing and using theory in interaction design. Following the distinction between "first-wave HCI" and "second-wave HCI" introduced by Cooper and Bowers (1995), we position activity theory as a second-wave theory, a representative of a group of interaction design theories that encompasses postcognitivist approaches.

2.1 CHALLENGING THE COGNITIVIST PARADIGM

A coupling of cognitive psychology and computer science brought forth the field of human–computer interaction in the early 1980s (Carroll 2003). HCI adopted the information-processing paradigm of computer science as the model for human cognition. Researchers created user models, conducted experiments to study factors underlying efficient use of the user interface, and emphasized usability. A burst of immense creativity, much of it at Xerox PARC, delivered the graphical user interface, a novel, usable framework for user interaction. The methods of experimental cognitive science were applied to improving graphical user interfaces (Johnson et al. 1989) and they are now in use by millions.

Despite this success, challenges to the cognitive paradigm began to appear as early as the mid-1980s. The limitations of the traditional information-processing paradigm were demonstrated in seminal books by Winograd and Flores (1986) and Suchman (1987). By the early

1990s, these limitations were acknowledged in the mainstream HCI community (see Kuutti 1996). Some expressed a "generally pessimistic view" of the power of cognitive theory to affect the development of HCI (Tetzlaff and Mack 1991). The trend toward the need for a broader focus in HCI research and development was identified by leading researchers such as Grudin (1990) and Bannon (1991).

Suchman's book *Plans and Situated Actions* (1987) provided a cogent critique of cognitivist thinking, arguing against the idea that the enactment of algorithmic plans underlies human action. While the critique was aimed at artificial intelligence research, it called into question the more general assumption that human cognition can be modeled as a computer program. Artificial intelligence researchers believed that their programs, which searched "problem spaces" according to preset goals in order to arrive at decisions or other outcomes, were descriptive of both human cognition and intelligent computational performance (Newell, Rosenbloom, and Laird 1989). Suchman proposed instead that the resources of the immediate situation shape human action. Human action is "situated," or ad hoc, she argued, responding opportunistically and flexibly to those resources. People are improvisatory. Computer programs may follow algorithms, but people do not.

This refreshing view imparted much-needed critical reflection on the cognitivist approach. In a deft stroke of Popperian falsification, Suchman undermined key cognitivist assumptions by way of a carefully developed counterexample involving experiments with copy-machine users who were shown *not* to be following algorithmic plans as they struggled to make copies (Suchman 1987).

A major clearing of the air had taken place. However, this significant critical moment did not lead to the development of a new theoretical foundation for interaction design. The work in situated action had developed from an unusually rebellious antitheoretical branch of sociology known as ethnomethodology.

Ethnomethodology, a small but influential subfield of sociology founded by Harold Garfinkel (1967), took as its project the description of how people produce orderly social conduct. Ethnomethodologists argue that orderliness is enacted as people draw on resources in their environments, resources with which to improvise meaningful action. Action

is not preordered by anything that can be reduced to theoretical principles; rather, the analyst considers specific instances of organized action, and describes those. An ethnomethodological account is often a sequential depiction of moment-by-moment actions analyzed as responses to events in a "local scene of action" (Lynch 1999). Ethnomethodology is a serious attempt to discover and document the "methods" or "commonsense knowledge of everyday activities" of members of some natural language group (Garfinkel and Sacks 1970). A key task for ethnomethodologists is to study

> members' methods for assessing, producing, recognizing, insuring and enforcing consistency, coherence, effectiveness, efficiency, planfulness, and other rational properties of individual and concerted actions. (Garfinkel and Sacks 1970)

This undertaking was a response to an overly formalized, sterile sociology that paid little attention to subjects' own rich understandings of their experience. Ethnomethodology took a respectful attitude toward subjects, acknowledging their deep expertise, much like anthropology's approach to attaining comprehensive knowledge of subjects' understandings of their cultures (Lynch 1999).

Despite an innovative research program, ethnomethodology was a completely renegade activity within academic sociology. Garfinkel and Sacks felt that what was necessary was not a compromise with traditional formal theories, but a complete rejection of the whole idea of sociological theorizing. They even discouraged students from reading such theorizing (see Lynch 1999). This rejection pushed ethnomethodology into a radical antitheory position, where much of it remains today. Suchman (2000) explained that ethnomethodology "refuses the call to engage in theory-building" in order to "recover" practical activity in "its endless detail." The ethnomethodological view prescribes that we avoid generalization and abstraction. Lynch (1999) noted that "Garfinkel and Sacks explicitly reject general theory and turn to 'naturally occurring,' 'actual,' 'real-worldly' sources of insight and inference."

Is an atheoretical focus on the recovery of endless detail a good idea? One answer comes from anthropology. Anthropology went down the atheoretical path early in the twentieth century, when squabbles erupted between "historical particularists" who believed anthropology's mission

was to document human cultures in intensive, atheoretical detail, and generalists who were looking for theoretical principles such as cultural evolution. Historical particularism is little practiced now; it became increasingly difficult to justify simply collecting more and more detail about various cultures. Anthropology has turned to distinctly theoretical pursuits. Though new squabbles have been launched, they are played out within sophisticated theoretical arenas.

Mainstream sociology also rejected description as an end in itself. For example, Brint (2001), evaluating the study of community in sociology, observed that purely descriptive work is no longer conducted and "must be judged a failure." Descriptive work on community "failed to yield a cumulative set of generalizations about human social organization ... and has largely disappeared from contemporary sociology." Hollan, Hutchins, and Kirsch (2000) advocated that HCI develop theory to "free research from the particulars of specific cases," as we move to identify and understand the "important constituents" of interaction among people and artifacts.

Thus atheoretical accounts that substitute description for theory face the same obstacles that positivism created for itself. Lacking a theoretical compass, there is no way to know where to begin. And it is impossible to cover, or recover, all the details; a descriptive infinite regress sets in immediately upon trying.

Antitheory such as ethnomethodology struggles with its own contradictions. The very idea of the orderliness of human conduct is itself an abstraction. The work of studying orderly conduct through the empirical investigation of specific instances amounts to the development of a theoretical principle, much as investigating instances of species diversity is part of the work of developing a theory of biological evolution. That human conduct is "orderly" is not itself a foregone conclusion. Human conduct might be studied as chaotic, or as swinging between order and disorder, or as order within chaos. The assumption that specific instances of organized action can be studied theory-free is without ground. All observation is a view from somewhere.

The difficulty of atheoretical social science is illustrated by the development of ethnomethodology itself. Its most studied area, conversation analysis, is notable not for vivid descriptions of talk grounded in specific

instances, but for the revelation of the existence of general rules of conversation. The ethnomethodological theory of conversation has produced a set of well-documented rules characterizing orderly conversations, such as turn-taking, repair, and back-channeling. As it is actually practiced, then, an important area of ethnomethodology has embraced just that which it set out to reject—accounts of general rules and principles of action. These accounts have, over the years, become more and more technical, documenting in minute quantitative detail the techniques by which conversations are managed. And the accounts are patently theoretical: conversation is explained as being orderly because people follow specific well-established rules (see Pollner 1991).

Perhaps the technicalization of ethnomethodology is understandable because of the difficulty of producing arresting accounts, again and again, of specific instances of organized action. Looking once more to anthropology, we find only a few practitioners, such as Clifford Geertz, who are noted for riveting "thick descriptions." Geertz is a superb writer, rendering a Balinese cockfight, a Moroccan souk, even Javanese rice paddy farming, with the skill of a novelist (which he at one time planned to be). Not many can carry it off.

Beyond the struggle to write well, what can we say about the status of accounts from the situated action perspective? Dourish (2001a) observed:

> [Situated action] rejects abstract depictions of action and argues instead that we must see the orderliness of action as derived "bottom-up" from the local, situated activities of actors. This model places the real-time, real-space activities of social actors—embodied actions—before abstractions or theoretical accounts of them. (Dourish 2001a)

Dourish pointed out that there is a *model* here, and as such, it must be selective, artifactual—a *rendering* of "bottom-up" activities. A model must not, however, be confused with the embodied actions themselves. We have only the menu and do not want to suppose it is the meal. The call to place embodied actions before abstractions summons precisely this confusion, a confusion that dwells uneasily beneath the surface of ethnomethodological accounts. Lynch, himself a respected ethnomethodologist, acknowledged the precariousness of employing terms such as "naturally occurring" and "actual." It is not possible to reproduce events in such a way that accounts would be "actual" in any sense (Lynch 1999).

Suchman (2000) observed that ethnomethodology resists "turn[ing] lived experience and embodied practice into general lexicons and associated models." While such resistance has a place in challenging overly formal sociological accounts, it is problematic when pushed even a little. If lived experience is not "turned into" models, what is the nature of the account? The account cannot be coterminous with the lived experience. The actions and practices have come and gone with the passage of time. We have only representations, which of necessity are abstractions. We fashion these representations to the best of our ability, but inescapably shape them with our viewpoints, perspectives, constructs, and theories in doing so. We use lexicons and models to explicate what we think we have understood. We do not "recover" practice, which, as a lived thing, passes beyond us as time advances.[1] The word cannot, at least within the scope of science, be made flesh. To represent our accounts as "natural" or "actual" is to obscure the culturally specific application of theory that shapes all accounts.

Ethnomethodologists themselves do not get by without lexicons and models. For example, Goodwin (1994) developed notions of professional practice such as "highlighting for perception" and "professional vision," notions invoked by Suchman (2000) to investigate the practice of civil engineering. While these concepts seem innocuous compared to gorillas like "cultural evolution" or "the unity of consciousness and activity," they initiate a slide down the slippery slope of theorizing, moving beyond description of specific instances of organized action.[2]

Sacks et al. suggested that ethnomethodological work is "context free, yet context sensitive" (quoted in Button and Dourish 1996). This statement expresses the contradictions of ethnomethodology but does little to clarify matters. Lynch commented on Garfinkel's own theorizing:

> Despite his disclaimers about theorizing, Garfinkel again and again enunciates a comprehensive vision of how "the ordinary society" organizes itself ... through its members' use of methods of all kinds ...: formal and informal, tacit and explicit, expert and ordinary, efficient and inefficient, rational and non-rational, methods for analyzing other methods, etc. and etc. (Lynch 1999)

The final words of this long sentence point to a key tension in ethnomethodology. At the beginning of the sentence it is made clear that ethnomethodology is about order in society. By the end, ethnomethod-

ology's yearning to break free of theory sets in motion a most disorderly "etc. and etc." So devout was the attachment to the details that Lynch recalled that Garfinkel demanded that his students *master* the practices they studied. This extreme participant-observation left some struggling to become adepts in such fascinating but difficult endeavors as truck driving and Tibetan argumentation (Lynch 1999).

Ethnomethodologists themselves have suggested that ethnomethodology has had a limited practical impact on interaction design because of what Button and Dourish called the paradox of technomethodology:

> Given the concern with the particular, with detail, and with the moment-to-moment organization of action, how can ethnomethodology be applied to the design of new technology? Certainly, ethnomethodologists have urged that designers take into account the methods and actions through which social action, interaction, and categories of work are organized; but in the face of the unavoidable transformational nature of technology and system design in working settings, it would seem that ethnomethodology becomes relatively powerless. (Button and Dourish 1996)

Lynch (1999) observed that in ethnomethodology "the vision projects a picture, but it does not deliver a foundational theory that sets up a coherent program of ... research." Ethnomethodology, he suggested, can be thought of as an "attitude" of "indifference" in which what is "*not take[n] up*" (emphasis in original) is "a social science model, method or scheme of rationality for observing, analyzing, and evaluating what members already can see and describe as a matter of course."[3]

Our critical analysis of ethnomethodology does not, of course, question the fact that key developments in interaction design can be credited to ethnomethodology. The critique of the cognitivist paradigm was fruitful in encouraging new lines of investigation and in helping interaction design move toward a wider range of accepted pursuits such as the inclusion of social and organizational factors in human–computer interaction and computer-supported collaborative work (Grudin 1990; Bannon 1991; Carroll 1991, 2003). Ethnomethodologically inspired research helped to extend the scope of interaction design and chart new territories of inquiry with thoughtful empirical studies. Button and Dourish (1996) suggested that designers can learn from ethnomethodology by developing system "accounts" that "continuously offer [representations] of their own behaviour and activity, as a resource for improvised and contextualized

action." Such an approach could open up computer systems by allowing them to provide more of their own detail to users. This seems an innovative and potentially useful application of ethnomethodology.

