VICTOR KAPTELININ

AFFORDANCES AND DESIGN

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Abstract

The concept of affordances originates from ecological psychology; it was proposed by James Gibson (1977, 1979) to denote action possibilities provided to the actor by the environment. In the late 1980s Norman (1988) suggested that affordances be taken advantage of in design. The suggestion strongly resonated with designers' concern about making possible uses of their products immediately obvious, and soon the concept came to play a central role in interaction design and Human-Computer Interaction (HCI). This book discusses the origins, history, and current interpretations of affordances in HCI research, and reflects on the future of affordances as an HCI concept.

CHAPTER 1

Introduction: Why affordances?

Good designs are intuitive[1]. Take for instance the Holmes stereoscope, designed in the 19th century (Figure 1). You can immediately see that: (a) there is a handle, which you can grasp with either right hand or left hand, (b) you hold the device, so that it is supported from below, (c) you can insert stereo cards (or "stereoviews") in a card holder slot, and (d) you can view the cards through a pair of lenses. The shape of the hood surrounding the lenses indicates how exactly the device should be placed for proper viewing.

1. This book appeals to a commonsense understanding of "intuitive" and does not intend to discuss the exact meaning of the term. Such discussions can be found elsewhere (e.g., Raskin, 1994; Baerentsen, 2000; O'Brien et al., 2010).

Even if you haven't seen a Holmes stereoscope before, you are likely to be able to use it almost immediately.

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FIGURE 1: A Holmes stereoscope.

There are myriads of cleverly, intuitively designed things around us, both old and new. Some examples include a car door handle, which we use correctly without thinking, even if we are encountering that particular handle for the first time (Figure 2), a Swiss Army knife (Figure 3), a summer cottage window lock (Figure 4), and so on. The list of things that dutifully and unobtrusively serve us in our daily lives is endless.

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FIGURE 2: Intuitive everyday designs: Car door handles.

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FIGURE 3: An intuitive everyday design: Swiss army knife.

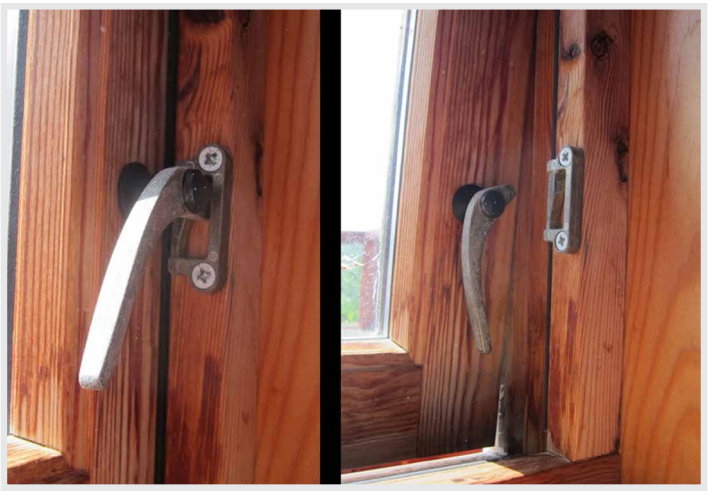

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FIGURE 4: An intuitive everyday design: Window lock.

However, the design of some of the things we encounter in our daily lives is not exactly intuitive – and, unfortunately, poorly designed things are not that uncommon. An insightful discussion of a diversity of confusing and frustrating objects, such as doors that may easily turn into traps, can be found in Norman (1988).

Poor designs can even have far-reaching political consequences. Tognazzini (2001) argues that the design of the butterfly ballot used in Palm Beach, Florida, during the 2000 US presidential election, may have tipped the balance of the election as a whole. Arguably, thousands of voters were confused by the design of the ballot and voted for the wrong candidate (see Figure 5).

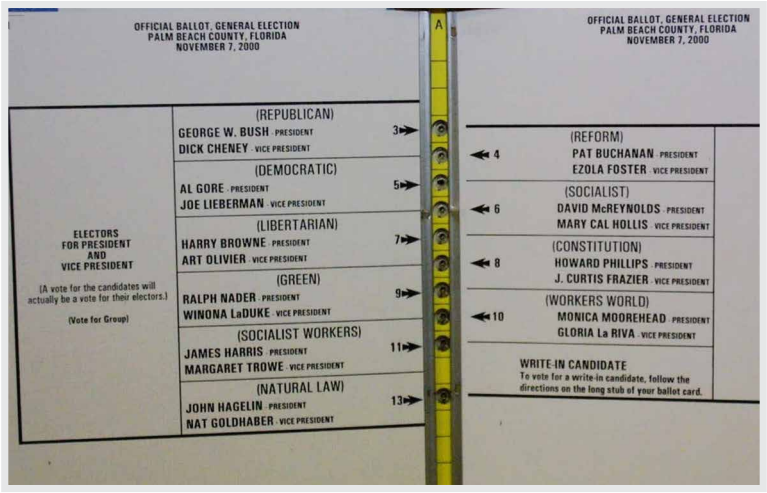

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FIGURE 5: A counterintuitive design: The "Butterfly ballot". The Democratic Party is listed second on the left column, but in order to vote for it one should press the third button. Pressing the second button would cast a vote for the Reform Party.

What is the secret of making designs intuitive? As suggested by the examples above, an essential part of it has to do with *perception*. It is not sufficient for a good design to be rational and logical. Great, intuitive designs are those that allow us directly, and correctly, *to see* what we can do with a thing.

Direct perception of possibilities for action is, essentially, what the concept of *affordance* is about. The concept was originally proposed by an American psychologist, James Gibson, to denote what the environment

"offers the animal, what it provides or furnishes, either for good or ill." (Gibson, 1979). The concept was introduced to the field of design, and eventually HCI, by Donald Norman in his groundbreaking book *The Psychology of Everyday Things* (1988). Norman defined affordances as:

> "... the perceived or actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used... A chair affords ('is for') support and therefore affords sitting. A chair can also be carried. Glass is for seeing through, and for breaking."
>
> *(Norman, 1988).*

Affordances, according to Norman, can be fruitfully employed in design:

> "Affordances provide strong clues to the operations of things. Plates are for pushing. Knobs are for turning. Slots are for inserting things into. Balls are for throwing or bouncing.

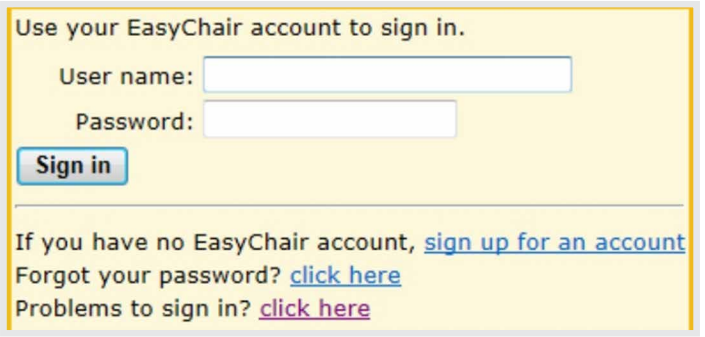
> When affordances are taken advantage of, the user knows what to do just by looking: no picture, label, or instruction needed."
>
> *(Norman, 1988).*

. . . . . .

The concept of affordances was quickly adopted in HCI and interaction design; it became popular among practitioners, researchers, and educators. For designers of interactive technologies the concept signified the promise of exploiting the power of perception in order to make everyday things more intuitive and, in general, more usable. Affordance is also considered a fundamental concept in HCI research and described as a basic design principle in HCI and interaction design textbooks (e.g., Rogers et al., 2011).

The use of affordance is not limited to the design of physical objects. In fact, the concept has been especially appealing to designers of graphical user interfaces. Compared to traditional industrial designers, user interface designers can more freely and easily define visual properties of the objects they create. Therefore, they appear to be particularly well positioned for providing what Norman (1988) calls "strong visual clues to the operation of things". Examples of user interface elements, which provide this kind of strong clues, are

clickable[2] buttons and tabs, *draggable* sliders, and *spinnable* controls, as well as other elements that more or less directly suggest suitable user actions (see Figure 6).



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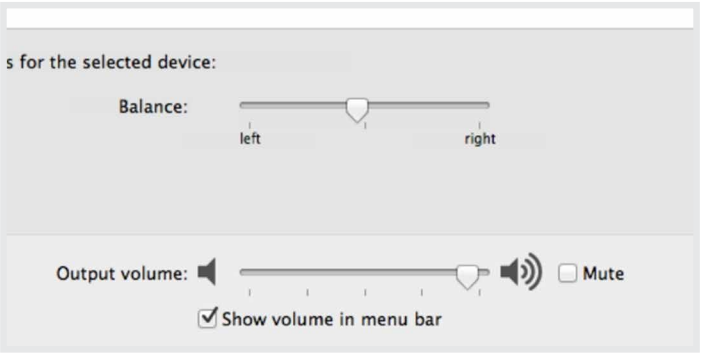

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2. Here "clickable" means that the interface object in question *can be activated by clicking on it*. As observed by McGrenere and Ho (2000), in such cases "button clickability is nested within the affordance of function invokability

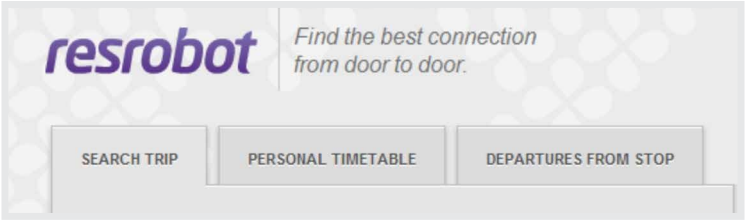

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FIGURE 6: Examples of user interface elements, which directly suggest suitable user actions: (a) clickable button and hyperlinks, (b) draggable sliders, (c) clickable tabs, (d) a swipable touchscreen slider, (e) "pressable" buttons and "spinnable" controls of a touchscreen widget.

Affordance is not only one of the most central of HCI concepts, but also one of the most controversial: its history in HCI is abundant with twists and turns. The meaning of the concept and its relevance to HCI and interaction design have been subjects of debate for over two decades.

This chapter discusses the concept of affordances and how it has been used in HCI; it explores the continuing debate in HCI research concerning theoretical interpretations and design implications of the concept. The remainder of the book is organized into four parts:

- Theoretical roots: A brief walkthrough of the history and main points of Gibson's theory of affordances.
- Affordances in HCI research: An overview of selected analyses.
- Key issues of debate: A discussion of some of the most controversial issues.
- Conclusion: Reflections on the present and future of the concept of affordances in HCI and interaction design.

CHAPTER 2

Theoretical roots

This chapter presents a brief overview of the theoretical roots of the concept of affordances. It discusses some relevant work in ecological psychology – the field in which the concept was originally developed before it was "imported" to HCI. The main focus is on the notion of affordances, proposed by Gibson (1977, 1979), while more recent, post-Gibsonian developments in ecological psychology are only mentioned in passing. The discussion in the chapters is not specifically related to HCI and interaction design; its aim is to clarify the original meaning of affordances and thus provide necessary grounding for analysis in the chapters that follow.

2.1 Gibson's ecological approach to visual perception

The concept of affordance was proposed by James Gibson (1977, 1979) as part of his ecological approach to visual perception. In traditional cognitive psychology perception is commonly understood as a process of developing representations. In this process sensory data that initially have no meaning, are combined with information stored in memory, interpreted, and eventually become meaningful. Gibson strongly opposed this view. He proposed an alternative, *anti-representationalist,* theory of perception.

2.1.1 Mutuality of animal and environment

A key idea underlying Gibson's approach is *mutuality (or complementarity) of animal and environment*. Animal and environment are two parts of a whole system: one of them implies the other. There is a coupling between animals' anatomy and behavior, on the one hand, and the structure of their environments, on the other, which makes it possible for the animals to survive and successfully act in the environments. At the same time, the notion of "environment" includes, if implicitly, the animal. We do not describe our environments in terms of atoms or galaxies. Instead, we point to objects (rooms, furniture, trees, paths, streets,

hills, etc.) that commensurate with us as animals of a certain size and having certain action capabilities.

2.1.2 Detecting invariants in ambient light

The notion of mutuality of animals and environments implies that there is no particular need for animals to create a representation of the "objective world". The purpose of perception is to efficiently obtain *meaningful* information, that is, information that has significance to acting in the environment.

Four arguments are critical to Gibson's reasoning. First, he observes that environments are *structured*: they are organized into dynamically changing configurations of substances and surfaces, which comprise objects, layouts, and events. Second, these structures of the environment are *meaningful* to the animal. For instance, they can mean shelters, tools, paths, obstacles, collisions, and so forth. Third, Gibson asserts that these structures, in turn, give *structure to ambient light*, that is, light that is reflected from objects in the environment and comes to the animal from all directions. Structured ambient light, or ambient optic array, can also change from moment to moment, for instance, because the animal is changing its position[3]. Fourth, Gibson argues that by detecting *invariants* in ambient light, corresponding

3. The notion of ambient light is contrasted to static flat pictures, which are often used in traditional psychological studies of perception.

to significant aspects of the environment, animals *directly pick up* meaningful information without developing internal representations of their environments.

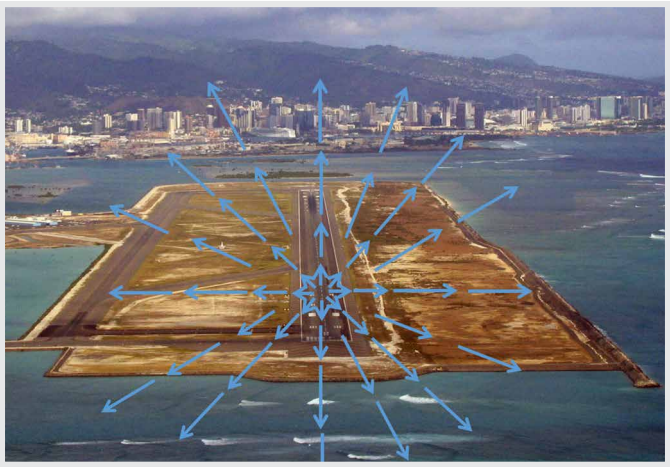

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FIGURE 7: An outflow of the ambient optic array indicating that airplane is on the landing glide.

Invariants in energy arrays can be rather complex and include sensory data widely distributed in space and time. For instance, a certain pattern of how an entire ambient optic array changes over time indicates to the pilot that the plane is landing (Figure 7) rather than taking off or flying over the terrain.

Animal's activity in the environment, including both body part movements and locomotion, is a crucial part of detecting invariants. Birds move their heads to

perceive depth: differences in visual field caused by moving the point of view help them compensate for the lack of binocular vision.

2.1.3 The notion of affordance

What kind of meaningful information about environment do animals directly pick up from ambient light? According to Gibson, this is information about *affordances*, that is, *action possibilities offered by the environment to the animal*. Affordances are determined by both the environment and the animal (or, more specifically, action capabilities of the animal). For instance, a chair affords sitting to animals having certain bodies – in other words, for such animals it is *seatable*. A hill can be *climbable* for some animals (and *un-climbable* for others), a needle is *pierce-with-able (*for people and not, for instance, dogs*)*, and so on.

An affordance is a property of the environment; it can be measured and studied objectively. At the same time, it is a *relational* property – it is determined by the relationship between animal and environment rather than by the environment alone[4]. For the sake of illustration, let us consider a simple example (a similar example is used by Vyas et al., 2006). Imagine that it has been empirically established that sheep cannot jump over a fence if the fence's height

4. An alternative interpretation of affordances as emergent properties of the animal-environment system, rather than properties of the environment *per se*, is proposed by Stoffregen (2003). A critical discussion of this position is presented, for instance, by Kirlik (2004).

exceeds a certain value (say, 117 centimeters, an arbitrary figure). In other words, fence's height, an objective attribute of the fence, can be used to determine whether or not the fence in question is *jump-over-able* by comparing it to an empirically established, objective value (in our case, 117 centimeters). But even though it is the fence that may or may not offer the affordance, fence's affordance only exists in relation to one particular animal species, sheep. It cannot be assumed to be the same for, say, horses.

It should be specifically emphasized that Gibson was *not* interested in affordances *per se*. To him affordances were relevant only to the extent to which they could help provide an account of how animals perceive their environments. He pointed out:

> "The central question for the theory of affordances is not whether they exist and are real but whether information is available in ambient light for perceiving them."
>
> *(Gibson, 1979).*

Gibson's theory asserts that animals *directly pick up* information about affordances, which makes detection of critically important aspects of the environment

quick and efficient. For instance, when we see the brink of a cliff right in front of us we directly recognize that it affords falling off and immediate action (or inaction) is needed to avoid the danger. Such direct perception appears to be quite successful. Preikestolen ("Preacher's pulpit"), a 600 meter-high cliff in Norway, is a major tourist attraction, visited each year by over 100 000 people (Figure 7). Even though there is no safety railing on the top of the cliff and many visitors enjoy standing or sitting close to the edge, no accidental falls have been reported so far.

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FIGURE 8: Preikestolen in Norway.

The concept of affordance bears some similarity to earlier concepts proposed in Gestalt psychology. In particularly, Gibson acknowledged that his work was influenced by Koffka's notion of "demand character" and Lewin's notion of "invitation character", or "valence" (Gibson, 1979). At the same time, Gibson insisted that there was a substantial difference between these concepts and "affordance":

> "The concept of affordance is derived from these concepts of valence, invitation, and demand, but with a crucial difference. The affordance of something does *not change* as the need of the observer changes. The observer may or may not perceive or attend to the affordance, according to his needs, but the affordance, being invariant, is always there to be perceived. An affordance is not bestowed upon an object by a need of an observer and his act of perceiving it. The object offers what it does because it is what it is."
>
> *(Gibson, 1979, original italics)*

2.1.4 Cultural and natural environments

Gibson's approach does not make a fundamental distinction between human beings and other animals. The assumption of the mutuality of animal and environment, as well as the arguments based on this assumption, which lay out the foundation of the theory of affordances, are general enough to be applicable to any animal. Some examples of affordances described by Gibson are related to specifically human objects, such as mailboxes, and he paid special attention to a variety of tools, including scissors, knives, and clubs. However, these affordances are considered similar to affordances provided by "natural" objects to non-human animals. Gibson observed:

> "...it would be a mistake ... to separate the cultural environment from the natural environment, as if there were a world of mental products distinct from the world of material products. There is only one world, however diverse, and all animals live in it, although we human animals have altered it to suit ourselves."
>
> *(Gibson, 1979)*

2.2 Selected analyses of affordances in post-Gibsonian ecological psychology

Gibson's concept of affordance was further explored and elaborated in a number of more recent studies in ecological psychology (e.g., Heft, 2000). These studies have made a relatively limited impact on HCI research compared to the original work by Gibson, while some of them are potentially relevant to HCI. This chapter briefly discusses a few selected examples of such studies.

As mentioned, the discussion is not intended to be a comprehensive analysis of post-Gibsonian developments in ecological psychology from the point of view of their potential implications for HCI. Such analysis is a separate (and much needed) task, which is beyond the scope of this book.

2.2.1 Learning

The notion of *learning* does not play a significant role in Gibson's original theory of affordances. Learning is briefly mentioned on a few occasions, for instance, when observing that perception can be enriched and refined with practice, but the issue of how exactly people learn to perceive a new affordance is basically avoided. Gibson acknowledges that perception of affordances can be incorrect (which is what he calls "misperception") and therefore there may be a need to un-learn existing

invariants and/or learn new ones, but he maintains that basic affordances do not require much learning.

A somewhat different view on the role of learning in the perception of affordances was presented by Eleanor Gibson (James Gibson's wife and a prominent psychologist herself) and Anne Prick (2003). In their book, *An ecological approach to perceptual learning and development,* they assert that affordances do not automatically present themselves to the actor. Instead, they typically must be *discovered* through perceptual learning, and actors must *learn to use* the affordances, which in some cases "...may require much exploration, patience, and time" (Gibson and Pick, 2003, p. 17).

The studies reported by Eleanor Gibson and Anne Prick show that much perceptual learning takes place during infancy. Growth provides infants with more advanced action and sensory systems, and these new capabilities are employed by the infants to expand and differentiate their perceptual worlds. Gibson and Prick also conclude that perceptual learning and development in infants is species-typical: it is generally similar for all infants of the same species. Arguably, a limitation of the analysis presented by Gibson and Prick is that it is predominantly concerned with perception in infants and young children. While it is stated that perceptual learning continues after infancy

and becomes more diverse and specific, little research on this issue is reported.

2.2.2 Tools

To James Gibson, tools are one of the main types of meaningful objects in the environment. He mentions several kinds of tools and their affordances. For instance, scissors are described as an extension of the human hand (Gibson, 1979). However, Gibson does not present a systematic conceptual analysis of what makes tools different from other objects in the environment. Some of the recent studies in ecological psychology provide more specific evidence on this issue.