Ethnomethodology is "indifferent" toward theory, but its attitude of respect toward subjects in their own practice—those for whom we design—is important. This commitment to respecting those we study and their deep understandings of their own practice is critical as we develop technologies that often dramatically alter those practices. Button and Dourish (1996) remarked that as designers we might profit by ethnomethodology's "respectfulness for the notion of improvised design, or for the social production and use of representations."

2.2 THE NEED FOR THEORY

The situated action approach growing out of ethnomethodology shook up the cognitivist paradigm. But ethnomethodology's attitude of indifference toward theory left interaction design without a means of theorizing what situated action claimed to be missing—the social and contextual aspects of human activity. Might we get along without theory, as Garfinkel and Sacks proposed? Why exactly are we searching for a postcognitivist theory for interaction design? In this section we discuss some practical reasons for theory in interaction design.

Most broadly speaking, theory forms community through shared concepts. While we will never achieve perfect communal unity in vocabulary and concepts (and would not want to), without some theoretical connective tissue we cannot speak to one another (Carroll 2003). We cannot merely relate accounts of endless detail with no summarizing, shaping, transforming tools at hand. We need the power to compare, abstract, and generalize.

Theory also helps us make strategic choices about how to proceed (Halverson 2002). The results of comparing, abstracting, and generalizing will always be provisional and mutable, but they will attain enough recognizable form that we can take stock and prepare for the next step.

An absence of theory is an absence of "dialogicity," that is, the opportunity to juxtapose different points of view so that each may illumine the other (Mannheim 1936; Bakhtin 1981; Miettinen 1999). Theory encour-

ages multivocality by its very nature: theories are exactly testable, dynamic, contingent things, designed to be subjected to critique, revision, or complete reformulation. Theory gives voice to multiple points of view by inviting—or rather demanding—critiques, revisions, and reformulations. To eschew theory is to endorse a unitary point of view in which a single activity becomes a closed endgame.

To move forward, to know where to invest our energies, we have need of theory. Otherwise we will always be going back to the square one of detailed renderings of particular cases. As interesting as the cases might be, we have no way of assessing whether they are typical, whether they are important exceptions to which we should pay particular attention, or if they are corner cases we do not have time for at the moment (see Kaptelinin 2002). We cannot discuss trends or look for commonalities across cases that could help us determine where to place our bets. Miettinen (1999) observed that positivistic empiricism was hobbled by a lack of theory. He asked, "How is it possible to decide what is important and essential and what is not without theoretical preconceptions?" Whittaker, Terveen, and Nardi (2000) argued that interaction design will advance more quickly when we develop means of utilizing reference tasks, an approach that has been successful in other related fields such as speech processing. Reference tasks demand intensive comparative work and a willingness to follow standard scientific methodologies of generalizing and seeking principles applicable across cases.

We believe that theoretical frameworks will facilitate productive cooperation between social scientists and software designers. Not only can such approaches help formulate generalizations related to the social aspects of the use of technology and make them more accessible to designers, they can support reflection on how to bring social scientists and software designers closer together, much as cognitive science and computer science found common ground in a shared model. The adoption of activity theory approaches by software designers is evident in work such as that of Barthelmess and Anderson (2002), Collins, Shukla, and Redmiles (2002), Fjeld et al. (2002), Zager (2002), and de Souza and Redmiles (2003), as well as researchers collaborating with software designers such as Bellamy (1996), DeCortis, Rizzo, and Saudelli (2003), and Gay and Hembrooke (2004).

Richard Rorty (1991), a philosopher of pragmatism, asked why the enterprise of science, with its theories, has been so successful. He concluded that science produces results that many people find valuable; in other words, science works because it delivers things people want. Scientific theories are not perfect representations of reality, noted Rorty, but they are good enough for important human purposes. Rorty observed that knowledge "[is not] a matter of getting reality right, but rather ... a matter of acquiring habits of action for coping with reality." There is no single correct vocabulary of knowledge; different vocabularies suit different human purposes (Rorty 1991). Writing about activity theory, Barthelmess and Anderson (2002) echoed this view, saying,

> The value of any theory is not "whether the theory or framework provides an objective representation of reality" (Bardram 1998), but rather how well a theory can shape an object of study, highlighting relevant issues.

Science and theory succeed because they attain desired objects often enough to keep the activity moving forward. Despite uneven progress, mistakes, and miscalculations, science has steadily expanded human knowledge in ways that people find worthwhile.

2.3 CHALLENGES IN INTERACTION DESIGN

The two approaches that have been dominant in interaction design at different times in its history are, in a way, mirror images. The cognitivist approach is based on a well-developed and highly structured conceptual framework that allows for generalizable models. These models are relatively easy to convert to design. However, the scope of the approach is too narrow; as discussed earlier, it ignores many issues critically important to interaction design. By contrast, ethnomethodological accounts often succeed in providing rich depictions of practice, but the accounts are not generalizable and are difficult to relate to designers' concerns (Button and Dourish 1996).

In our view, the history of conceptual developments in interaction design suggests that the search for an adequate theoretical foundation should be carried out somewhere in the middle of the territory marked by these extremes of cognitive science and ethnomethodology. The theory must meet two criteria: it should be (a) rich enough to capture

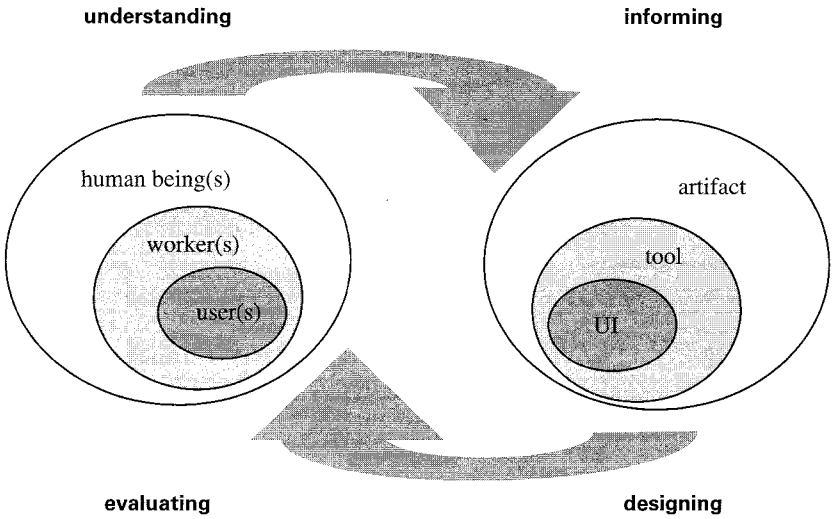

Figure 2.1
The expanding scope of interaction design.

the most important aspects of the actual use of technology and (b) descriptive and generalizable enough to be a practical, useful tool in interaction design, as suggested in figure 2.1. Figure 2.1 sketches a post-cognitivist perspective that incorporates the complexity of real practice, widening analysis to include a cycle of evaluation and design in which people and artifacts influence one another.

The arenas in which we believe we will get the most leverage from theory are those involving complex systems with multiple actors and objects. The focus in design is changing from a knowledge worker using a desktop computer to: (a) collaborative uses of technology by groups and the larger society, (b) varied virtual and physical contexts, (c) an expanded set of activities (including those conducted at home), and (d) human experience in general, not just cognition. Of particular interest are the ways individual and collective activities are linked, negotiated, and managed over time.

Recent trends in interaction design include emotion in design, extending usability to include the "pleasurability" of interactive products (Norman 2004), technology as experience (McCarthy and Wright 2004), the technology of connected presence (Licoppe 2004), persuasive

technologies (Fogg 2000), affective computing (Picard 1997), affective design (Aboulafia and Bannon 2004), autonomous characters (Tomlinson 2005), performative design (Kuutti, Iacucci, and Iacucci 2002), context-aware computing (Dourish 2001b), cultural probes (Gaver, Dunne, and Pacenti 1999), and intelligent buildings and workspace integration (MacIntyre et al. 2001; Nardi et al. 2002; Kaptelinin 2003; Fisher and Nardi in press).

Let us consider some examples of the trends mentioned above. Systems designed to promote e-democracy may involve thousands or millions of users collaborating to elect a candidate or influence a legislative body (Foot et al. 2003; Robertson 2005). New forms of disseminating publications online, such as full-service digital portals, require negotiating what it means to be published, finding the best ways for digital materials to be widely disseminated and retrieved, and integrating documents and services for communities served by portals. New modes of publication such as blogs and wikis may penetrate beyond small groups to larger arenas such as political conventions and campaigns, or loop back to print publication as authors gain devoted audiences. Scientific collaboration is growing in scale in disciplines such as molecular biology and ecology, creating the need for better digital tools (Baker, Bowker, and Karasti 2002; Zimmerman 2003).

New technologies such as robotics and nanotechnology pose interesting user interface challenges. We have some science fiction scenarios to help us imagine interacting with advanced robots, but what about invisible machines small enough to clean our teeth or deliver medication intravenously?

Work itself is changing. Work is more distributed, more contingent, less stable. How do we understand social forms such as networks and virtual teams that partially replace standard organizational hierarchies (Mortensen and Hinds 2001)? Many workers experience constant interruptions (Kirsh 2001; Czerwinski, Horvitz, and Wilhite 2004; Fussell et al. 2004; González and Mark 2004). This reality needs to be taken into account as we design. Knowledge work usually involves multitasking and working with diverse groups and individuals. Efforts to design technologies to meet these conditions benefit from careful theoretical analysis of workers' activities (Kaptelinin 2003; dePaula 2004; Morteo et al.

2004; Fisher and Nardi in press). Work is not accomplished simply with mental representations but involves complex, flexible assemblages of diverse tools arranged by workers to meet their particular needs (Spinuzzi 2003).

Interaction design is not all work and no play. Online games with thousands of participants playing in persistent worlds herald new forms of global collaboration. We are just beginning to see the formation of ways of interacting that involve little if any face-to-face interaction. MMOGs or massively multiplayer online games, are less than a decade old but engage millions of players worldwide. Several million copies of Lineage 2 have been sold in Korea, and references to the game permeate Korean pop culture (Whang and Kim 2005). MMOG characters are bought and sold on eBay. Friendships are formed in the games, and players collaborate to kill enemies, heal the wounded, and engage in all the other high fantasy actions of the games. Experience in these games may translate to other arenas such as work and school. The social networks formed online in games and other venues may shape social interaction in unexpected ways (Wellman 2001).

Education is also changing. The information transfer model is being supplanted by constructivist approaches influenced by Vygotsky. Digital educational tools in this emerging tradition are gaining ground (Cole 1996; Koschmann 1996a; Pea 1999; Sharples 2000; Haythornwaite 2002; Roschelle and Pea 2002; DeCortis, Rizzo, and Saudelli 2003; dePaula 2004; Gay and Hembrooke 2004; Stahl 2006). And design itself is evolving. New digital environments for more collaborative design are the result of careful theoretical analysis (dePaula 2004; Fischer 2004).

A theory offering a set of basic concepts to guide systematic exploration of the ever-expanding universe of complex and often confusing issues could be of enormous help in modern interaction design. Such a theory could support researchers and designers by structuring ways to approach the object of study, breaking down problems into smaller, more manageable subproblems, setting priorities, and establishing the relative importance of research issues.

We believe that activity theory could be useful for such efforts. The focus of activity theory is on *purposeful, mediated, human social activities*. A fundamental insight of the approach is that the understanding

and design of technology should be based on analysis of its role and place in activity. The concerns of interaction design can include moral and ethical issues (Friedman 1997), cultural diversity, social implications, critical analysis (Muller 1999), emotions, feelings, and spirituality (Muller et al. 2001). With its developmental perspective on purposeful mediated actions in a social context, activity theory plausibly addresses the widening purview of interaction design.

Shneiderman (2002) identified five types of roles and uses of theories (which are not mutually exclusive): (1) descriptive theories identify key concepts or variables and make basic conceptual distinctions; (2) explanatory theories reveal relationships and processes; (3) predictive theories, such as Fitts' Law or GOMS, make it possible to make predictions about performance in a range of potential contexts; (4) prescriptive theories provide guidelines based on best practice; and (5) generative theories facilitate creativity, invention, and discovery.