For instance, Wagman and Carello (2001, 2003) conducted a series of studies of how people use a particular tool, a rod. Rods and sticks can be used, among other things, for hammering and poking, so their affordances include '*hammer-with-ability*' and '*poke-with-ability*'. In the experiments conducted by Wagman and Carello it was found that when a stick is intended to be used for different purposes (hammering vs. poking) different grips were employed by the participants and the use of a tool depended on how people explored inertial constraints – even without being able to see a tool. When physical parameters of a stick, e.g., those relevant to its *hammer-with-ability* (such as the relative weight of different parts of a stick) were modified, correspond-

ing changes in the grip were observed. Wagman and Carello conclude that when analyzing how people use affordances of a tool one should differentiate between tool-user interface and tool-environment interface. They also emphasize the importance of studying how visual information is combined with perceptual information from other modalities.

2.2.3 Collaborative action

Gibson's framework is almost exclusively concerned with how *individual* animals perceive and act in their environments (which environments may include other animals, too). But animals, especially human beings, can also perform joint, collective actions. For example, several people can carry an object, such as a stretcher, which can be too heavy or bulky to be carried by a single person. In recent research Gibson's theory of affordances was extended to such actions as well, and used in studies of how people perceive action possibilities for joint actions. For instance, Davies et al. (2010), who analyzed how people view a possibility to go through a doorway together with another person, have shown that possibilities for joint actions, – that is, actions performed by two persons at the same time, – can be perceived directly.

Chapter 3

Affordances in HCI research: An overview

This chapter gives an overview of some of the key conceptual explorations of affordances in HCI research. The overview is unavoidably selective and incomplete. The sheer volume of HCI literature that uses the concept of affordances[5] makes it impossible to cover all relevant work. Some important analyses therefore may not be included in the discussion below. In addition, some insightful interpretations of the concept in areas just outside the scope of HCI (e.g., Chen et al., 2007; Ihara et al., 2009; Laarni et al., 2007; Suthers, 2006; Sahin et al., 2007; Zhang, 2008) are not discussed here.

5. For instance, a search in the ACM Digital Library using ”HCI” & ”affordances”, performed on June 16, 2013, produced 1,790 hits.

The overview is organized around four main themes: (a) affordances in Ecological Interface Design, (b) specifying affordance as an HCI concept, (c) reframing affordances from non-Gibsonian theoretical perspectives, and (d) exploring alternative or complementary concepts.

3.1 Affordances in Ecological Interface Design

Ecological Interface Design (EID) is an approach in cognitive systems engineering, developed by Vicente and Rasmussen in the late 1980s and early 1990s (e.g., Rasmussen and Vicente, 1989; Vicente and Rasmussen, 1990). The framework is explicitly informed by ecological psychology, primarily by the work of Gibson and Brunswik (see, e.g., Rasmussen and Vicente, 1989). The concept of affordances was adopted in EID at approximately the same time as it was introduced to design by Norman and, apparently, independently of Norman.

The main objective of EID is to create user interfaces for operators of complex industrial systems that would support efficient and safe work practices. The approach capitalizes upon Rasmussen's taxonomy of three levels of cognitive control: skill-based level, rule-based level, and knowledge-based level. The first two levels are concerned with perception and action, and control that takes place at these levels is faster, more effortless, and

less error-prone than analytical problem solving associated with control at the knowledge-based level.

The aim of EID is to make sure that as much control as possible is performed at the lower levels (that is, skilled-based and rule-based levels). This aim is achieved by designing interfaces that make abstract invisible properties of the industrial processes visible and thus allow the operators to take advantage of the power of perception. Gibson's theory of affordances is primarily used in EID to explore design strategies for supporting the operator in direct perception of action possibilities in industrial control settings.

While EID is an influential approach with a good record of successful practical implementations, it has been relatively loosely related to other developments in HCI at large, especially in the last two decades. A likely reason is that the approach was specifically developed for highly structured complex industrial settings, which have eventually become a less central object of study in the mainstream HCI (which is now mainly interested in "loosely coupled domains", see Albrechtsen et al., 2001).

3.2 Specifying affordance as an HCI concept

When the general idea of affordances was introduced to design by Norman (1988), it was expressed,

metaphorically speaking, in a few powerful brush strokes. The introduction was strong and convincing but not particularly detailed and, as subsequently acknowledged by Norman himself, a little imprecise. Some of more recent papers in HCI and interaction design make an attempt to clarify the meaning of affordances and relate the concept to specific agenda of HCI research and practice.

3.2.1 Gaver (1991, 1992, 1996): Affordances vs. their perception, affordances for complex actions, and multimodality

An important early analysis of affordances in the context of HCI was conducted by Gaver (1991, 1992). In his paper "Technology affordances" (1991), which, as observed by McGrenere and Ho (2000), was the first CHI conference paper on affordances, Gaver provides an insightful, if rather succinct, discussion of a range of key issues that need to be elaborated upon in order to make affordance a useful and usable HCI concept.

First, Gaver systematically analyzes the relationship between affordances and perceptual information about affordances. He identifies four possible combinations of the presence or absence of *affordances*, on the one hand, and the presence or absence of *information about affordances*, on the other hand: perceptible affordances, false

affordances, hidden affordances, and correct rejection (Figure 9). As noted by McGrenere and Ho (2000), Gaver's differentiation of affordances as such from perceptual information that specifies them (which is in line with the original Gibsonian meaning of the term) is somewhat different from Norman's (1988) interpretation, which combines affordances and their perception.

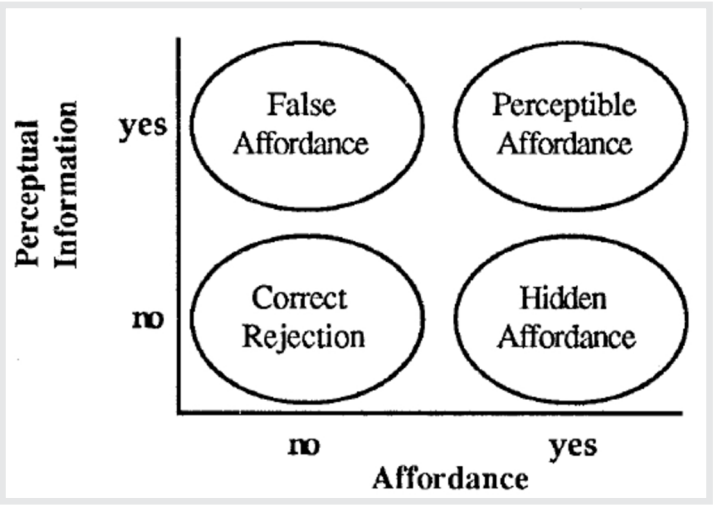


Figure 9: Separating affordances from the information available about them allows the distinction among correct rejections and perceived, hidden and false affordances. From Gaver (1991).

Second, Gaver discusses affordances for complex actions, that is, actions comprising several sub-actions. He identifies two types of such affordances:

- *Sequential affordances*: "acting on a perceptible affordance leads to information indicating new affordance" (Gaver, 1991, p. 82). For instance, visual information about a door handle may indicate that the handle is *graspable*, while grasping the handle may reveal that it is also *turnable*.
- *Nested affordances:* one affordance serves as context for another one. For instance, a door handle's affordance of *graspability* can be nested within the door's affordance of *pullability*.

Gaver emphasizes the importance of *active exploration* in revealing and using affordances of complex objects. He also suggests that the role of metaphors in design should be in guiding users' exploration of a system rather than conveying the actual knowledge about how exactly the system in question is supposed to be used.

Third, Gaver points out that information about affordances is not limited to visual information. Other modalities, such as tactile information and sound, as well as their combinations, are important as well, and should be taken into account in design.

In addition, Gaver briefly comments on the issue of making affordances perceptible. He observes that the

attributes of the object, which are relevant for action, should be made available for perception without using mediating representations: "What is perceived is what is acted upon". Designs that successfully offer perceptible affordances, according to Gaver, are employing *nomically* (causally) mapped graphical objects, whose meaning is directly available to the perceiver[6].

The concept of affordances has informed a number of concrete studies, conducted by Gaver, such as an investigation of how groups of people perceive and use media spaces, as opposed to regular physical spaces (Gaver, 1992; Gaver 1996).

3.2.2 Norman (1999): Real vs. perceived affordances and types of constraints

In a paper published a decade after introducing the concept of affordances to design, Norman (1999) commented on how the concept was taken up by designers. Norman noted that employing the concept was often associated with confusion about its actual meaning, and made an attempt to clarify the confusion. In particular, he acknowledged that his interpretation was somewhat different from Gibson's original meaning, that by "affordances" he meant "perceived affordances", which can be different from Gibsonian "real affordances".

6. A systematic comparison of three types of mapping – symbolic, metaphorical, and nomic – can be found in Gaver (1986)

While the meaning of "perceived affordances" was not explicitly defined, it appears to correspond to Gaver's (Gaver 1991) "false affordances" and "perceptible affordances" (see McGrenere and Ho, 2000).

Norman uses the distinction between three types of constraints – physical, logical, and cultural – to describe the difference between "real affordances", mental models, and conventions. He explains that real affordances are closely related to physical constraints, while good mental models go hand in hand with logical constraints, and cultural constraints are in fact conventions shared by a social group (Norman, 1999).

3.2.3 McGrenere and Ho (2000): Degree of affordance, functional hierarchies, and usefulness vs. usability

Gaver's work on contextualizing the concept of affordances in HCI research (Gaver 1991, 1992) was continued in a more recent paper by McGrenere and Ho (2000). The paper argues that the original Gibsonian concept of affordances needs to be further developed to become a more useful analytical tool for the design of interactive systems. Two of the directions identified by McGrenere and Ho are: (a) incorporating the notion of varying degrees of an affordance, and (b) understanding functional hierarchies of affordances.

Degree of affordance

McGrenere and Ho call for moving beyond a binary view of affordance (as something that either exists or does not exist) toward a more nuanced interpretation of the "possibility for action". In particular, it is argued that the difficulty of using an affordance is highly relevant to usability and should, therefore, be taken into account. McGrenere and Ho refer to the work of Warren (1995) as an example of research in ecological psychology that addresses this issue.

Functional hierarchies of affordances

Building on Gibson's (Gibson 1979) references to nested objects in the environment and Gaver's notion of nested affordances, McGrenere and Ho argue that affordances comprise functional hierarchies, not limited to physical interaction with the system:

> "Possible actions on a computer system include physical interaction with devices such as the screen, keyboard, and mouse. But the role of affordances does not end with the physical aspect of the system [...]. The application software also provides possible actions. A word processor affords writing

> and editing at a high level, but it also affords clicking, scrolling, dragging and dropping. The functions that are invoke-able by the user are the affordances in software."
>
> *(McGrenere and Ho, 2000).*

. . . . . .

They also observe that:

. . . . . .

> "It is important to note that affordances exist (or are nested) in a hierarchy and that the levels of the hierarchy may or may not map to system functions."
>
> *(McGrenere and Ho, 2000).*

. . . . . .

In addition, McGrenere and Ho (2000) argue strongly for separating affordances from their perception (the position they ascribed to Gibson) because, as they claim, the separation would help researchers and practitioners to differentiate more clearly between two aspects of design, namely: designing the utility of an object (an affordance) and designing usability (the information that specifies the affordance). A similar

position was also expressed by Tornvliet (2003). (This view on the issue of the relationship between affordance and perception is discussed in more detail in section 4.1 below).

3.2.4 Hartson (2003): Types of affordances and Norman's model of action

Norman (1986, 1988) describes the structure of human action as an execution-evaluation cycle comprising seven stages: (1) setting a goal, (2) developing an intention to act, (3) planning a sequence of actions, (4) executing the sequence of actions, (5) perceiving the state of the world caused by the execution of the action sequence, (6) interpreting the perception, and (7) evaluating the interpretation. If the goal is achieved, the action is completed. If not, the cycle is repeated over again or the action is terminated. The model makes the task of design or evaluation more manageable by breaking it down into separate components and allowing the analyst to focus on individual stages, as well as concrete relations between the stages. The model suggests that key concerns of interaction design should be bridging the gulf of execution (stages (2) – (4)) and the gulf of evaluation (stages (5)-(6)).

Hartson (2003) argues that Norman's model of action can be used to make the notion of affordances

more specific and applicable in the context of design. He differentiates between four kinds of affordances: cognitive, physical, sensory, and functional. These are defined as follows:

> "We have named the different kinds of affordances for the role they play in supporting users during interaction, reflecting user processes and the kinds of actions users make in task performance. Norman's perceived affordance becomes *cognitive affordance*, helping users with their cognitive actions. Norman's real affordance becomes *physical affordance,* helping users with their physical actions. We add a third kind of affordance that also plays an important role in interaction design and evaluation, *sensory affordance*, helping users with their sensory actions. A fourth kind, *functional affordance*, ties usage to usefulness. We offer guidelines for considering these kinds of affordance together in a design context."
>
> *(Hartson, 2003, p.316, original italics).*

These four types of affordances are mapped to Norman's model of action: a need for cognitive and sensory affordances is located at the step of moving from an intention to act to planning a sequence of actions, physical and sensory affordances are related to the execution of the action sequence, sensory affordances are associated with perceiving the state of the world, and cognitive affordances are claimed to be needed when interpreting the perception (Figure 10).

A modified version of Norman's action model, called "the Interaction Cycle", is used by Hartson as a high-level organizing scheme for the User Action Framework (UAF). UAF includes structured comprehensive sets of specific usability issues, related to each kind of affordances, – with the exception of functional affordances. Functional affordances are considered a special case: they are related to a system's reactions to user actions, which reactions (or "outcomes") are often not directly visible to the user. According to Hartson, providing users with feedback on the outcomes of their actions is a special task in the design of interactive systems.

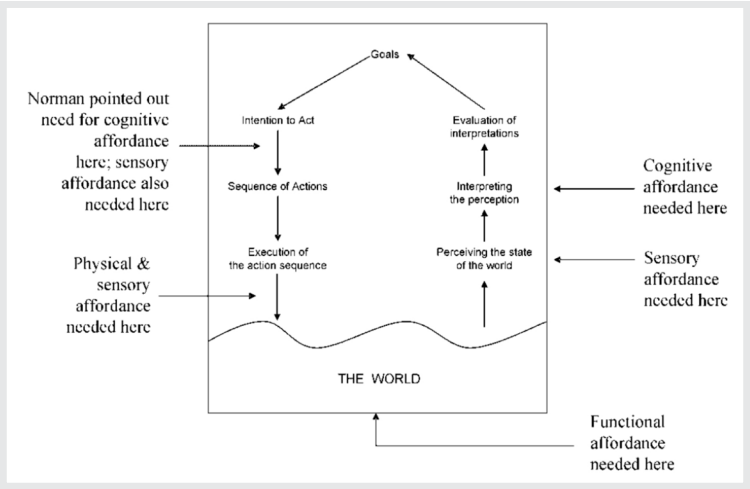


FIGURE 10: Four types of affordances mapped to Norman's action model. (Hartson 2003, p. 328).

3.3 Reframing affordances from non-Gibsonian theoretical perspectives

When limitations of information-processing psychology as a theoretical foundation of HCI became apparent to the research community (Carroll, 1991), a number of alternative approaches were adopted in the field, with activity theory and phenomenology being the leading "post-cognitivist" HCI frameworks (e.g., Boedker, 1991; Dourish, 2001; Rogers, 2004, Rogers, 2012; Kaptelinin and Nardi, 2006).

Both Heidegger's phenomenology (Heidegger, 1962), which emphasizes the primacy of human

existence in the world, and Leontiev's activity theory (Leontiev, 1978), in which purposeful, social, mediated, and developing activity is used as a foundational concept, are similar to Gibson's ecological psychology in postulating, in their own ways, the mutuality of the actor and the environment.

The notion of mutuality is expressed, for instance, in Heidegger's concept of "being-in-the-world" and Leontiev's concept of activity, which integrates "subject" and "object" in a single unit of analysis. Even though these theories do not use the term "affordance", they all assume that perception and action are tightly integrated with one another, and the general idea of direct perception of possibilities for action fits well with their general lines of reasoning.

These approaches are also substantially different from Gibson in that they intend to move beyond animal-environment interaction and provide an account of characteristically human activities and experiences. The meaning of "possibilities for action offered by the environment" in these approaches is different from how it was understood by Gibson. Therefore, it is hardly surprising that a number of attempts have been made to reframe the concept of affordance and propose interpretations informed by activity-theory (Albrechtsen et al, 2001; Baerentsen and Trettvik, 2002;

Kaptelinin and Nardi, 2012), phenomenology (Dourish, 2001; Turner, 2005; Bonderup Dohn, 2009), and some other approaches (Vyas et al., Rizzo, 2006; Rizzo et al., 2009; Still and Dark, 2013). The main points of these theoretical accounts are summarized below.

3.3.1 Activity-theoretical accounts

3.3.1.1 *ALBRECHTSEN ET AL. (2001): AFFORDANCES IN ACTIVITY THEORY AND GIBSON'S ECOLOGICAL PSYCHOLOGY*

A discussion of affordances from the point of view of activity theory is presented by Albrechtsen et al. (2001)[7]. The authors conclude, in particular, that there are some similarities between activity theory and Gibson's ecological psychology:

> "Activity theory and Gibsonian thinking share the basic idea that perception is not afferent, that it is connected with action. Only through acting do people perceive their environment."

7. The paper also analyzes the interpretation of affordances in Cognitive Systems Engineering, more specifically, in the work of Vicente and Rasmussen, discussed in section 3.1.1 of this chapter.

At the same time, it is argued that activity-theory provides a broader perspective on perception and action than the Gibsonian approach. Activity theory, as opposed to Gibson's ecological psychology, is concerned with the social-historical dimension of an actor's interaction with the environment, and takes into consideration mediation and learning. Activity theory aims to provide an account of human activities at all hierarchical levels, while Gibsonian analysis generally focuses on the level of operations (using activity theory terminology). In addition, activity theory offers an understanding of tools as functional organs, a concept which does not have a counterpart in the theory of affordances. Finally, it is noted that Bødker's (Boedker 1991) distinction between three complementary aspects of the use of computing technologies –physical (directed at the computer as a physical artifact), handling (directed at computer application), and subject/object-directed (interaction with subjects and objects through the artifact) – can be used to identify three dimensions, or types, of affordances, corresponding to the above aspects.

3.3.1.2 *BAERENTSEN AND TRETTVIK (2002): TOWARD A CONCEPT OF AFFORDANCES BASED ON A MORE DEVELOPED NOTION OF ACTIVITY*

Another analysis of affordances from an activity-theoretical perspective was proposed by Baerentsen and

Trettvik (2002)[8].Baerentsen and Trettvik start with observing that many interpretations of affordances in HCI research are deviating from the basic assumptions underlying the concept in the Gibsonian approach. They note:

> "The concept of affordance was meant to cut though the subjective-objective dichotomy of traditional psychology and philosophy, but its interpretation in HCI often retained this dichotomy."
>
> *(Baerentsen and Trettvik, 2002).*

At the same time, the authors point to some shortcomings of Gibson's theory of affordances. The main obstacle to a more successful application of the theory in HCI, according to Baerentsen and Trettvik, is an undifferentiated notion of activity employed by Gibson, which:

8. An earlier paper by Baerentsen (2000) in a special issue of the Scandinavian Journal of Information Systems on activity theory was one of the very first attempts to employ both activity theory and Gibson's theory of affordances in the context of HCI. The paper explored the notion of intuitive interfaces by using insights from both ecological psychology and activity theory. It did not, however, intend to provide a systematic account of affordances from an activity theory perspective.

> "...makes it a difficult and nontrivial matter to address areas of research like HCI that have substantial cultural, symbolic, and technological components of a cultural-historical origin. ... It is necessary to extend the analysis of affordances and their basis in organismic activity to the cultural-historical development of human activity..."
>
> *(Baerentsen and Trettvik, 2002).*

Baerentsen and Trettvik (2002) argue that adopting a more advanced notion of activity, developed in activity theory (Leontiev, 1978), can help understand affordances as embedded in cultural contexts and emerging in concrete interaction between the actor and the environment. They identify several issues that should be taken into account in order to understand culturally-specific affordances, such as learning and the use of symbols and representations.

3.3.1.3 *KAPTELININ AND NARDI (2012): A MEDIATED ACTION PERSPECTIVE ON AFFORDANCES*

In activity theory, tools have a special status. Human action is considered fundamentally mediated (Leontiev, 1978), and the notion of interactive technologies being

mediating artifacts, through which human beings interact with the world, has informed a number of HCI concepts, models, and concrete studies (e.g., Bødker, 1991; Nardi, 1996; Beaudouin-Lafon, 2000; Bødker and Andersen, 2005; Kaptelinin and Nardi, 2006), including, as mentioned, activity-theoretical analyses of affordances (Albrechtsen et al., 2001; Baerentsen and Trettvik, 2002).

Building on this research, as well as some relevant post-Gibsonian studies in ecological psychology (e.g., Wagman and Carello, 2001; Wagman and Carello 2003), Kaptelinin and Nardi (2012) propose a mediated action perspective on affordances in HCI. They describe the structure of instrumental affordances (Figure 11) as comprising handling affordances (possibilities for interacting with the artifact in question) and effecter affordances (possibilities for employing the artifact to make an effect on an object of interest). For instance, a computer mouse affords moving it on a horizontal surface (handling affordance), which causes changing the pointer's position on the computer screen (effecter affordance). According to Kaptelinin and Nardi, in addition to instrumental affordances, artifacts can also provide auxiliary affordances, such as maintenance, aggregation, and learning affordances.