Activity theory can play at least three of these roles. First, it is a descriptive theory that identifies a number of fundamentally important concepts such as mediation. Second, it is an explanatory theory that suggests mechanisms explaining why and how certain phenomena take place (e.g., internalization and externalization). And, it is a generative theory, with application to problems of interaction design (discussed in chapters 4 and 5) as well continuing theoretical development (discussed in chapters 6, 7, and 10).

The search for theory in interaction design also includes the postcognitivist approaches of distributed cognition, phenomenology, and actor-network theory. These approaches are discussed in chapter 9 and compared to activity theory. In the next chapter we introduce the fundamentals of activity theory, presenting them in the historical context in which they were developed.

3

Activity Theory in a Nutshell

3.1 INTRODUCTION

The inspiration for this chapter comes from Aleksey Leontiev's *Activity, Consciousness, and Personality* (1978), the most authoritative exposition of activity theory. This "small theoretical book," as Leontiev himself described it, is not an introduction to activity theory, but a collection of essays, each focusing on a limited set of fundamental theoretical concepts. Leontiev specifically emphasized that many issues were mentioned only in passing and not clearly articulated in the book. Currently there is no standard systematic, entry-level introduction to activity theory. There is a clear need for such an introduction, especially in interdisciplinary fields such as interaction design where not everyone may have encountered original works by Leontiev, Vygotsky, and other key contributors.

This chapter is intended as a primer in activity theory. It introduces the reader to key ideas, concepts, and principles of activity theory. The chapter is different from most other short introductions to activity theory (e.g., Wertsch 1981; Davydov 1990a; Bødker 1991; Kuutti 1992; Nardi 1992, 1996a, 1998; Blackler 1995; Kaptelinin, Kuutti, and Bannon 1995; Kaptelinin 1996a; Kaptelinin and Nardi 1997; Verenikina and Gould 1998; Bertelsen and Bødker 2003). These works typically summarize the basic ideas of the theory, while giving the historical development of the ideas much less attention. Such summaries appear to be the only feasible approach, given the space limitations of a journal article or a conference paper. We ourselves have used this approach on more than one occasion. However, according to our experience, this way of introducing activity theory is not always effective. The underlying ideas of

the theory are difficult to grasp without an understanding of where the ideas come from. In this chapter we use a different approach. The main focus here is on the historical development of activity theory which is followed by a summary of its basic concepts and principles.

The chapter deals primarily with the version of activity theory developed by Aleksey Leontiev within the general framework of what is known as "Vygotsky's cultural-historical tradition," understood in a broad sense. A diversity of theoretical approaches influenced by Leontiev's activity theory has emerged in recent decades (e.g., Engeström 1987; Greif 1991; Rabardel and Bourmaud 2003). Some of them are discussed later in the book. In particular, an influential approach developed by Engeström (1987; 1990) is described in chapter 4 and compared with Leontiev's framework in chapter 6.

This chapter puts together and organizes into a coherent structure materials and ideas taken from a variety of diverse sources. Inevitably, we used our judgment, so our way of structuring the main concepts and principles of activity theory reflects our own preferences and views. Our interpretation of what constitutes the core of activity theory may differ from other interpretations.

This overview of activity theory is oriented toward interaction design. Issues that are currently, in our view, less closely related to this domain, such as the development of personality or the structure of consciousness, are discussed in less depth than other issues we think are more relevant to interaction design.

The chapter is structured as follows. We begin with a discussion of the concept of activity in general and its implications for interaction design. We then present a historical overview of the development of the main ideas underlying activity theory, from its roots in Vygotsky's cultural-historical psychology to the conceptual framework formulated by Leontiev, to current theoretical developments. We conclude with a summary of the basic principles of activity theory.

Figure 3.1
A basic representation of activity (S, subject; O, object).

3.2 THE CONCEPT OF ACTIVITY: BRIDGING THE GAP BETWEEN THE SUBJECTIVE AND THE OBJECTIVE

3.2.1 The Basic Notion of Activity

Activity theory is an approach in psychology and other social sciences that aims to understand individual human beings, as well as the social entities they compose, in their natural everyday life circumstances, through an analysis of the genesis, structure, and processes of their activities. The concept of *activity* is therefore the most fundamental concept in activity theory. Activity in general, not only human activity, but activity of any *subject*, is understood as a purposeful interaction of the subject with the world, a process in which mutual transformations between the poles of "subject–object" are accomplished (Leontiev 1978). The most basic representation of activity is shown in figure 3.1.

When defined in such a general way, activity appears to be the object of study within a variety of other conceptual frameworks as well. What sets activity theory apart is its fundamental insight about the primacy of activity over the subject and the object. Activity is considered the most basic category; analysis of activities opens up a possibility to properly understand both subjects and objects. This idea may appear counterintuitive. Traditional analytical thinking, typical, for instance, of natural sciences, would assume that to understand an activity it is necessary to understand the subject and the object separately and then make an inference about their interaction. Activity theory challenges this assumption. It claims that this apparently flawless logic can be misleading.

First, activity theory maintains that no properties of the subject and the object exist before and beyond activities (e.g., Leontiev 1978). These properties do not just manifest themselves in various circumstances; they truly exist only in activities, when being enacted. Of course, one can make generalizations and assume that subjects possess abstract attributes not limited to specific situations, such as "John is not good at math." To a certain degree such generalizations are useful and even inevitable. However, the accuracy of predictions based on such generalizations can be limited. The way an abstract attribute is manifested can depend critically on the situation at hand. For instance, the same arithmetic operation

can be performed successfully on familiar objects in common situations but not necessarily in the case of abstract or artificial tasks (Cole 1996).

Second, activity is considered the key source of *development* of both the object and the subject. In particular, developmental changes in the subject, which result from participating in activities and are determined by the nature of these activities, may cause substantial changes in the subject's properties. Let us consider a person lifting weights in a fitness room. One can argue that the process of weightlifting is determined by the physical strength of the person. If the person is strong enough, the weight will be lifted; if not, the attempt will not be successful. This causal explanation appears to be the only possible one. However, let us put the event in a larger-scale historical perspective. We might well find that the cause–effect relation is the reverse. If the person has developed muscles over an extended period of time through determined and persistent efforts, then weightlifting is the cause of the physical strength, not vice versa.

Therefore, a straightforward, logical approach to defining activities through their components can be problematic. The problems can be avoided if the analysis begins with focusing on purposeful activities. In other words, activity is proposed as the basic *unit of analysis* providing a way to understand both subjects and objects, an understanding that cannot be achieved by focusing on the subject or the object separately.

3.2.2 Agency

The notion of activity cannot be extended to all types of interactions. In activity theory, any activity is an activity of a subject. Not any entity is a subject. Subjects live in the world; they have needs that can be met only by being and acting in the world. Information-processing units, for instance, do not have "needs" (except in a metaphorical sense) and cannot be considered subjects. Therefore, interaction between the subject and the object, shown in figure 3.1, is not a symmetrical relationship between two components of a larger-scale system. The interaction is initiated and carried out by the subject to fulfill its needs. The meaning of the word "interaction" as used throughout this book when referring to activities can be described as "acting-in-the-world." Agency, the ability to act in

the sense of *producing effects*, is a fundamental attribute of both the subject and the object. The very notion of interaction implies mutual effects produced by both sides on each other. However, the agency manifested by the subject of activity is of a special character. It can be defined as *the ability and the need to act.* (Different meanings of "agency" are discussed further in chapter 10.)

The asymmetry between subjects and objects can be observed even in very early and simple forms of life. Living organisms have internal biological needs for survival and reproduction that cause them to interact with reality in specific, patterned ways. Nonliving things lack these internal needs for survival and reproduction. They have the ability to act but not the need to act. For living things, the combination of the ability and the need to act entails unique forms of agency. Living things have remarkable internal capabilities to struggle for their own survival (and subsequent reproduction). Part of this struggle involves the ability to orient to objects in the world. Even amoebas stretch out their pseudopods toward food, and pull it into their bodies. They swarm with other amoebas. In short, they act as subjects, however primitive, in the effort to live.

Nonliving things do not orient to reality in order to survive or reproduce in a self-generated way based on internal needs. A computer virus, for example, appears to struggle to survive and reproduce, but it follows a program from outside itself (written by a programmer). This program is not the same as a need. The computer virus's behavior is more analogous a human rolling a ball down an incline plane than it is to the activity of amoebas—which they generate internally from their own "programs" encoded in their RNA and DNA. These "programs" are far more flexible, mutable, and responsive to changing conditions than computer programs (a topic science is learning more about from the field of proteomics), giving "life," at least as we know it so far, a qualitatively different character than the mechanisms governing the behavior of nonliving things.

3.2.3 Implications for Interaction Design

Models of human–computer interaction popular within first-wave HCI, based primarily on information-processing psychology (e.g., Nielsen

1986), appear to focus on the same unit of analysis as activity theory, that is, on interaction between human beings (users) and objects (interactive systems). However, while the "user–system" interaction can be considered a component part of activity, the purposeful interaction with the world cannot be limited to interaction with the user interface of an interactive system. HCI models deal with lower-level interaction limited to "tasks." Tasks are typically described in terms of the functionality of a system rather than their meaning for the subject. However, using a system does not normally have its own purpose; its meaning is determined by a larger context of human activity carried out to accomplish things that are important regardless of the technology itself, such as writing a memo to a colleague or keeping in touch with a friend.

Activity theory requires that the scope of analysis be extended from tasks to a meaningful context of a subject's interaction with the world, including the social context. The boundary of the "objective world" is not limited by the user interface. People are interacting with the world "through the interface" (Bødker 1991). In other words, according to activity theory, "user–system" interaction is too narrow a phenomenon to count as a genuine activity. Making a meaningful activity the unit of analysis means that not only an interaction between people and technology is considered, but also the objects in the world with which subjects are interacting via technology.

Another difference between the activity theory perspective and traditional HCI is that while traditional HCI models focus on abstract, formal representations of individual component parts of interaction (the user and the system), activity theory emphasizes the importance of studying the real-life use of technology as a part of unfolding human interaction with the world.

Finally, traditional approaches and models in HCI pay limited attention to developmental changes, with some exceptions such as attempts to provide an account of the differences between novice and expert computer users (e.g., Allwood 1989; Mayer 1988).

Therefore, focusing on the activities of people using technology rather than on "user–system" interaction calls for going beyond the limits of traditional HCI and points to specific directions of such a development:

Table 3.1
From "user-system" interaction to activity.

	Unit of analysis	
	User-system interaction	Subject-object interaction
Context	Users and systems	Subjects in the social world
Level of analysis	System-specific tasks	Meaningful goal-directed actions
Methods	Formal models, lab studies	Studies of real-life use
Time span	Limited time span	Developmental transformations

- extending the scope of analysis to include higher-level, meaningful tasks that can be supported by diverse technologies;
- studying technology in use instead of focusing on users and systems separately; and
- taking into account long-term developmental changes in users, technology, their interaction, and the overall context.

These claims, summarized in table 3.1, represent a preliminary set of implications based on a very general notion of activity. More implications will be discussed later in the book as the notion is elaborated further.

3.3 THE ORIGINS OF ACTIVITY THEORY: CULTURAL-HISTORICAL PSYCHOLOGY

3.3.1 Russian Psychology of the 1920s and 1930s

Activity theory is not an esoteric teaching that claims to possess deep truths obtained from a mysterious source. In fact, it is a part of a time-honored worldwide intellectual tradition that can be traced back for hundreds, even thousands of years. In chapter 1 we quoted Buddha speaking of the primacy of activity in human life. Looking to the West, we find Goethe's Faust thinking the same thing:[1]

> 'Tis written: "In the beginning was the Word!"
> Here now I'm balked! Who'll put me in accord?
> It is impossible, the Word so high to prize,
> I must translate it otherwise

> If I am rightly by the Spirit taught.
> 'Tis written: In the beginning was the Thought!
> Consider well that line, the first you see,
> That your pen may not write too hastily!
> Is it then Thought that works, creative, hour by hour?
> Thus should it stand: In the beginning was the Power!
> Yet even while I write this word, I falter,
> For something warns me, this too I shall alter.
> The Spirit's helping me! I see now what I need
> And write assured: In the beginning was the Deed!

It has been, and continues to be, the project of activity theory to explain how it is that we are "bound by action" as Buddha said, how we begin not with word or thought, as Faust learned, but with activity.

In this chapter we begin with the immediate predecessor of activity theory, cultural-historical psychology, developed in Russia in the 1920s and 1930s by Lev Vygotsky and his colleagues. The founder of activity theory, Aleksey Leontiev, was a disciple of Vygotsky and conducted his first studies under the direct supervision of Vygotsky. Many ideas underlying cultural-historical psychology were directly and organically assimilated into activity theory. The line between cultural-historical psychology and activity theory is so fine that in recent years these two approaches are sometimes collectively referred to as *CHAT*, which stands for "cultural-historical activity theory" (Center for Activity Theory and Developmental Work Research, n.d.).

The time and place of the birth of cultural-historical psychology was not accidental. After the Bolshevik Revolution of 1917, there was a social demand in Russia to create a new Marxist psychology that would replace the old "bourgeois" one. A variety of conceptual frameworks were suggested during this time as candidates for the new psychology. Many of them were short-lived and are of purely historical interest. Fortunately, however, some of the ideas developed during that time proved to be important contributions and had a significant impact on the development of psychology in the twentieth century. These ideas included the notions of the unity of consciousness and activity and the social nature of the mind.

The unity of consciousness and activity An idea shared by many Russian psychologists, including Vygotsky, was that the human mind is in-

trinsically related to the whole context of interaction between human beings and the world, that it is an organ of a special kind, emerging and developing in order to make interaction with the world more successful. Therefore, an analysis of mind should include an analysis of the interaction between human beings and the world, in which the mind is embedded.

The social nature of the human mind Another fundamental idea that greatly influenced Russian psychology was that the human mind is social in its very nature. This idea was closely related to the principle of the unity of consciousness and activity. At a philosophical level, the notion of the embeddedness of the human mind in activity followed from dialectical materialism's maxim that "social being determines consciousness" (Marx and Engels 1976). Therefore, according to the Marxist philosophy adopted by Russian psychologists of the early Soviet era, the interaction between subjects and objects—that is, "being"—was understood as social.

This notion applies to both poles of the interaction. On the one hand, the subject is social. Human beings are shaped by culture, their minds are deeply influenced by language, and they are not alone when interacting with the world. Typically, they act with, or through, other people, for instance, as members of groups, organizations, communities, or cultures. A key factor of an individual's success is the success or failure of the social entity, a collective subject, to which the individual belongs. On the other hand, the world itself is fundamentally social. The entities people are dealing with are mainly other people and artifacts developed in culture.

These ideas signified a radical deviation from other psychological approaches of the time. Selecting social activities as the main object of psychological research contrasted with the exclusive focus on either subjective or objective phenomena, a focus typical of the leading theoretical frameworks of the early twentieth century including introspective psychology and behaviorism. Gestalt psychology (see, e.g., Köhler 1925) attempted to extend the scope of analysis to both subjective and objective phenomena by proposing the notion of an isomorphic relationship between the phenomenal world and the physical world. However, to

explain this relationship, Gestalt psychologists employed the concepts of physics—more specifically, physical field theory—which set them apart from the underlying assumptions of Russian psychology. Nevertheless, Russian psychology of the 1920s and 1930s had a natural affinity with Gestalt psychology, especially with studies of child development (Koffka 1924) and environmental/social psychological studies (Lewin 1936).

Most closely related to Russian psychology of the 1920s and 1930s was the constructivist approach developed by the Swiss psychologist Jean Piaget (1952). Piaget's psychology was based on a biological view of organisms trying to reach equilibrium with their environments, rather than on the notion of culture. However, the fundamental idea of the human mind emerging as a component part of the interaction between individuals and the world was not that different from the principle of the unity of consciousness and activity. According to Piaget, the objective constraints and regularities of the interaction of an organism with the world determine the logics underlying human cognition. In other words, cognitive functions and abilities are *constructed* by individuals in their continuing attempts to strike an equilibrium with the environment. It is no coincidence that the notion of internalization, which played a key role in Piaget's constructivism, was also one of the basic concepts of Russian psychology.

However, despite the similarity between Piaget's constructivism and Russian psychology, the two approaches were fundamentally different with respect to the role of culture. For Piaget, culture was an important but secondary factor that contributed to cognitive development. In Russian psychology, culture played (and continues to play) a more prominent role. The very interaction between human beings and the world was defined in terms of culture and society.

3.3.2 Lev Vygotsky (1896–1934)

Lev Vygotsky is the most prominent, and even legendary, figure in Russian psychology. He is considered one of the greatest psychologists of the twentieth century (Toulmin 1978). Vygotsky's career in psychology lasted only ten years. It started, as the legend has it, in 1924, with an out-

standing presentation at a national psychological congress after which the obscure teacher from the provincial town of Vitebsk was invited to Moscow to work at the Psychological Institute. Ten years later Vygotsky died of tuberculosis at the age of thirty-seven. During his brief career, Vygotsky undertook one of the most ambitious projects in the history of psychology. He considered contemporary psychology to be in crisis: empirical studies resulted in an accumulation of evidence in fragmented areas rather than in new fundamental insights about the nature of mind. Vygotsky's ambition was no less than to lay the foundation for a new approach that would allow integration and generalization of psychological knowledge.

3.3.3 The Cultural Determination of the Human Mind

The most fundamental issue for Vygotsky was the relationship between the mind, on the one hand, and culture and society, on the other. He believed that the notion of culture should not be limited to a set of external factors influencing the human mind. Vygotsky maintained that culture and society are not external factors influencing the mind but rather are generative forces directly involved in the very production of mind. It was critically important, according to Vygotsky, that this fundamental idea be assimilated by psychology.

At the same time, Vygotsky rejected a straightforward view of culture and society as directly determining or shaping the human mind. Vygotsky argued that the only way to reveal the impact of culture on the mind was to follow developmental, historical transformations of mental phenomena in the social and cultural context.

The idea of a nonstraightforward, dialectical cultural determination of mind was elaborated by Vygotsky into a set of principles, concepts, and research methods. He contributed to the advancement of a research methodology suitable for developmental research by introducing the notions of *molar units of analysis* and the *formative experiment.* This methodology was employed in studies of the mechanisms of the cultural determination of mind, studies that questioned traditional dichotomies of the external and the internal, the individual and the collective.

3.3.4 The General Methodology of Developmental Research

Psychological experiments typically aim at establishing, through observations or controlled studies, how certain variables are related to each other. Traditional experimental methods are difficult to apply in studies of human development. When analyzing developmental changes one cannot limit the analysis to isolated variables, because the relationship between the variables can change over the course of development.

An alternative approach, proposed by Vygotsky, is to identify "the germ" of the phenomenon under investigation, that is, the most basic, initial form, which already has the most important features of the analyzed phenomenon. Tracking down the moment when the germ emerges in the process of development and then following its transformations into more and more developed forms was considered by Vygotsky to be the basic strategy for developmental research.

Vygotsky asserted that analysis should be conducted by "units" rather than by "elements." This meant that the germ cannot be defined simply as a sum of its component parts. The parts can be the same, but if they are not related to each other in a certain way, they make up not the same germ but a different entity.

This idea was illustrated by Vygotsky with the example of water. A molecule of water consists of atoms of oxygen and hydrogen joined in a certain way. The molecule, but not its constituent parts, can be considered a germ of water. For instance, both oxygen and hydrogen are highly flammable substances when taken separately. However, the attributes of individual components are of little consequence when the components are integrated within a higher-level unit. It is the structure of the molecule of H_2O that makes water nonflammable.

Another feature of Vygotsky's methodology differentiating it from most other psychological research is its position regarding the effect of research on the object of study. Traditional psychological research methodology requires that researchers avoid any intentional intervention into the phenomena they study. However, in the context of developmental research, conducting a controlled experiment, that is, a comparative study of the impact of various factors on the process of development necessarily involves an intervention into the process. The ability to influence the

process of development can be considered an indication that the underlying understanding of development is correct. On the other hand, if the outcome of development is different from what is expected, this can be crucial feedback indicating the need for further analysis. An intentional intervention into the process of development can be considered a legitimate and even necessary research strategy (see, e.g., the concept of "action research," Argyris and Schön 1996). Accordingly, the preferred method of empirical study within Vygotsky's cultural-historical psychology was the "formative experiment," an experimental intervention into the process of development aimed at facilitating the emergence of certain developmental outcomes.

These general methodological principles were applied by Vygotsky in studies of the relationship between the mind and society. The studies focused on two dimensions of the dialectical interaction between individuals and the world: (a) internal–external, and (b) individual–collective. These two dimensions were addressed with sets of different, if closely related, concepts and research methods. However, the general idea in both cases was the same: the border between the individual and the social world is not an absolute one. The human mind is intrinsically related to culture and society through processes and phenomena that transcend the borders between internal and external, individual and collective.

3.3.5 The Internal–External Dimension: Higher Psychological Functions, Mediation, and Internalization

One concept proposed by Vygotsky for analysis of the social determination of mind was the notion of higher psychological functions. Higher psychological functions can be contrasted with "natural" psychological functions, that is, mental abilities such as memory or perception with which every animal is born. Natural functions can develop as a result of maturation, practice, or imitation, but their structure does not change and these functions are basically the same in similar species. Human beings have natural psychological functions, too, which are similar to those of other primates. However, human beings also develop higher psychological functions. Higher psychological functions emerge as a result of a restructuring of natural psychological functions in a cultural

environment. This restructuring can be described as an emerging mediation of natural psychological functions.

Human beings seldom interact with the world directly. An enormous number of artifacts has been developed by humankind to mediate our relationship with the world. Using these artifacts is the hallmark of living the life of a human being. Tools or instruments—physical artifacts mediating external activities—are easy to recognize, and their impact on the everyday life of every individual is obvious.

By way of analogy to conventional technical tools (like hammers), Vygotsky introduced the notion of psychological tools, such as an algebraic notation, a map, or a blueprint. Technical tools are intended to help people affect things, while psychological tools are signs intended to help people affect others or themselves (Vygotsky 1982a). Of course, "psychological tools" and tools in a more traditional sense are very different. Vygotsky warned against pushing the analogy too far (Vygotsky 1982a, 1983).[2] However, one thing is common to instruments and signs: their role in human activity. Both hammers and maps are mediators. The use of mediators, whether crushing a nutshell with a hammer or orienting oneself in an unfamiliar city using a map, changes the structure of activity. Psychological tools transform natural mental processes into *instrumental acts* (fig. 3.2), that is, mental processes mediated by culturally developed means. Vygotsky referred to mediated mental processes as

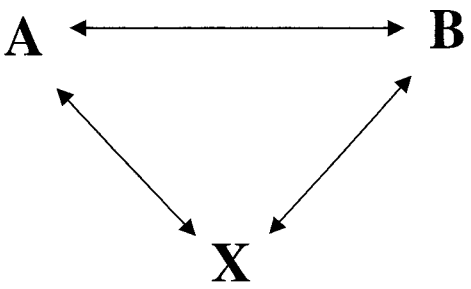

Figure 3.2
The structure of an instrumental act (Vygotsky 1982a). "A-B" represents a simple association between two stimuli, underlying a natural mnemonic act. When memory transforms into a high-level psychological function, this association is replaced with an instrumental act comprising "A-X" and "X-B."

higher mental functions, to separate them from unmediated *natural mental functions* that can be observed in other animals as well.

Initially, Vygotsky (1982a) made no distinction between psychological tools as physical artifacts (e.g., pieces of art, maps, diagrams, blueprints) and as symbolic systems (e.g., languages, numeric systems, algebraic notations) that in some cases can exist only "in the head." It did not take long, however, for him to realize the importance of whether or not psychological tools are physical, external artifacts. Empirical studies of higher psychological functions showed that in many cases, subjects who used external mediational artifacts to solve a task spontaneously stopped using these artifacts and improved their performance. Vygotsky (1983) explained this phenomenon in terms of internalization,[3] or the "transition of an external operation into an internal one" (Vygotsky 1983, our translation).