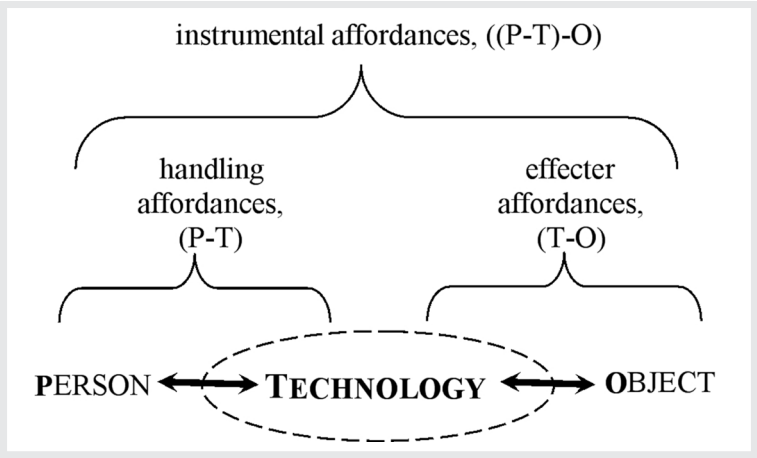


Figure 11: Two facets of instrumental technology affordances: handling affordances and effecter affordances-P: Person, T: Technology, O-Object of interest (Kaptelinin and Nardi, 2012).

Kaptelinin and Nardi observe that the mediated action perspective on affordances, which they are advocating, shares some basic assumptions with the original Gibsonian approach: both consider affordances as a relational property and emphasize the importance of direct perception of affordances for successful acting in the environment. At the same time, the mediated action perspective is different in a number of respects from Gibson's approach. Technology affordances are understood as relational properties emerging in a three-way interaction between actors, tools, and cultural

environments. The perspective also highlights the importance of taking into account learning as well as the dynamics of a person's action capabilities, caused by tool switching. In this respect, the mediated action perspective is similar to the phenomenological account of affordances by Bonderup Dohn (2009), which is discussed in the next section.

3.3.2 Phenomenological accounts

3.3.2.1 *DOURISH (2001): AFFORDANCES AND EMBODIED INTERACTION*

In Dourish's embodied interaction framework (Dourish, 1991), which is strongly and explicitly informed by phenomenology, the concept of affordances is used to illustrate some of the key aspects of the framework. Applications of Gibson's ecological psychology in the context of HCI and Computer Supported Cooperative Work (CSCW) are considered an example of research that is actually exploring the idea of embodied interaction. In particular, Dourish refers to how analysis and design of cooperative systems by Gaver and his colleagues (1992, 1995) incorporated the idea of an actor's exploration of the world.

"Ontology", a key aspect of meaning within Dourish's framework, is mostly discussed in relation to affordances. It is argued that the scope of the concept of

affordances could be extended beyond physical actions to include affordances for particular ways of understanding the design of an artifact.

Even though the meaning of the concept of affordances is not a central issue within the embodied interaction framework[9], the use of the concept indicates that the concept is generally consistent with the phenomenological perspective.

3.3.2.2 *TURNER (2005): SIMPLE VS. COMPLEX AFFORDANCES, SIGNIFICANCES, AND EQUIPMENT*

A deliberate attempt to conceptualize affordances from a phenomenological perspective is made by Turner (2005). Turner analyzes a variety of uses of the term "affordance" in current research and observes that the interpretations of affordances in HCI and some other fields have moved far beyond Gibson's original account.

According to Turner, current interpretations of affordances can be divided into two general categories: "simple affordances" and "complex affordances". "Simple affordances" are affordances in the Gibsonian sense of the term. "Complex affordances" are defined in terms of culture, history, and practice, and therefore

9. Dourish defines affordance as a "three-way relationship between the environment, the organism, and an activity" (p. 118) but does not elaborate upon this definition.

cannot be properly addressed within Gibsonian ecological psychology.

Turner briefly outlines two theoretical perspectives, which he posits are capable of dealing with complex affordances. The first one is the concept of "the ideal", proposed by the Russian philosopher Evald Ilyenkov. Ilyenkov (1977) understands "the ideal" as objectively existing in the world in the form of *significances*, produced by purposeful human activities. In this respect, according to Turner, significances are similar to affordances.

The second perspective is Martin Heidegger's phenomenology (Heidegger, 1962). Turner argues that several concepts proposed by Heidegger can be used to understand complex affordances. In particular, Turner mentions Heidegger's notions of breakdowns and resulting transition of tools from being ready-to-hand to being present-at-hand, familiarity, and, especially, equipment. He also refers to a more elaborated taxonomy of breakdowns, developed by Dreyfus (2001). According to Turner, since Heidegger understood equipment as context, applying Heidegger's framework to affordances leads to the conclusion that "affordances and context must be synonyms" (p. 12). This conclusion is claimed to be consistent with considering affordances as Ilyenkov's significancies.

3.3.2.3 *BONDERUP DOHN (2009): BODY SCHEMA, DYNAMIC AND CULTURE-RELATIVE VIEW OF AFFORDANCES*

Another analysis of affordances from a phenomenological perspective is presented by Bonderup-Dohn (2009), who proposes a "dynamic, relational, and culture- and skill-dependent view" of affordances. The analysis is specifically oriented toward the field of Computer-Supported for Collaborative Learning (CSCL) but it draws heavily on the affordances debate in HCI.

Bonderup-Dohn points to the notion of "body schema"[10], proposed by the French phenomenological philosopher Merleau-Ponty (1962), as being directly relevant to understanding affordances. She observes that the notion, which emphasizes a pre-reflective correspondence of the body and the world in a concrete activity and serves as a basis for structuring the space around us and making intuitive sense of spatial relations between objects, highlights some aspects of our interaction with the world that are essential to analyzing affordances.

Of key importance to understanding technology affordances, according to Bonderup Dohn, is that body

10. Bonderup Dohn (2009) observes that "interaction potential" could be a more appropriate term than "action capabilities", since environments can offer the actor what she calls "intransitive affordances", that is, possibilities for actions that are not carried out by the actor, but rather by somebody else on the actor (consider, e.g., the affordance of "being seen by someone")

schema is a dynamic entity. Not only does it shape our interactions with the world, it is also shaped as a result of such interactions. Bonderup Dohn notes that technology can transform the body schema in a way, similar, for instance, to the one highlighted by the activity-theoretical notion of functional organs (e.g., Kaptelinin and Nardi, 2006). For instance, for a skilled typist the keyboard may become a part of the phenomenal body and "for very experienced avatar users the avatars may become incorporated into the body schema" (Bonderup-Dohn, 2009).

Adopting a Merleau-Pontian view on affordances, according to Bonderup Dohn, means that action capabilities[11] of actors should be considered depending on actors' culture and experience. Accordingly, the understanding of affordances as being culture- and experience-independent (as argued, for instance, by McGrenere and Ho, 2000) is rejected and a culture- and skill-relative interpretation of affordances is proposed instead.

3.3.3 Some other relevant theoretical accounts

Vyas et al. (2006) propose a conceptualization of affordances, according to which affordances emerge in activities and practices and are being socially and culturally constructed:

11. The concept is also translated to English as "body image"

> "...during the user-technology interaction, users actively interpret the situation and make sense of the technology while being involved in certain activities. Users' 'active interpretation' is central to the emergence of affordance that is socially and culturally determined."
>
> *(Vyas et al., 2006).*

It is claimed that affordances should be analyzed at two levels: the artifact level and the practice level. To analyze affordances at the practice level and understand them in a broader socio-cultural context the authors suggest using Giddens' (Giddens 1994) structuration theory. In addition, the framework they propose differentiates between two types of affordances: affordance in information (i.e., *what* is afforded) and affordance in articulation (i.e., *how* the system in question is supposed to be used). The ideas are further developed in a subsequent paper (Vyas et al., 2008), which differentiates between three levels of analysis of affordances: single user, organizational/work group, and societal.

Rizzo (2006) points to neurophysiological findings (Rizzolatti and Craighero, 2004) that indicate that certain

basic neuronal responses correspond to whole classes of human actions having a shared goal, and similar responses can be registered when people observe other human beings trying to achieve the same goal. It is concluded that by way of imitative learning children can come to understand the action potential of objects in terms of what goals can be achieved by using these objects. Rizzo argues that it is important to understand how people communicate intentions and how "intentional affordances" (a term, originally proposed by Tomasello, 1999) are produced and perceived. Such analysis, according to Rizzo, opens up new ways to study affordances as being culturally determined through individual history. A follow up paper by Rizzo et al. (2009) suggests that to fully exploit the heuristic potential of the notion of affordances interaction design research needs to focus on the interplay between basic, sensory-motor affordances, on the one hand, and intentional affordances, on the other hand.

Still and Dark (2013) offer an account of affordances in terms of traditional cognitive psychology concepts and models. The most central concept within this account is *automatization*, the process during which the cognitive pattern recognition system learns to automatically identify constraints (irrespective of whether the constraints are physical, cultural, logical, etc.). The emergence of perceived affordances is linked to the

transition from controlled to automatic processing. In cognitive psychological research automatic processing is described as "not open to awareness, rendered without intention, carrying light long-memory load, and leading to rapid responses" (p. 293). The characteristic features of controlled processing are, generally, opposite. Designers can support the transition from controlled processing to automatic processing and, therefore, help the user take advantage of perceived affordances, by making sure their designs are highly consistent.

3.4 Exploring alternative and complementary concepts

3.4.1 Norman (2008; 2011; 2013): Signifiers

As mentioned earlier, a decade after introducing affordances to HCI Donald Norman felt obliged to clarify his understanding of affordances and warn against overusing (and abusing) the concept in design (Norman, 1999). Yet another decade later he made an even more radical claim and suggested that designers should be concerned about *signifiers*, rather than affordances. The concept of signifiers was briefly introduced by Norman in 2008 (Norman, 2008) and discussed in more detail in his subsequent books, *Living with Complexity* (Norman, 2011) and a revised edition of *The Design of Everyday Things* (Norman 2013). Norman explains

that by signifiers he understands "any mark or sound, any perceivable indicator that communicates appropriate behavior to a person." (Norman, 2013).

Special emphasis in the introduction of the concept of signifiers is made on how signifiers are related to affordances. According to Norman, these two concepts are substantially different and should not be confused with one another[12]:

> "Affordances define what actions are possible. Signifiers specify how people discover those possibilities: signifiers are signs, perceptible signals of what can be done. Signifiers are of far more importance to designers than are affordances. "
>
> *(Norman, 2013).*

12. Despite a substantial effort made by Norman (Norman, 2011, Norman, 2013) to clarify the meaning of signifiers and differentiate them from affordances, some uncertainty still remains. One the one hand, affordances (action possibilities) are strictly separated from signifiers ('perceptible signals of what can be done'). On the other hand, it is hinted that other interpretations are also possible. In particular, it appears that signifiers can be considered components of affordances ('I call the signaling component of affordances signifiers', Norman, 2013) or in some cases signifiers can be affordances ('Some signifiers are simply the perceived affordances, such as the handle of a door or the physical structure of a switch.', Norman, 2013).