In the process of internalization, some of the previously external processes can take place in the internal plane, "in the head." The processes remain to be mediated, but mediated by internal rather than external signs. It should be emphasized that internalization is not a translation of initially external processes into a preexisting internal plane; the internal plane itself is created through internalization (Leontiev 1978). Internalization of mediated external processes results in mediated internal processes. Externally mediated functions become internally mediated.

Internalization is not just an elimination of external processes but rather *a redistribution* of internal and external components within a function as a whole. Such a redistribution may result in a substantial transformation of both external and internal components, such as an increased reliance on internal components at the expense of external ones, but both internal and external components are always present. The raison d'être for internal activities is their actual or potential impact on how the individual interacts with the world. The impact can be made only through external activities. For instance, after conducting calculations "in the head" a child may decide to buy fewer candies than she had originally planned because she realizes that their total cost would exceed the amount of cash she has.

Internalization was the object of study in an empirical investigation conducted by Leontiev (1931) under Vygotsky's supervision. The

study employed a method called "double stimulation," created by Vygotsky specifically for studies of the development of higher psychological functions. The main feature of this method is presenting the subject with two sets of stimuli. The first, primary set comprises stimuli used by the subject to solve an experimental task. The task could be—as it was in Leontiev's study—remembering a set of words (stimuli) for subsequent recall. The subjects are also provided with another, secondary set of stimuli as auxiliary means for performing the task. Stimuli of the secondary set are *signs* referring to the stimuli of the primary set. The aim of using the method of double stimulation was to be able to compare problem solving with and without secondary sets of stimuli. The design allowed for the analysis of the impact of mediation on subjects' performance in various cognitive tasks.

In the study conducted by Leontiev, the double stimulation method was employed as follows. Subjects of three age groups—preschool children, middle school children, and university students—were presented with lists of words with the instruction to remember the words. After the presentation the subjects were asked to recall as many words as possible. The lists of words constituted the primary sets of stimuli. Each group of subjects was divided into two subgroups corresponding to two experimental conditions. In one condition the words were the only stimuli presented. In another condition the subjects were given a secondary set of stimuli, a stack of picture cards, which they could use as mnemonic tools. For instance, to remember the word "dinner," a subject could select a picture of an onion and lay it away. Layaway cards could be used by the subjects during the recall phase of the experiment.

It was found that performance in each of these conditions improved with age and that using cards generally improved performance. However, the difference between recalling words with or without cards was manifested differently in the three age groups (see fig. 3.3).

In preschool children, the performance was rather poor and approximately at the same level in both conditions. In middle-school children the usage of cards resulted in a marked increase in performance level compared to the no-cards condition. University students showed a high level of performance under both conditions, and the difference between the conditions was small.

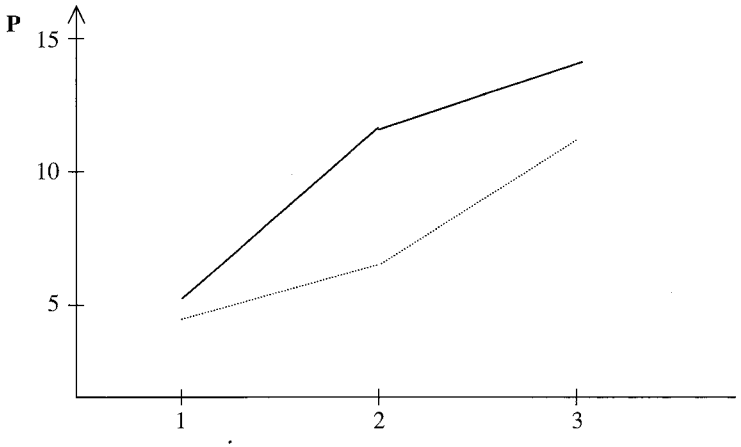

Figure 3.3
"Leontiev's parallelogram": memory task performance with and without secondary stimuli in three age groups (P-performance, the number of correctly recalled words; solid line, memory recall with secondary stimuli; broken line, memory recall without secondary stimuli; 1, preschool children; 2, middle school children; 3, university students) (adapted from Leontiev 1931).

The data were interpreted by Leontiev as an indication that children of the three age groups were at different levels in the development of mediated memory. Preschool children had not yet developed mediation capabilities, so they could not benefit from using the cards. That was why there was little difference between their performance under the two conditions. Middle-school children could successfully use the cards as external mediational tools and that was the reason they could substantially benefit from using the cards. Finally, the university students, according to Leontiev, reached similar levels of performance in both conditions because their memory was mediated whether or not they used the cards. When they could use the cards, they relied on them as external mediators. When no external mediators were provided, they used internal mediators, which were almost as effective as external mediators.

Empirical data from this and other studies employing the double stimulation technique (Vygotsky 1982b) supported the view of a restructuring of mental processes as a result of development in a cultural environment. The restructuring follows the stages of (a) no mediation, (b) external mediation, and (c) internal mediation resulting from internalization.

Therefore, over the course of internalization, external processes can transform into internal ones and there is no firm boundary between the internal, the inner world of subjective phenomena, and the external, the objective world. Internalization is one of the main modes of cultural determination of the mind. Internalization enables external mediation by culturally developed tools to effect internal, mental processes, which become culturally mediated, as well.

The individual–collective dimension: The dynamics of the social distribution of the mind Vygotsky's call for a revision of the traditional view of a border separating the mind from the physical world was paralleled by a call for a revision of another dichotomy, that between the individual and others. It was claimed that individuals and their social environments are not separated by an impenetrable border. Instead, they were to be understood as two poles of a single individual-collective dimension. Mental processes transform along this dimension of the dynamics of mental processes over the course of their development.

Sometimes this dimension is not clearly differentiated from the previous one: both the internal–external dimension and the individual–collective dimension are considered different aspects of the same phenomenon of internalization. In other words, internalization is considered a process during which phenomena external to the subject, both physical and social, become both individual and internal.

However, these two dimensions—internal–external and individual–social—should not be merged into a single dimension (see also Arievitch and Van der Veer 1995). The dynamics of the internal and external components of psychological functions can be relatively independent of the dynamics of individual and collective processes.

This can be illustrated with examples of internalization that are not paralleled by a transformation of collective activities into individual ones. For instance, consider a person driving a car who initially relies on a map but eventually learns the map and gets by without it. The means of carrying out the navigation task undergoes a significant transformation: from relying on an external artifact to relying on an internalized representation. However, over the course of this transformation the activity does not necessarily become less (or more) collective; it remains

an individual activity. Or, consider a musician who plays in an orchestra and internalizes musical scores when participating in the collective activity. The degree to which the musician relies on external artifacts (music sheets) has little to do with participation in the collective activity of the orchestra.

These examples indicate that a decreased reliance on an external artifact does not necessarily imply a corresponding transformation of a collective activity into an individual one. But it does not mean that these two processes are completely independent. They may well be two aspects of the same phenomenon. Yet they are different issues and each deserves a special analysis.

The dynamics of the individual and the social was a key issue in cultural-historical psychology. This issue was addressed by Vygotsky with two concepts, closely related to each other: the law of psychological development and the zone of proximal development.

From interpsychological to intrapsychological According to Vygotsky, the acquisition of psychological functions is subordinated to a universal law of psychological development: new psychological functions do not directly appear as functions of the individual (i.e., intrapsychological functions). First a function is distributed between the individual and other people; it emerges as an interpsychological function. Even though the individual may carry out some or even most components of a function, she cannot initially perform the function alone. Over time, the individual progressively masters the function and can reach the phase at which he can perform the function without help from others.

For instance, when new drivers start learning to drive a car in a specially equipped training car, they may appear responsible for the driving (performing basic operations such as pressing pedals and turning the steering wheel). But much of the driving may in fact be performed by the instructor, who sets the direction, monitors the overall situation, and makes most decisions. With time, the learner can assume responsibility for more and more tasks and eventually develop the ability to drive on his own. The same or similar phenomena can be observed in practically any other case of an individual acquiring a new function, including reading and writing. Even if an individual appears to learn alone, a closer

look may reveal support provided by other people in the design of a textbook, the functionality of an interactive help system, or other artifacts and environments that embody the experience of other learners, helpers, and teachers.

Therefore, the "universal law of psychological development" states that new psychological functions first emerge as interpsychological ones and then as intrapsychological ones. An application of this law to the practical tasks of assessment and support of child development resulted in the formulation of the most well-known concept of cultural historical psychology, the concept of the *zone of proximal development.*

3.3.6 The Zone of Proximal Development

Traditionally, the way of assessing the level of development of a child has been (and still is) to measure the *achievement level* of the individual, that is, what the individual can accomplish at the moment of evaluation. The achievement level can be measured, for instance, by establishing the maximum level of difficulty of tasks that can be solved by the individual. Vygotsky observed that, paradoxically, achievement-based methods of developmental assessment do not assess how a child is going to develop. They are oriented toward the past. Indicators of current performance can only assess the outcomes of development that has already taken place. These indicators are not especially useful for assessing the future of development, of how the level of performance can be expected to change over time.

The idea of the zone of proximal development was proposed by Vygotsky as a solution to this problem with traditional methods of assessment of development. Vygotsky's original definition of the zone of proximal development was as follows:

> The distance between the actual level of development as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. (Vygotsky 1978)

Vygotsky's suggestion was to measure the level of development not through the level of current performance, but through the difference ("the distance") between two performance indicators: (1) an indicator

of independent problem solving, and (2) an indicator of problem solving in a situation in which the individual is provided with support from other people.

Imagine two eight-year-old children. The kinds of math problems the children can solve are approximately the same and correspond to what is considered "normal" for their age. However, if the same amount of help is provided to these two children in solving the test problems, the results may be very different. The first child reaches the level characteristic of twelve-year-olds, while the second child only reaches the level characteristic of nine-year-olds. Apparently, the developmental potential of the first child is higher than that of the second child. However, these differences cannot be captured by the traditional methods used to measure the level of development.

The notion of the zone of proximal development can be derived from the law of psychological development described in the previous section. According to this law, psychological functions develop through two phases: first they emerge in the interpsychological plane and then in the intrapsychological plane. The emergence of a function in the interpsychological plane can be the first phase of further development, for the function that emerges in the interpsychological plane is likely to appear in the intrapsychological plane as well. Even if the individual has not yet reached a certain level of psychological function according to indicators of actual development (e.g., independent problem solving), the fact that this function already exists as distributed between the individual and other people can be a powerful predictor of the next step in the individual's development.

At the same time, the notion of the zone of proximal development does not imply that the law of psychological development should be understood in a deterministic sense. The first interpsychological phase of development of a function creates conditions for the second phase, but it does not mean that this function will inevitably emerge as an intrapsychological one.

Once again, the emphasis of this discussion on two separate dimensions of the relation between human beings and the world—the internal–external dimension and the individual–collective dimension—does not mean that these dimensions are independent of each other. Even though

these dimensions are distinct, they are still closely related. For instance, when an external component is internalized, it also affects the individual –collective dimension. Externally used tools and signs can be shared and thus facilitate communication, while internalization can make communication more problematic.

3.3.7 Pushing the Boundaries of the Individual

Taken together, Vygotsky's ideas defined a new perspective in psychology. This perspective attempted to find the origins of mind in culture and society. Instead of considering the social world an external context in which mind originates and develops according to its own immanent laws, cultural-historical psychology considered culture and society to be a generative force shaping the very nature of the human mind. Many other approaches took (and still are taking) for granted that the subjective processes of the individual constitute a separate world related to objective reality mostly through perception. It is up to the individual to decipher sensory inputs and transform them into a meaningful picture of reality (and, possibly, actions, understood as motor responses). Cultural-historical psychology takes a radically difference stance. It postulates that reality itself is filled with meanings and values. Human beings develop their own meanings and values not by processing sensory inputs but by appropriating the meaning and values objectively existing in the world. The most thorough perceptual analyses of the shape, color, and other visual attributes of religious symbols and texts do not guarantee that the perceiver understands the commandments of a religion, for example. Such an understanding requires an interaction with the world at a higher level than visual perception: the person needs to relate to meanings that are already there. The border between the mind and the physical world, between the individual and other people, is not closed. It is being dynamically redefined on a moment-to-moment basis depending on a variety of factors. Meaning and values can cross these borders—and of course, are creatively transformed along the way.