Norman notes that signifiers are commonly confused with affordances. In many cases, when designers claim that they "put an affordance on a product" what they actually do is make visible the presence of an already existing affordance. Therefore, they add a signifier rather than an affordance. (Norman, 2011).

Therefore, Norman's message to designers is:

> "I strongly encourage the design community to distinguish between affordances and signifiers. In most cases, the word affordance should go away, for invariably the designer cares only about what can be perceived, which means signifiers."
>
> *(Norman, 2011, p. 229).*

3.4.2 Djajadiningrat et al. (2002) and Vermeulen et al. (2013): Feedforward

Vermeulen et al. (2013) discuss another concept, feedforward, which, as they suggest, can in certain cases be used instead of affordances. They adopt the concept of feedforward as it was introduced to design by Djajadiningrat et al. (2002). Feedforward is

defined as information provided to the user before he or she carries out the action (as opposed to feedback, which is information provided after the user carries out the action).

Vermeulen et al. (2013) argue that the potential of the concept of feedforward in design is currently underexplored, partly because the exact meaning of feedforward is not well defined. They set out to clarify the meaning by clearly separating feedforward from feedback and affordances and capitalize upon the taxonomy of affordances and the mapping of various types of affordances to the Norman's Stages of Action model, proposed by Hartson (2003). They claim that some of the elements in Hartson's diagram (see Figure 9) can in fact be classified as examples of feedback and feedforward, rather than affordances. A revised diagram is suggested, which is shown in Figure 12.

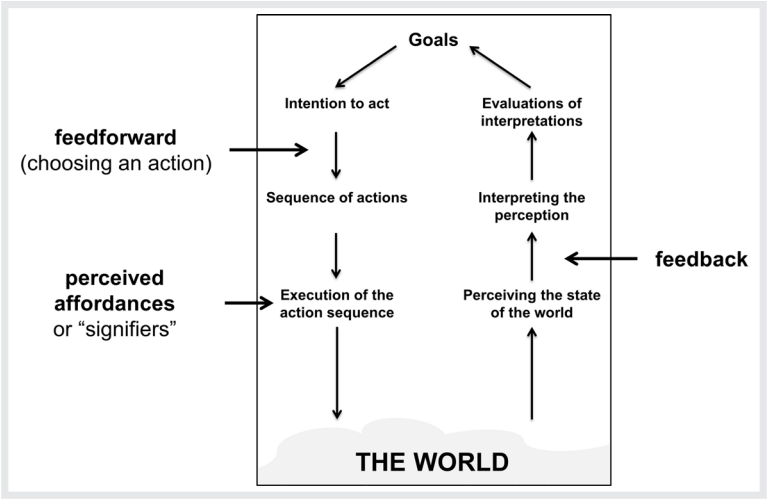


FIGURE 12: The position of perceived affordances, feedforward and feedback in Norman's Stages of Action model according to Vermeulen et al. (2013).

The difference between (perceived) affordances and feedforward is described by Vermeulen et al. (2013) as follows:

> "Both perceived affordances and feedforward tell users something about a particular action through a combination of a physical and functional affordances. Perceived affordances and feedforward essentially provide

> different information about the action that users have to perform to achieve their goals. While *perceived affordances reveal the physical affordance*, which tells users that there is an physical action available and how to perform it, *feedforward reveals the functional affordance*, which tells users what will happen when they perform that action."
>
> *(Vermeulen et al., 2013, original italics).*

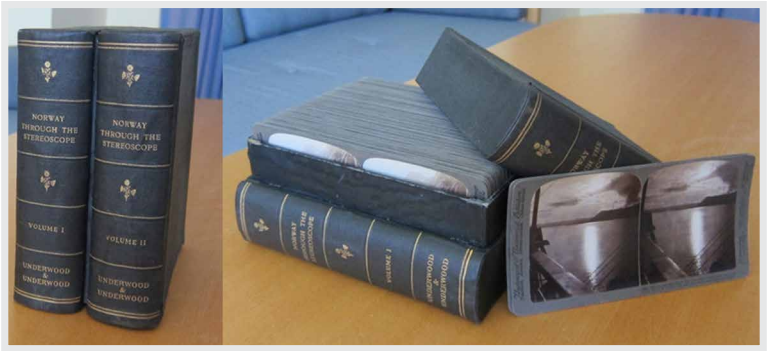
. . . . . .

Vermeulen et al.'s (2013) discussion of feedforward aims to provide a theoretical account of the "gulf of execution" in Norman's model of action (Figure 12). Recently, the term feedforward was used for similar reasons by Norman himself. An updated presentation of Norman's model of action in the 2013 edition of *The Design of Everyday Things* (Norman, 2013) refers to feedforward when describing the gulf of execution. The meaning of the term is however somewhat different from how the term is understood by Vermeulen et al. (2013). Norman does not explicitly contrast feedforward and affordances. Instead, feedforward is understood in a broad sense, as any kind of information that helps to execute actions. The notion

of feedforward is applied to the gulf of execution as a whole, rather than its specific part. Norman observes that feedforward is achieved through the appropriate use of signifiers, constraints, mappings, and conceptual models (Norman, 2013).

3.4.3 Skeuomorphism

A design concept that is popular among interaction design practitioners (not so much among HCI researchers…) and often considered as related to affordances, is *skeuomorphism*. Generally speaking, a skeuomorph is an object or feature copying the design of a similar artifact in another material (Oxford English Dictionary, n.d.). A wallpaper pattern that copies the look of a brick wall is an example of a skeuomorph. Another example, shown in Figure 13, is a box for stereo cards (intended to be used with the Holmes stereoscope shown in Figure 1), which looks like a two-volume book set.



Courtesy of Victor Kaptelinin. Copyright: CC-Att-ND-3 (Creative Commons Attribution-NoDerivs 3.0 Unported).

FIGURE 13: Skeuomorphism: A stereo card box looking like a two-volume book set.

In digital design skeuomorphism usually means realistic imitation of real-world objects, either in appearance (e.g., a stitched leather look of an electronic calendar, Figure 14) or in other modalities (e.g., a shutter-click sound produced by digital cameras). Skeuomorphism used to be especially common in the design of Apple products. The arguments in favor of skeuomorphism are that it makes digital objects more aesthetically pleasing and helps the user understand how to handle an unfamiliar object (which can be considered as providing perceptual information specifying object's affordances).

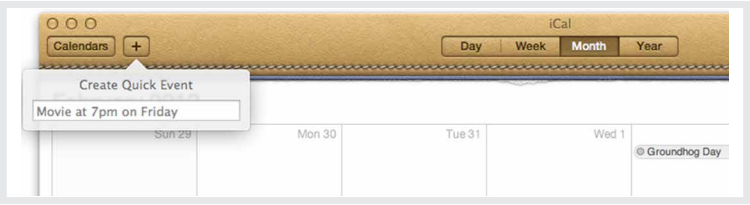


FIGURE 14: Skeuomorphism: Stitched leather look of an electronic calendar.

Recently, skeuomorphism has been losing ground in interaction design. For instance, a Technopedia.com article (Technopedia, n.d.) notes that:

> "... skeuomorphism has increasingly come under fire, largely because many of the nostalgic elements it attempts to portray - such as calendars, day planners, address books, etc. - are almost entirely foreign to younger generations of users. In addition, critics of skeuomorphism point to this reliance of physical objects in design as an impediment to making more useful designs."
>
> *(Technopedia, n.d.).*

The design of the latest releases of some of the most popular digital environments, such as Windows 8 and iOS 7, shows a clear trend of moving away from skeuomorphism. As a recent BBC News Magazine article observes:

> "Skeuomorphism has fallen out of favour in recent years, and is almost regarded as a dirty word by many in the design community."
>
> *(Judah, 2013).*

Chapter 4

Key issues of debate

The brief overview of the affordances debate in HCI research, presented in the previous chapter, allows us to identify some common issues emerging from the debate. It should be noted that many of these issues are closely related to – and even overlap with – one another.

4.1 Affordances and perception

The relationship between affordances and perception has been a debated issue in HCI research for over two decades, with a general trend being toward progressively stricter separation of affordances from perception. This trend is especially apparent in the evolution of Norman's interpretations of affordances, discussed

in detail in Chapter 3 above. The evolution can be briefly presented as follows[13]:

- **1988**: Norman introduces affordances to design, describing them as "perceived and actual properties of a thing"; the concept is understood as referring to *both the possibilities for action, provided to the actor, and their perception* by the actor;
- **1999**: Norman differentiates "real affordances" (which correspond to Gibsonian "affordances") from "perceived affordances" (which may or may not be real); he clarifies that in his previous work by "affordances" he actually meant "perceived affordances";
- **2008/2011/2013**: Norman takes a step further and completely separates affordances (which can only be affordances in the Gibsonian sense, or "real" affordances) and information about them (i.e., signifiers).

13. It is claimed that the theory of affordances can be applied to the perception of language as well (Gibson, 1979), but the logical and empirical arguments supporting this claim are not as advanced and thorough as those provided for the direct perception of physical objects, layout, and events.

Inconsistency between Norman's initial interpretation of affordances (Norman, 1988) and the original Gibsonian meaning of the term was noticed, discussed, and found problematic by several researchers, e.g., McGrenere and Ho (2000) and Tornvliet (2004). Soegaard (2009) observes:

> "Unlike Norman's inclusion of an object's perceived properties, or rather, the information that specifies how the object can be used, a Gibsonian affordance is independent of the actor's ability to perceive it."
>
> *(Soegaard, 2009)*

Undoubtedly, these efforts aiming to clarify the difference between Norman's and Gibson's interpretations should get credit for resolving some terminological uncertainties. Such clarifications are important, since variations of early Norman's interpretations of affordances, abandoned by Norman himself, can still be found in literature. For instance, a popular interaction design textbook describes affordance as the term, "...which is used to refer to an attribute of an object that allows people to know how to use it." (Rogers et al., 2011).

At the same time, some attempts to clarify terminological problems go to the point of advocating the need to completely separate affordances and perception in order to return to the original Gibsonian notion. In particular, McGrenere and Ho (2000) claim that, according to Gibson, affordances are "independent of the actor's experience, knowledge, culture, or *ability to perceive*" (italics added; for a critical analysis of this position see also Bonderup Dohn, 2009). A similar claim is made by Tornvliet (2003): "Gibson labored to make affordances a characteristic of the environment that exists relative to an object but *independent of perception*." (italics added). There are reasons to believe that such a strict separation of affordances from perception is not unproblematic.

Independence of perception can be interpreted in three different ways, namely, as independence of: (a) the actor's general ability to perceive the environment, (b) perceptual information about affordances in ambient energy array, and (c) whether or not the actor, who possesses the general ability to perceive, actually picks up information about an affordance, which information is present in ambient energy array. Arguably, it is only the last interpretation that is both accurate and relevant in the context of Gibson's theory of affordances.

To claim that affordances are independent of an actor's general ability to perceive is, apparently, wrong. Gibson's emphasis on the tight coupling of perception and action implies that actor's action capabilities include perception. It should be noted that in modern ecological psychology, affordances are commonly defined as "real possibilities for action for a *perceiving-acting* system" (Wagman and Carello, 2001, emphasis added). That perception is a key factor defining action capabilities can be illustrated with a simple example: if a car driver breaks his or her eyeglasses, the car can become "undrivable". In that case an object's affordances change not because something happens to the car but because the driver's action capabilities become insufficient; and action capabilities become insufficient not because the driver is unable to make physical movements any more, but because of a diminished perceptual function.

The claim that affordances are independent of perceptual information about them in ambient energy array (as, for instance, in the case of a hidden door in a paneled room, see McGrenere and Ho, 2000) is probably formally correct but it is not directly relevant to Gibson's theory of affordances. As already mentioned, Gibson (1979) emphasized that his theory of affordances was predominantly about whether information

about affordances is available in ambient light, rather than whether affordances exist or are real. Therefore, Gibson's theory of affordances is specifically concerned with possibilities for action, *which are reflected in corresponding structures of ambient arrays of energy and thus can be perceived by the actor*, and in the context of the theory it is more or less meaningless to analyze affordances independently of their relation to perceptual information. In this respect, Norman's early perception-centered interpretation of affordances – apart from some terminological problems, as well as certain disagreements about the meaning of "direct pickup" (see Norman, 1988) – is, arguably, generally consistent with the original Gibsonian approach.

But is there a contradiction between Gibson's claims that (a) the theory of affordances is essentially concerned with perceptual information in ambient light and (b) affordances exist even if they are not noticed by the actor? Not really, since information that is *present in ambient light* may not be *actually perceived* by the actor. For instance, a *pickable* mushroom could be unnoticed by a person walking in the woods if the person does not look in the direction of the mushroom.

Therefore, while confusion between affordances and their perception should of course be avoided, a complete separation of affordances from perception

would, as argued above, mean going to the opposite, equally undesirable, extreme.

4.2 Direct and "indirect" perception

Relevance to direct perception appears to be a key factor in the popularity of the concept of affordances in HCI and interaction design. Gaver (1991), points that the main advantage of the ecological perspective is that it "may offer a more succinct approach to the design of artifacts that suggest relevant and desirable actions in an immediate way." (italics added)

One would expect, therefore, that exploring the ways in which direct perception of affordances can be supported with appropriate designs should be a key research issue. However, it has not been the case. The term "Direct Perception" is widely used in HCI literature but analysis of mechanisms, criteria, conditions, and solutions for achieving direct perception of action possibilities of interactive products does not seem to be an actively explored issue in HCI research on affordances.

There are some conceptual obstacles that may have prevented researchers from fruitfully addressing this issue in a concrete and constructive way. On the one hand, Gibson's approach essentially claims that direct perception of our material environment can only

be direct. His theory of affordances can be interpreted so that there is no need to support direct perception, since it takes place naturally. It cannot be otherwise: direct perception is the only kind of perception there is.

On the other hand, an opposite argument can be made in case of the visual perception of information expressed in language. Gibson's theory of direct perception does not seem to apply here14: apparently, we need to perceive characters comprising a word, and probably look up the word in the dictionary, in order to determine the meaning of the word and associated action possibilities. But in such cases it may appear that perception can only be indirect – so that the task of supporting the transition to direct perception, again, cannot be meaningfully defined.

Therefore, some of the questions, central for putting direct perception of affordances on the agenda of HCI research are: Can the basic principles of ecological psychology allow for the existence of perception, which is *not* direct? Can visual language representations be perceived directly? It can be argued that the answer to both of these questions is "yes".

Eleanor Gibson and Anne Prick (Gibson and Prick 2003), who studied perceptual learning from an

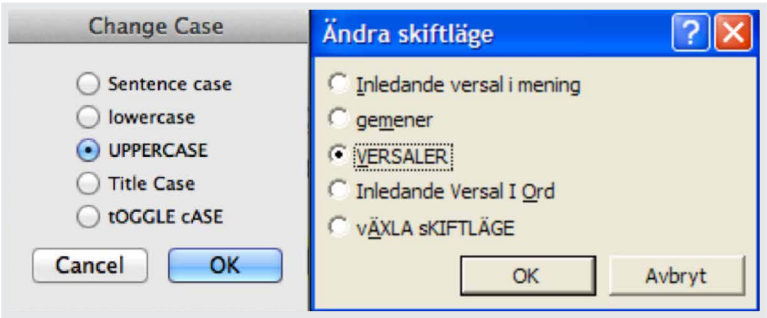
14. For the sake of simplicity, discussions of affordances in Norman's work published between 1989 and 1999 (e.g., Norman, 1993, 1998) are not included here.

ecological perspective, conclude that affordances often need to be discovered, and sometimes it takes much exploration, effort, and patience. Apparently, exploration means that various types of relationship between perceptual information and an affordance are "examined" and "tried out" before the perception of the affordance becomes direct. Therefore, research in ecological psychology suggests that not all perception is direct; direct perception should be considered an accomplishment rather than something that just happens naturally.

At the same time, there is empirical evidence indicating that visual recognition of verbal material can become direct in the sense of visual features being directly used to carry out appropriate actions without language recognition. For instance, evidence obtained in a study of menu selection (Kaptelinin, 1993) suggests that with practice users switch to selecting commands without reading their names, that is, to menu selection based on extracting "non-verbal" visual features, such as screen location or the length of a command name.

How can designers support the transition to direct perception? The general strategy proposed by Still and Dark (2013) is to make designs as consistent as possible. A related, more concrete strategy is to structure ambient optic array so that there is a clear mapping between the structure and appropriate user actions.

Consider, for instance, MS Word's "Change case "dialog box (Figure 15). The design of the widget employs certain visual features that make it possible for the user to perceive the widget's affordances without reading the names of the options. The user does not even need to know the language, as long as the writing system is familiar.



Copyright status: Unknown (pending investigation). See section "Exceptions" in the copyright terms below.

FIGURE 15: Using visual features to support direct perception: The MS Word "Change Case" dialog box.

4.3 Culture

Gibson's ecological approach specifically and explicitly deals with perceiving and acting *animals*. The key concepts of the approach, including affordances, are defined in terms of animal-environment interaction. While a variety of illustrating examples, provided by Gibson himself and other proponents of his approach,

refer to specifically human objects, such as knives, mailboxes, stairs, airplanes, pictures, and so forth, interaction with these objects is analyzed within the same general framework as interaction of other animals with objects in their respective ecological niches. This perceptive is characteristic for much work in ecological psychology in general. For instance, Eleanor Gibson and Anne Pick (2003) mention an "action instigated by the animal itself, such as driving the truck."

Of course, it is true that we are animals, and this fact has deep implications for how our man-made world is created and experienced. Our built environments, as well as individual things comprising the environments, are as they are to a large extent because we are animals equipped with certain bodies, hands, motor functions, and senses. If we were a different kind of animal, then our houses, cars, airplanes, and computers, if we had them, would look different. Undoubtedly, when designing interactive products, it is important to take into account what ways of action are natural for us as a certain animal species.

However, we humans are also fundamentally unique in a number of respects. As opposed to other animals we are social, cultural creatures: we use language, take part in socially organized collective activities, and employ various artifacts that other animals do not have.

Therefore, it is logical to ask: Can an animal-centric theory of affordances provide an account of the *whole* range of human interaction with the world? Can the Gibsonian concept of affordances be used to understand possibilities for specifically *human* action? As mentioned above, these questions have received some attention in HCI research of the last decade.

Some researchers, including Turner (2005), Rizzo (2006) and Vyas et al. (2006), argue that while the framework proposed by Gibson can provide a sensible account of the perception of possibilities for object manipulation and locomotion, that is, immediate interactions with the physical environment, it is difficult to apply the framework to more advanced examples of social, cultural activities. Even some of Gibson's examples, such as using a mailbox, do not easily lend themselves to analysis in terms of layouts, objects, events, and ambient light. While the physical interaction part of using a mailbox is rather straightforward, understanding exactly how people perceive the affordance of sending a letter to a remote location appears to be rather problematic. In general, the analysis of tools by Gibson almost exclusively focuses on simple physical objects, which can in principle be used not only by humans but also by other animals, such as apes. Analysis of more complex tools, which are of main concern to HCI, is virtually missing.

There is growing skepticism in HCI research regarding the potential of the original Gibsonian notion of affordances to serve as a framework for analysis and design of interactive technologies for human use. Considering humans as just another animal species is increasingly perceived as a major limitation of Gibson's theory of affordances in HCI. There are reasons to assume that the general notion of affordances can be fruitfully applied beyond the original Gibsonian scope, that is, animal-environment interaction. Possibilities for human social actions are specified in ambient energy arrays in much the same way as possibilities for physical actions, and they can also be directly perceived. The posture and facial expression of another person may convey an imminent verbal attack as immediately as a view of a cliff would convey a threat of falling off. An open door to a colleague's office may provide as strong a cue to the possibility of striking up an ad hoc conversation as to the possibility for physically going through the doorway. These and similar cases can apparently be described in terms of affordances and their perception, even though the interactions they describe are not limited to object manipulation and locomotion.

Therefore, a key challenge for future research on affordances in HCI appears to be taking into account the context of culture in order to understand

how possibilities for *human action* are created, perceived, and can be supported by appropriately designed technology.

4.4 Affordances of tools

Gibson discusses a variety of tools, such as clubs, knives, and scissors, but he does not systematically explore the issue of what makes tools different from other objects in the environment. For instance, he notes: "A graspable object with a rigid sharp edge affords cutting and scraping (a knife)." (Gibson, 1979). The example suggests that the object's affordances include not only *cut-with-ability* (or scrape-with-ability) but also *graspability*, but the latter is not explicitly considered an affordance. In addition, Gibson describes tools (e.g. scissors) as extensions of the body (e.g., human hand). However, he does not systematically explore how the use of tools affects affordances of other objects in the environment, e.g., how the use of scissors makes a sheet of paper *cuttable*. Therefore, the question, central to HCI, of how affordances of tools are different from affordances of other objects remains open.