The ideas of cultural-historical psychology were carried further by Aleksey Leontiev, who elaborated them (or at least some of them) into a system of concepts and principles known as activity theory. Interestingly

enough, the development of activity theory, as we discuss below, was in a sense a by-product of another project undertaken by Leontiev.

3.4 THE DEVELOPMENT OF THE MIND

3.4.1 Aleksey Leontiev (1904–1979)

As mentioned, during the first phase of his professional life as a psychologist, Leontiev studied phenomena of mediated memory within the framework of a large-scale research program initiated and coordinated by Vygotsky. Later in his career, Leontiev formulated his own agenda which directed his research for several decades. This agenda was one of the most ambitious in the history of psychology (after all, Leontiev was a student of Vygotsky). The objective was no less than to provide a historical account of the mind, from the emergence of basic forms of psyche early in biological evolution, all the way through to advanced forms of human consciousness. The study, reported in the book *Problems of the Development of Mind* (Leontiev 1981),[4] is one of the most well-known and influential studies in Russian psychology. However, no matter how fundamental and insightful, it is not Leontiev's exploration of the evolution of mind that is considered his main contribution, but the conceptual framework of activity theory which eventually grew out of the evolutionary exploration of mind.

3.4.2 The Concept of Activity and the Evolution of Psyche

The general idea of the human mind as a special kind of organ that emerged in evolution to help organisms survive has been part of Russian psychology since the 1920s. However, the idea remained an abstract statement, a philosophical claim rather than a theory. Leontiev's ambition was to translate this general statement into a concrete description of how the first phenomena that can be called "psyche" emerged in history, and how they developed into the current variety of mental phenomena. To accomplish this goal Leontiev needed a special kind of analytical tool, a concept more general than psyche, that would make it possible to define the context in which the psyche emerges and develops. An obvious

candidate for such a concept is "life," since ultimately this is what undergoes evolutionary changes. However, this concept is too general and too vague. "Activity," as we will see below, was chosen by Leontiev as a concept that can provide a more concrete insight into what "life" is.

The concept of activity first played the role of an analytical tool helping to build a theory of the evolutionary development of the mind. However, over the course of the implementation of Leontiev's research program, the concept underwent substantial transformations. It was elaborated on, its meaning became more developed, and its relation to mind in general became more concrete. In effect, Leontiev's research program produced two results instead of one. Not only did it provide an account of the historical development of the mind, it also formulated a number of ideas and principles about the nature of activity. In the 1970s Leontiev summarized these ideas and principles into a coherent, if incomplete, framework comprising the foundations of activity theory (Leontiev 1978).

3.4.3 The Emergence of Psyche in Biological Evolution

The analysis of the evolution of the mind was conducted by Leontiev according to the main principles of the developmental research methodology described above. This methodology requires: (1) identifying the point in development when the initial, early instance of the developing system (the phenomenon under consideration), which already has the characteristic features of the system, emerges for the first time; (2) identifying the main contradictions existing at each phase of development; and (3) tracing the development of the system, unfolding as a result of resolving the contradictions. Contradictions in developmental research methodology are understood in a broad sense, as inconsistencies or discrepancies within the system or, more commonly, between the system and its environment.

For Leontiev, the phenomenon under consideration, the developing system he analyzed, was the mind, or psyche. Accordingly, the first challenge was to find the earliest, most elementary form of psyche as it emerged in evolution. The task was anything but trivial. There were a number of views regarding when exactly in biological evolution psyche appears for the first time. Is psyche a property of all living organisms?

Must the "evolutionary threshold" be raised to include only animals having central nervous system? Only humans? Since answers to these questions were, quite understandably, based on logical arguments and beliefs rather than empirical evidence, it was hardly possible to establish with certainty which of the answers, if any, was correct. Therefore, the problem remained open and a space was left for suggesting new possible solutions. Leontiev did just that by developing his own line of arguments and proposing his own hypothesis about the emergence of psyche in biological evolution. These arguments and hypothesis can be summarized as follows.

A characteristic feature of all biological organisms is their ability to actively respond to environmental factors, that is, their *responsiveness*. Organisms are not passively influenced by the environment; they develop their own internal and external responses using their own energy. This responsiveness, according to Leontiev, can be of two different types. First, organisms can respond to stimuli that produce direct biological effects. For instance, food may trigger digestive processes and can be actively assimilated by an organism, while changes in the ambient temperature may result in responses directed at maintaining an organism's own temperature within certain limits. Another type of responsiveness takes place when an organism responds to a stimulus that does not produce a direct biological effect. A smell of food or a sound signifying danger can elicit a strong response without immediately affecting the organism's biology. This second type of responsiveness, called *sensitivity*, that is, an ability to respond to *signals* carrying biologically significant information, was considered by Leontiev the most basic manifestation of psyche.

Since the inception of sensitivity there have been two main lines of development of organisms in biological evolution. The first line is the development of the ability to maintain basic life-support processes, such as digestion. The second line is development of the ability to interact with the environment which results in the acquisition of new perceptual, cognitive, and motor functions and organs, such as the senses, the nervous system, and limbs.

Having identified the most basic form of psyche, Leontiev went on to trace the development of progressively more advanced forms of psyche caused by dialectical contradictions between organisms and their

environments. He considered changes in the environment, on the one hand, and the acquisition of more sophisticated forms of interaction with the environment, on the other, to be the driving forces behind development.

The emergence of psyche itself was, according to Leontiev, caused by a radical change in the life conditions of biological organisms: a transition from living in a homogeneous "primordial soup," in which life originally appeared, to living in an environment consisting of discrete things, or objects. Objects are characterized by relatively stable combinations of properties. Some of these properties, which are of direct biological importance, are systematically associated with other properties, which are not. The latter, therefore, can be used as signals of the former. As a result, organisms that develop sensitivity—the ability to respond to signals—have better chances of survival in an environment composed of distinct objects than do organisms without such an ability.

Leontiev discerned three stages of the development of psychological functions in animals: the sensory stage, the perceptual stage, and the intelligence stage. At the sensory stage, organisms recognize and respond to isolated attributes of the environment but cannot recognize whole objects and their relations. Imagine a fish that is placed in an aquarium where food, located very close to the fish, cannot be reached directly because of an obstacle, say, a glass wall separating the fish from the food. The fish eventually learns to reach the food by following the shape of the obstacle. When the obstacle is removed, the fish can get the food much more easily, but, as shown in some experimental studies (Leontiev 1981), it may continue to follow the shape of the obstacle for some time after the obstacle is removed. Most animals are at a more advanced perceptual stage of development. When they see that the obstacle between themselves and the food is removed, they go to the food directly.

Some animals, such as apes, reach the highest stage in Leontiev's hierarchy of animal psyche, the intelligence stage. These animals are able to develop sophisticated mental representations of problem situations in which they are immediately engaged. Such representations allow for problem-solving behavior characterized by effectiveness, fast learning, and high transfer. An example of intelligent animal problem solving is Köhler's famous chimpanzee trying to reach a banana without success

and suddenly "realizing" that a stick could be used to get the banana (Köhler 1925). Such an insight can instantly change the chimpanzee's behavior and can be applied directly, without any trial-and-error, in a wide range of similar situations.

3.4.4 The Origins of the Concept of Activity

The concept of activity plays a crucial role in Leontiev's analysis of the evolution of psyche. The concept was introduced as fundamental as soon as Leontiev set out to discover the earliest manifestations of mind:

> I will call the processes of *activity* the specific processes through which a live, that is, active relation of the subject to reality is realized, as opposed to other types of processes. (Leontiev 1981)

Immediately after introducing the concept of activity Leontiev introduced the concept of the object of activity. He emphasized that activities cannot exist without their objects: "Any activity of an organism is directed at a certain object; an 'objectless' activity is impossible" (Leontiev 1981).

A distinction between mental and nonmental phenomena required that both be defined in terms of a general overarching concept and then differentiated within this frame of reference. Activity was chosen by Leontiev to play the role of such a basic, fundamental concept. He used this concept to describe the transition from "premental" life, that is, life processes prior to the emergence of psyche, to more advanced forms of life associated with mental phenomena, as

> a transition from a "pre-mental" activity, that is, activity, which is not mediated by a representation of objective reality, to activity, which is mediated by a representation of objective reality.... Therefore, psyche, mental activity, is not something that is added to life but a special form of life, inevitably emerging in the process of its development. (Leontiev 1981)

Thus, two historical threads can be discerned in Leontiev's analysis of the evolution of psyche. The first thread is a long-term project dealing with developmental transformations of the mind. The second thread is a development of the key analytical tool used by Leontiev in his historical analysis, the concept of activity. When the concept is first introduced, it is a basic and rather undeveloped seed, possessing the crucial attributes of the concept (an active relation of the subject to reality, always oriented

toward and determined by its object) but virtually nothing else. However, over the course of Leontiev's developmental analysis, as will be shown in the next section, the meaning of the concept also develops, especially when Leontiev goes on to discuss the development of the human mind.

3.4.5 The Historical Development of the Human Mind

The development of the human mind was a radically new phase in the evolution of the psyche. For animals, mind is an organ of survival; it increases the organism's fitness regarding its natural environment, just as claws or fur do. Through assuring the survival of the fittest, evolution stimulates the development of mind in animals. But with the emergence of human culture and society, biological evolution ceased to be the main factor in the development of the mind. The survival of an individual living in society depends on economics, politics, and technologies, rather than fitness understood as the body's ability to adapt to the natural environment. Accordingly, the nature of the human mind is determined not only by biological factors but also by culture and society.

Leontiev specifically analyzed three aspects of culture that have a fundamental impact on the mind: tools, language, and the division of labor.

In his analysis of the role of tools and language, Leontiev by and large followed the approach established by Vygotsky. He considered tools to be a vehicle for transmitting human experience from generation to generation. The structure of a tool itself, as well as learning how to use a tool, changes the structure of human interaction with the world. By appropriating a tool, integrating it into activities, human beings also appropriate the experience accumulated in the culture. Elaborate practices of creating, storing, and maintaining tools are the most basic features of human beings, differentiating them from other animals.

The use of tools is closely related to other factors influencing the development of the mind, namely, the use of language and the division of labor. Continuing the cultural-historical tradition of using the tool metaphor for understanding the role of signs and symbols in the functioning and development of the mind, Leontiev focused on the role of tools in the development of concepts. Concepts have a general meaning applica-

ble to a variety of concrete situations and experiences. Over the course of their individual development (*ontogenesis*), human beings learn and appropriate concepts already existing in their cultures. The concepts, however, have not always been there. They are a result of the positive and negative experiences of people who contributed to the development of the culture. One might ask: How did the first concepts, the first generalizations emerge from individual human experience? Leontiev suggested a hypothesis that may provide an answer, at least a partial one, to this question.

Early tools, such as a stone axe, could be used for a variety of purposes. They could, for example, cut trees, kill animals, or dig soil. The objects to which an axe was applied could be soft or hard. Some objects were easy to cut, some required substantial time and effort, and some were so hard that it was impossible even to leave a dent on them. Despite these differences, all the objects could be compared against the axe, which was an invariant component of all encounters. Therefore, the axe could be considered an embodied standard of softness/hardness. Using the axe for practical purposes to do something with an object in the environment had the side effect of placing the object on a "scale" of softness/hardness. This scale emerged as a generalization of the individual experience of using the tool. Since people followed shared, culturally developed procedures of creating and using tools, the tools could serve as an embodiment of abstract concepts based on the generalization of both individual and collective experience.

Another implication of the use of tools for the historical development of the human mind is their role in the emergence of the division of labor. Even though the division of labor was the result of a variety of factors, it was tools that assured the development of the sophisticated forms of coordination typical of collaborative work and other socially distributed activities. On the one hand, the production of tools became a separate activity that required specialized skills. Individuals who possessed these skills were likely to make tools for other members of a social group, which was probably one of the first examples of the division of labor. On the other hand, tools and other artifacts (such as clothes) could facilitate the coordination of individual contributions to collective activities by signifying the social status and specific responsibilities of their owners.

The division of labor, according to Leontiev, had special significance for the development of the mind. When a person participates in a socially distributed work activity, his actions are typically motivated by one object but directed to another. Let us consider Leontiev's canonical example of activity, the collective activity of hunting. Individuals participating in a collective hunt may be divided into two groups: one group (the beaters) beats the bushes in order to scare the animals and make them move in a certain direction, and another group hides, waiting to ambush the animals directed toward them by the beaters. Both groups are motivated by food. However, for members of the first group, the immediate goal is not to get closer to the animals and kill them but, on the contrary, to scare them away. These hunters are motivated by their share of the whole catch which they expect to receive as a reward for their contribution to the hunt. But taken out of the context of the collective activity, the actions of these hunters appear to have no meaning.

A noncoincidence of objects that motivate an activity and objects at which that activity is directed is a characteristic feature of human activity. In animal activities, motivating objects and directing objects basically coincide. If the activity of an animal is directed toward an object, this object typically immediately corresponds to a certain need. In human activities, however, the link between what an individual is doing and what she is trying to attain through what she is doing is often difficult to establish. The structure of human activities, as opposed to the structure of the activities of other animals, can be extremely complex. The main reason behind this, according to Leontiev, is a transformation that individual activities undergo as a result of participation in the division of labor. When an individual takes part in a socially distributed activity, the difference between motivating and directing objects is forced on the individual by the organization of the activity. The division of labor makes dissociation between the motivation and the direction of activity an objective attribute of an individual's interaction with the world. Internalization of this dissociation changes the structure of individual activities. Individual activities can potentially develop a complex relationship between motivating and directing objects.

In a way, the historical evolution of mind illustrates the "universal law of psychological development" formulated by Vygotsky for individual

development: new functions and attributes emerge first as distributed between the individual and his or her social environment (that is, as interpsychological ones) and then become appropriated by individuals (that is, become intrapsychological ones). The division of labor makes attaining a goal within a collective activity meaningful (or at least rewarded) even if the relation of the goal to the object of the activity as a whole is not straightforward. The ability to connect the current focus of one's efforts with their ultimate intended outcome and to integrate indirectly related actions first emerges in history as supported by the division of labor. At this stage of development, the ability to coordinate intermediate goals can exist only as distributed between people. For instance, the beaters in the hunt above could perform their roles without understanding the actual meaning of their actions. But it seems plausible that collective activities can be carried out much more successfully if contributing individuals understand the relationship between intermediate and ultimate outcomes. Therefore, the division of labor creates conditions for the dissociation between motives and goals. This dissociation first emerges in collective activities and then in individual activities and minds.

3.4.6 The Structure of Human Activity

Needs, motives, and the object of activity So far we have discussed "activity" in a broad sense, as subject–object interaction in general. In this broad meaning, any process of a subject's interaction with the world can be qualified as an activity. However, in activity theory, the term also has a narrower meaning. According to this meaning, activity refers to a specific level of subject–object interaction, the level at which the object has the status of a *motive*. A motive is an object that meets a certain need of the subject. The reason the notion of motive plays a key role in the conceptual framework of activity theory will be evident from the discussion below.

Let us consider more closely the idea of subject–object interaction that takes place at several levels simultaneously. Obviously, at any given moment, we can discern a whole range of objects with which a subject is interacting. For instance, depending on the angle from which a person is

viewed, he can be described as hitting a key on a computer keyboard, typing a word, or writing a novel. Accordingly, the objects the person is dealing with include the key, the word, and the novel, all at the same time. These objects constitute a hierarchy, where objects located higher in the hierarchy define larger-scale units of subject–object interaction. The top-level object in the hierarchy, according to activity theory, has a special status. The reason the subject is attempting to attain this object is the object itself. The object is perceived as something that can meet a need of the subject. In other words, the object motivates the subject—it is a motive.

Activity in the narrow sense is a unit of subject–object interaction defined by the subject's motive. It is a system of processes oriented toward the motive, where the meaning of any individual component of the system is determined by its role in attaining the motive.

Therefore, according to activity theory, the ultimate cause behind human activities is *needs*. Needs can be viewed, according to Leontiev, from either a biological or a psychological perspective. From a biological perspective, a need is an objective requirement of an organism. Having a need means that something should be present in the environment. Organisms may need food, water, air, or a certain temperature maintained in an appropriate range, in order to survive and reproduce. From a psychological perspective, a need is a directedness of activities toward the world, toward bringing about desirable changes in the environment. It is expressed in particular behavior and subjective experiences.

At the psychological level, needs can be represented in two different ways. Needs that are not "objectified," that is, not associated with a concrete object, cause general excitement which stimulates the search for an object to satisfy the need. The subject may experience discomfort ("a need state"). However, this discomfort cannot direct the subject and help satisfy the need, except in stimulating an exploratory behavior that is not directed at anything in particular. When a need meets its object, which, according to Leontiev, is "a moment of extraordinary importance" (1978), the need itself is transformed, that is, objectified. When a need becomes coupled with an object, an activity emerges. From that moment on, the object becomes a motive and the need not only stimulates but also directs the subject. An unobjectified need is a raw state of

need looking for an object, while an objectified need is one with a defined object, where the subject knows what it is looking for.

Therefore, the most fundamental property of needs, according to Leontiev, is that they cannot be separated from objects. The defining feature of unobjectified needs is that they are seeking objects, while objectified needs manifest themselves through their objects. The very concept of activity includes its orientation toward an object, an object that both motivates and directs the activity. The object of activity, which is defined by Leontiev as the "true motive" of an activity (Leontiev 1978), is the most important attribute differentiating one activity from another.

Human needs are different from other animals' needs. Psychological needs of other animals are related to biological needs, and their activities are directed toward objects associated with biological needs. However, even in nonhuman animals, biological needs do not directly determine the objects of the needs. When selecting objects of their activities, animals can rely on a wide range of attributes that may be only indirectly related to biological properties. This ability provides obvious advantages. For instance, a lion that attacks only the slower antelopes might survive longer than a lion that attacks indiscriminately. The more developed an animal, the more its psychological needs are influenced by the structure and affordances of the environment, and the more difficult it is to trace the behavior of the animal to underlying biological needs.

In humans, some psychological needs are clearly based on biological needs. However, even these needs are transformed by culture and society which provide incentives, guidance, and constraints on selecting the objects of the needs and the means of satisfying them. More importantly, human psychological needs are not limited to needs based on biology. The relationship of human psychological needs to biology is difficult or impossible to trace, and sometimes this relationship appears to be negative rather than positive. Some cultural practices and many rituals do not seem to be healthy, sensible, or even pleasant.

Activity theory neither proposes a taxonomy of potentially effective needs (as do some psychological approaches, e.g., Maslow 1968) nor provides strict criteria to differentiate motives from nonmotives. Human needs are always in the process of developing, so it is impossible in principle to give a definitive description of all possible needs and motives.

What activity theory does propose is a conceptual framework to bridge the gap between motivation and action. Activity theory provides a coherent account for processes at various levels of acting in the world.

Activities, actions, and operations Activity in a narrow sense is a unit of life, a subset of all possible processes related to the interaction of the subject with the world. The subset is defined by its orientation toward a specific motive. However, activities are not monolithic. Each activity, in its turn, can be represented as a hierarchical structure organized into three layers. The top layer is the activity itself, which is oriented toward a motive. The motive is the object, which stimulates, excites the subject. It is the object that the subject ultimately needs to attain.

However, human activities are typically not directed straight toward their motives. As in the hunters example, described above, socially distributed activities are characterized by a dissociation between their motivating and directing objects. Complex relations between these two types of objects are present in society and are a fact of life for people who live in society. Participation in social activities makes it necessary for individual subjects to reproduce within the structure of their individual activities the complex, mediated dissociation between (a) objects that attract them and (b) objects at which their activities are directed.

In other words, an activity may be composed of a sequence of steps, each of which is not immediately related to the motive even though the sequence as a whole may eventually result in attaining the motive. According to activity theory terminology, these components of activity are *actions*. The objects at which they are directed are called *goals*. Goals are conscious; we are typically aware of the goals we want to attain. In contrast, we may not be immediately aware of our motives. Leontiev observed that making motives conscious requires a special effort of making sense of "indirect evidence," that is, "motives are revealed to consciousness only objectively by means of analysis of activity and its dynamics. Subjectively, they appear only in their oblique expression, in the form of experiencing wishes, desires, or striving toward a goal" (Leontiev 1978).

Actions, in their turn, can also be decomposed into lower-level units of activity called *operations*. Operations are routine processes providing an adjustment of an action to the ongoing situation. They are oriented to-

ward the conditions under which the subject is trying to attain a goal. People are typically not aware of operations. Operations may emerge as an "improvisation," as the result of a spontaneous adjustment of an action on the fly. For example, walking through a crowd, one can carry out elaborate maneuvering to avoid colliding with other people and physical obstacles without even realizing it. Another source of operations is the automatization of actions. Over the course of learning and frequent execution, a conscious action may transform into a routine operation. For instance, some skills that in experienced car drivers are apparently operations result from many hours of practice. When first learning to drive a car, a novice may need to focus consciously on the procedure of, for example, changing lanes. Changing lanes for inexperienced drivers can require total concentration, making it impossible to be engaged in any other activity (such as conversation). However, gradually this action may become more and more automatic. Eventually a driver reaches the phase at which changing lanes is done automatically and is hardly noticed. The driver can now also engage in other simultaneous activities.

The separation between actions and operations according to their orientation—respectively, toward the goal and toward the conditions in which the goal is "given" to the subject—is relative rather than absolute. Some actions are more directly related to the object of activity than others. For instance, adding a new section to a draft document is clearly related to the goal of writing a paper. However, accomplishing this goal may require a range of auxiliary actions more loosely related to the goal at hand. One may need to respond to other people's comments, learn new features of a word processor such as styles or "track changes," or find information in physical or electronic archives. Therefore, the main criterion separating actions from operations is that operations are automatized.

Levels of activity, shown in figure 3.4, can transform into one another. Automatization is an example of transformations between actions and operations. Over the course of practice actions can become automatic operations. The opposite process is "deautomatization," the transformation of routine operations into conscious actions. Such a transformation can take place, for instance, when an automatized operation fails to produce the desired outcome and the individual reflects on the reasons for

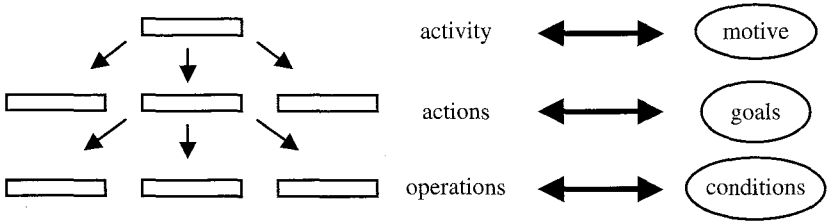

Figure 3.4
The hierarchical structure of activity. Activities are composed of actions, which are, in turn, composed of operations (left). These three levels correspond, respectively, to the motive, goals, and conditions, as indicated by bidirectional arrows.

the failure and on how the operation can be "fixed." Typically a new, more appropriate procedure is devised which first is carried out as a conscious action and then becomes an operation. Transformations can also take place between activities and actions. For instance, a goal subordinated to another higher-level goal can become a motive, so that a former action acquires the status of an activity.

Functional organs A key concept of activity theory from the point of view of interaction design is the concept of *functional organs*. The origins of this concept can be traced to earlier works, for instance, those by the Russian physiologist Ukhtomsky, who defined a functional organ in a broad sense as "Any temporary combination of forces which is capable of attaining a definite end" (Ukhtomsky 1978, cited in Zinchenko 1996). Leontiev (1981) elaborated this concept by introducing the idea of functional organs as created by individuals through the combination of both internal and external resources. Functional organs combine natural human capabilities with artifacts to allow the individual to attain goals that could not be attained otherwise. For instance, human eyes in combination with eyeglasses, binoculars, microscopes, or night-vision devices, constitute functional organs of vision that may significantly extend human abilities.

To create and use functional organs, individuals need special kinds of competencies (Kaptelinin 1996b). *Tool-related competencies* include knowledge about the functionality of a tool, as well as skills necessary to operate it. *Task-related competencies* include knowledge about the

higher-level goals attainable with the use of a tool, and skills of translating these goals into the tool's functionality.

One implication of the notion of functional organs is that the distribution of activities between mind and artifacts is always functional. It takes place only within subsystems that have specific functions, more or less clearly defined. Such subsystems, whether distributed or not, are integral parts of the subject, who makes ultimate decisions on when to use a functional organ and whether it has to be updated, modified, or even completely abandoned. Therefore, the subject must have competencies of a special type to create and use functional organs efficiently. These competencies, which can be tentatively labeled as *metafunctional*, integrate the functional organs into the system of human activities as a whole (Kaptelinin 1996b). In contrast with tool-related and task-related competencies, metafunctional competencies are not directly related to employing functional organs for reaching goals. Instead, they deal with the coordination of multiple goals that can be attained via one action, with the limitations of functional organs (for instance, which goals *cannot* be achieved with them), and with side effects, maintenance, and troubleshooting.

3.5 BASIC INSIGHTS AND PRINCIPLES OF ACTIVITY THEORY: AN OVERVIEW

The aim of this section is to summarize the concepts discussed earlier in the chapter. We identify two main ideas underlying activity theory and a set of basic principles that elaborate the ideas and jointly constitute the general conceptual system of activity theory. The structure we use to outline the approach builds on a set of the main features of activity theory identified by Wertsch (1981).

3.5.1 The Main Ideas of Activity Theory

The two main ideas underlying activity theory, originating from Russian psychology of the 1920s and 1930s, are

1. the unity of consciousness and activity, and
2. the social nature of the human mind.

The first idea asserts that the mind emerges, exists, and can be understood only in the context of the subject–object relationship. The second idea claims that society and culture are not external factors influencing the human mind but rather generative forces directly involved in the very production of the mind.

It is important to mention that Leontiev specifically emphasized that the individual is not a carbon copy of culture and society. In particular, he pointed out that meanings live a "double life" in the consciousness of the individual as both (a) meanings that objectively exist in a culture and are generally shared by individuals who belong to the culture and (b) "personal senses" that are different for each individual.

3.5.2 Basic Principles of Activity Theory

Object-orientedness All human activities are directed toward their objects. When people design, learn, or sell, they design, learn, or sell *something*. Their dreams, emotions, and feelings are also directed toward something in the world. Analysis of objects is therefore a necessary requirement for understanding human beings, acting either individually or collectively. Objects of activities are prospective outcomes that motivate and direct activities, around which activities are coordinated, and in which activities are crystallized in a final form when the activities are complete. Objects separate one activity from another. The world provides resistance and affordances to our attempts to reach the objects of our activities; through resistance and affordances, objects constrain and direct what we do. We also develop internal, subjective counterparts of the objects, which may be no less effective in constraining and directing our activities than the resistance and affordances of the world. Therefore, objects can be considered as both external and internal.

A way to understand objects of activities is to think of them as *objectives* that give meaning to what people do. Concrete actions can be assessed as to whether or not they help (or otherwise) accomplish the objectives. But objects do not unilaterally determine activities: it is activity in its entirety, the subject–object relationship, that determines how both the subject and the object develop.

For example, a new family house can be the object of a person's activity (as well as an activity of a family as a whole). Over the course of the activity, the initial idea of the home could change many times, and the final outcome may look very different from what people envisioned initially. The subjects of the activity, the individuals and the entire family, may also change as a result. The house becomes a part of social reality—for instance, it is partly shaped by explicit and implicit rules, norms, and requirements (even, probably, conflicts) existing in the family and the wider community. Therefore, neither subject nor object alone is the determining factor; activity unfolds in a social context, transforming both the subject and the object. It is important that not only subjects but also objects are taken into account when understanding people and their activities.

Objects can be physical things (such as the bull's eye on a target) or ideal objects ("I want to become a brain surgeon."). Leontiev clearly understood that the concept of object in psychology could not be limited to the physical, chemical, and biological properties of things. Socially determined properties, including those of artifacts, and the very involvement of things in human activity, are also objective properties that can be studied with objective methods. So, the principle of object-orientedness states that human beings live in a reality that is objective in a broad sense: the things that constitute this reality have not only the properties that are considered objective according to natural sciences but socially and culturally defined properties as well.

The hierarchical structure of activity An activity in its broad sense, such as the subject–object relationship, can be analyzed at different levels: *activities, actions*, and *operations* (Leontiev 1974). Actions are conscious goal-directed processes that must be undertaken to fulfill the object. Different actions may be undertaken to meet the same goal. Goals can have lower-level goals, which can have lower-level goals, and so forth (akin to the concept of goals/subgoals in artificial intelligence research and other traditions). For example, making a hunting weapon is an action that entails at a lower level, finding suitable materials and tools for the manufacture of the weapon. Therefore, the level of actions is itself

hierarchically organized and can be decomposed into an arbitrary number of sublevels, from higher-level actions to lower-level actions.

Moving down the hierarchy of actions we cross the border between conscious and automatic processes. For instance, dialing a phone number can be a conscious action, but implementing this action by pressing phone buttons can be performed automatically. The automatic processes, according to activity theory terminology, are *operations*, which correspond to the way the action is actually carried out. Operations may emerge spontaneously, but a more common source of operations is the automatization of actions, which become routinized and unconscious with practice. Operations do not have their own goals; rather they provide an adjustment of actions to current situations. When one is learning to drive a car, the shifting of the gears is an action with an explicit goal that must be consciously attended to. Later, shifting gears becomes operational, and "can no longer be picked out as a special goal-directed process: its goal is not picked out and discerned by the driver" (Leontiev 1974).

Activity theory holds that the constituents of activity are not fixed but dynamic, and this can change as reality changes. This is an important distinction between activity theory and other constructs such as GOMS. In activity theory, all levels can move both up and down (Leontiev 1974). As we saw with gear-shifting, actions become operations as the driver habituates to them. An operation can become an action when "conditions impede an action's execution through previously formed operations" (Leontiev 1974). For example, if a user's email program ceases to work, the user continues to send mail by substituting another program, though now it is necessary to pay conscious attention to an unfamiliar set of commands. The object remains fixed, but goals, actions, and operations change as conditions change.

Internalization–Externalization The human mind is not separated from culture and society. Internalization and externalization are processes that relate the human mind to its social and cultural environment. There are two dimensions of externalization–internalization. The first dimension corresponds to the distinction between mental processes and external behavior. The second dimension corresponds to the distinction between

individual (intrapsychological) and collective (interpsychological) phenomena. These dimensions emphasize, respectively, the physical and the social aspects of internalization and externalization.

Mental processes vs. external behavior Activity theory differentiates between internal and external activities. The traditional notion of mental processes (as in cognitive science) corresponds to internal activities. Activity theory maintains that internal activities cannot be understood if they are analyzed in isolation from external activities, because there are mutual transformations between the two kinds of activities. Internalization is the transformation of external activities into internal activities. For example, when first learning to type, the learner may look at the keys. Later, after much practice, "touch typing" is possible and the typist types without looking at the keyboard. The internal activity grows out of the external activity. But it is not a carbon copy of the external activity, that is, the typist does not see a keyboard in her mind. A transformation has taken place in which the external becomes internal, but also changes somewhat in form.[5]

Internalization provides a means for people to consider potential interactions with reality through mental simulations or imaginings without performing any actual manipulations with real objects. Internalization is not a simple transfer of previously external actions into an internal plane, "in the head"; even the most skilled typists and the most experienced drivers of manual transmission cars still need to press physical keys and change gears. Internalization causes a redistribution between external and internal components of activity, and in some cases, external components can be omitted in order to make an action more efficient, as in the case of the typist not needing to look at the keyboard.

Externalization transforms internal activities into external ones. Externalization is often necessary when an internalized action needs to be "repaired," or scaled. For example, if a suspect result is achieved when mentally adding numbers, or if a calculation is too large to do in the head, a calculator may be deployed. Externalization is also important when a collaboration between several people requires their activities to be performed externally so that the activities are coordinated. While the concept of internalization shares much with traditional cognitive science's notion of information processing, externalization is not emphasized in

cognitive science. Activity theory emphasizes that it is the constant transformation between the external and the internal that is the basis of human activity.

Interpsychological vs. intrapsychological According to Vygotsky (1986), there are two stages in the development of mental abilities. First, these abilities emerge as *interpsychological* mental functions, distributed between the learner and other people, and after that they become *intrapsychological* functions, when social distribution is no longer necessary.

In many respects, the dimension of intrapsychological–interpsychological is similar to that of mental processes–external behavior. In both cases the dynamics of human activity include mutual transformations between two extremes. These transformations produce similar outcomes. Internalization as individual appropriation of socially distributed functions is a powrful source of development. Externalization as social redistribution of activities relates individuals to their social environments and can be a way to "repair" a process in case of a breakdown.

Mediation Activity theory's emphasis on social factors and on the interaction between people and their environments explains why the principle of tool *mediation* plays a central role within the approach. First, tools shape the way human beings interact with reality. And, according to the principle of internalization–externalization, the shaping of external activities eventually results in the shaping of internal ones. Second, tools usually reflect the experience of other people who tried to solve similar problems earlier and invented or modified the tool to make it more efficient and effective. Their experience is accumulated in the structural properties of tools, such as their shape or material, as well as in the knowledge of how the tool should be used. Tools are created and transformed during the development of the activity itself and carry with them a particular culture—the historical evidence of their development. So the use of tools is an accumulation and transmission of social knowledge. It influences the nature of external behavior and also the mental functioning of individuals.

Many relevant theoretical explorations were conducted either before the notion of mediation was developed within the Vygotskian tradition or in parallel with cultural-historical studies. For instance, the problem

of identifying a border between an individual and the world was addressed by William James (1890) and Gregory Bateson (1972). From different perspectives, both James and Bateson came to the idea that some artifacts can be considered a part of the individual rather than the "outside" world. Crucial insights about the main types of artifacts and the ways they influence individual experience were provided by Marx Wartofsky (1979).

All these perspectives capture crucially important aspects of mediation. But they are different from the activity-theoretical view, which integrates the functional and the developmental aspects of mediation, placing artifacts in the context of purposeful interaction between the subject and the world, and, at the same time, in the context of the creation and transmission of social experience within a culture. In other words, activity theory recognizes a special status of culturally developed artifacts, considering them as fundamental mediators of purposeful human actions that relate human beings to the immediately present objective world and to human culture and history. This view identified the key components of mediation: subjects, objects, and mediational artifacts. In addition, this view suggested that the relationship between components can change over time, and that developmental, historical analysis is the only way to gain insight into the three-way interaction between these entities. It was this particular notion of mediation, developed within the cultural-historical approach, that was introduced to HCI by Bødker (1989, 1991), employed to develop the concepts of cognitive artifacts (Norman 1991) and "person plus" (Perkins 1993), and more recently used to revise the direct manipulation paradigm (Beaudouin-Lafon 2000). (Chapter 4 discusses such work in detail.)

Development Finally, activity theory requires that human interaction with reality should be analyzed in the context of development. Of course, activity theory is not the only psychological theory that considers development as a major research topic. However, in activity theory development is not only an object of study, but also a general research methodology. Activity theory sees all practice as the result of certain historical developments under certain conditions. Development continuously reforms and develops practice. That is why the basic research

method in activity theory is not that of traditional laboratory experiments but that of the formative experiment which combines active participation with monitoring of the developmental changes of the study participants. Ethnographic methods that track the history and development of a practice have also become important in recent work. Activity theory does not prescribe a single method of study. It only prescribes that a method be chosen based on the research question at hand. Unlike approaches wedded to a particular method, such as contextual inquiry, activity theory starts from the problem and then moves to the selection of a method.

3.5.3 Integration of the Principles

These basic principles of activity theory should be considered as an integrated system because they are associated with various aspects of the whole activity. That is, systematic application of any of the principles makes it eventually necessary to engage all the others. For instance, an analysis of the mechanisms underlying the social determination of the human mind should take into consideration tool mediation, internalization of social knowledge, and transformations of the structure of activity resulting from learning and development. Activity theory insists on the unity of these principles and does not abstract out any single process because the whole activity could not then be understood. It is sometimes the case that other theoretical traditions or approaches mirror aspects of activity theory (such as Haraway's [1991] concept of the cyborg; or mental representations in cognitive science—see e.g., Norman 1991), but the insights are not integrated into a larger theoretical framework as in activity theory.

Having provided a primer of the basic ideas, concepts, and principles of activity theory in this chapter, we now turn to a discussion of interaction design informed by activity theory.