Analyses of affordances in HCI do not provide an answer to this question, either. Most of them do not explicitly differentiate between affordances of technological tools and affordances in general (even analyses,

which deliberately focus on affordances *of technology*). Take, for instance, Norman's model of action (see Figures 10 and 12 above), employed in several explorations of affordances in HCI. The model does not include an explicit notion of technological tools; it describes how people interact with the "world" and appears to be equally applicable to, say, internet banking and picking berries.

The discussion in Chapter 3 suggests that some "technology-specific" accounts of affordances can be offered by activity theory and phenomenology. For instance, activity theoretical concept of mediation and phenomenological concepts of breakdowns are explored in, respectively, the mediated action perspective (Kaptelinin and Nardi, 2012) and the analysis of breakdowns (Turner, 2005). However, each of these analyses is currently incomplete and needs to be further developed.

4.5 Learning

A common assumption about affordances is that perceiving them does not usually require much (or even any) learning; an ability to directly understand affordances is something that we all have. Without any instruction we can see that cliffs afford falling off, small stones afford throwing, and chairs afford sitting. The

assumed independence of learning has probably been one of the reasons behind the popularity of affordances among designers. As argued below, however, that assumption is actually a misconception.

To be fair, the misconception is not entirely groundless: in fact, there is virtually no discussion of learning in Gibson's exposition of his theory of affordances. The ability of animals to correctly pick up behaviorally relevant information is, essentially, taken for granted, considered a direct consequence of mutuality between the animal and the environment. On the grand scale of biological evolution the assumption is sound: the very existence (that is, survival) of an animal species testifies that individuals that belong to the species are in principle capable of correctly perceiving affordances of the environment.

However, this argument cannot be directly applied at the level of specific life circumstances of individual animals. When animals are born into the world, their perceptual functions are rudimentary and action capabilities extremely limited. It is only through maturation and practice that they acquire both the ability to act and the ability to pick up information about emerging affordances. Moreover, individual life conditions even for animals of the same species can be very different, so that different affordances are provided to

and have to be perceived by the animals. Therefore, for an individual animal the ability to perceive an affordance is not something that can be taken for granted but rather an accomplishment, a result of learning and development.

Studies of perceptual learning and development, conducted within the general framework of Gibson's ecological approach by Eleanor Gibson and her colleagues (e.g. Gibson and Prick, 2003), undoubtedly provide important insights into the centrality of learning in the perception of affordances. A limitation of the studies is that they predominantly deal with processes that take place in *stable* life conditions (e.g., perceptual learning during infancy). In such conditions the outcome of learning is a progressively more advanced adjustment of actors to their environments over extended periods of time. However insightful and important, such studies are of limited relevance to design. New designs are often disruptive. By providing new affordances they may cause significant changes of the environment and create a need for new learning efforts. Anticipating such needs and efficiently supporting users in their learning requires an understanding of how actor-environment mutuality is restored when a disruption takes place - that is, what happens between the moment when new affordances replace old ones

and the moment when the actor acquires the ability to directly perceive new affordances. Unfortunately, currently there is a lack of empirical evidence about such phenomena.

It can be concluded, therefore, that explicitly taking affordances into account means that supporting users' discovery of affordances and learning how to use them should be a key designer's concern. Currently there is a lack of evidence on how exactly people learn, unlearn, and re-learn new affordances.

CHAPTER 5

Conclusion: Reflections on the present and future of affordances as an HCI concept

5.1 Interpretation of affordances in different research contexts

As discussed in this book, there have been rather dramatic twists and turns in the affordance debate in HCI research since Norman's (Norman 1988) introduction of the concept to the field. Norman's initial interpretation was found to be not entirely consistent with the Gibsonian meaning of the term (Norman, 1999; McGrenere and Ho, 2000; Tornvliet, 2003; Soegaard, 2008). It has been argued that the Gibsonian theory of affordances has a limited relevance to HCI because

it does not provide sufficient support for understanding specifically human interaction with – and action through – technology (Albrechtsen et al., 2001; Baerntsen and Trettvik, 2002; Turner, 2005; Rizzo, 2006; Kaptelinin and Nardi, 2012). Repeated attempts to downplay the role of affordances in HCI and interaction design have been made by Norman himself (Norman, 1999, 2008, 2011). Alternative and complementary concepts, such as signifiers and feedforward, have been proposed (Norman, 2011; Vermeulen et al., 2013). As a result, there is currently a significant degree of uncertainty about the meaning and role of the concept of affordance in the field. While a general understanding of affordances as "action possibilities offered by the environment" is universally accepted, specific interpretations of this general idea are different in different research contexts.

Broadly speaking, the concept of affordances in HCI is used in three related but distinct research agendas, which are predominantly concerned with understanding and supporting, respectively: (a) direct perception, (b) purposeful user action in general, and (c) meaning making. Each of these concerns is associated with a particular perspective on affordances.

Supporting *direct perception* of suitable user actions was the original rationale behind bringing the

concept of affordances to HCI (Norman, 1988; Gaver, 1991). The interpretation of affordances in this research agenda is close to the Gibsonian notion, except that "direct perception" is not necessarily understood in the Gibsonian anti-representationalist sense; it can simply mean that no label or instruction is needed to figure out how to use an artifact (Norman, 1988).

Using affordances as an analytical tool to develop *technological support for purposeful human action in general* is an extension of the "direct perception" research agenda. There are two general strategies of using affordances as such an analytical tool. The first strategy is to (a) provide a system of hierarchically organized affordances, that is, action possibilities, which jointly enable the user to attain their meaningful goals and (b) support the user in perceiving these action possibilities (Vicente and Rasmussen, 1990; McGrenere and Ho, 2000). The second strategy is to focus on the "execution-evaluation" cycle of one particular action. The cycle is broken down into specific stages using the model of action, proposed by Norman (1988) and the concept of affordances – alone (Hartson, 2003), or in combination with other related concepts (Vermeulen et al., 2013) – is applied to identify possible ways of supporting the user at each of these stages. Irrespective of the strategy, perception is playing a key role in the analysis.

However, the difference between "direct" and "indirect" perception is usually of secondary importance.

Finally, in a number of relatively recent studies (Turner, 2006; Rizzo, 2006; Vyas et al., 2006; Vyas et al., 2008) it is proposed that the scope of the concept be extended even further, to include *meaning making in social context*. Notions of affordances based on the original Gibsonian concept, are considered limited, as only describing the most basic types of affordances (e.g., "simple affordances", Turner, 2005). It is argued that there is a need for a more advanced notion, according to which affordances are understood as emerging possibilities for individual and collective action in social and cultural contexts, actively constructed by technology users in their everyday practices through both doing and interpretation. The main focus of analysis in this research agenda is not on the "perception – action" cycle but rather on how people generally make sense of the world in terms of action possibilities provided by the environment. Accordingly, perception, as opposed to other research agendas, is either mentioned in passing or not mentioned at all.

Each of these research agendas is associated with its own challenges. Analyses of direct perception of affordances have so far been mostly dealing with physical or physical/virtual actions, such as grasping door handles or clicking on onscreen buttons (e.g., Norman,

1988; Gaver, 1991). Supporting direct perception of possibilities for "non-physical" actions, such as invoking an abstract logical function (see McGrenere and Ho, 2000), while theoretically possible, remains an open issue. The issue is closely related to understanding how direct perception is formed in learning, that is, how an originally indirect process of perception can be transformed into a direct one.

Using affordances as an analytical tool for designing support for purposeful action raises the questions of (a) how the types and properties of affordances, identified in HCI research (e.g., "sequential affordances", Gaver, 1991, or "degrees of affordances", McGrenere and Ho, 2000) can be systematically applied in interaction design and (b) whether or not the notion of affordance can be applied to stages of an action rather than whole actions (Hartson, 2003; Vermeulen et al., 2013). Finally, attempts to employ the notion of affordances in studies of meaning making (Turner, 2005; Vyas et al, 2006; Vyas et al., 2008) are yet to provide a clear definition of the new understanding of the term and justify its "added value" compared to other, already existing concepts.

5.2 Challenges associated with alternative concepts

As argued in the previous section, a number of terminological uncertainties and other conceptual challenges

are associated with the concept of affordances. Therefore, a logical question to ask is: Wouldn't it be a better solution to use instead (at least partly) an alternative or complementary concept proposed in HCI research, namely, signifiers or feedforward? Let us consider these alternatives one at a time.

An obvious advantage of the concept of signifier (Norman, 2008, Norman, 2011, Norman, 2013) is that it suggests a wide range of possibilities for the designer to orientate, direct, and otherwise support people in their encounters with complex configurations of interactive artifacts, practices, and (social) environments. Instead of narrowly focusing on helping the user to operate a particular device, the designer is encouraged to think about supporting people in dealing with meaningful, real-life problems. Providing efficient clues that would help people make right decisions in everyday contexts becomes a central objective of design.

The flip side to this advantage, however, is that the meaning of the notion gets extremely broad. Defined as "any perceivable sign for appropriate behavior, whether intentional or unintentional" (Norman, 2011), a signifier can mean virtually any information available to the senses. Probably the biggest problem caused by the broad meaning of the concept and its strict separation from affordances is that the notion of signifiers provides

little guidance in distinguishing successful designs from less successful ones. Apparently, not all signifiers are equally good. An indication of a poor design, according to Norman, is the use of certain types of signifiers, such as labels (e.g., "Push") or handwritten signs explaining how to operate a device (Norman, 2011). A real question, therefore, is how to choose or devise *right* signifiers. The question remains largely open. A possible way to address it is to more closely and explicitly relate the concept of signifiers with the notion of supporting direct perception (which would probably mean bringing in some of the insights offered by Gibson's theory of affordances.

The concept of feedforward (Djajadiningrat et al. , 2002, Vermeulen et al., 2013) faces a similar challenge. What is the added value of feedforward, compared to affordances, in providing more specific guidance to designers? For instance, what specific criteria, informed by the concept of feedforward, could be used for differentiating more successful designs from less successful ones? A straightforward advice, following from the introduction of the notion of feedforward to design, is that designers should be concerned about informing users about the outcomes of users' actions. The advice is undoubtedly useful but it is also rather general.

In addition, while there has been significant progress in separating the meaning of "feedforward"

from the meaning of "affordance" (Vermeulen et al., 2013), there is still some uncertainty regarding how exactly the concepts can be differentiated from one another. Simply stating that affordances refer to actions while feedforward refers to actions' outcomes, does not seem to be sufficient, since in some cases separating actions from their outcomes may be problematic. A "print preview" seems to be a clear case of feedforward. But does the "close" button of a window inform the user of the *outcome*, a closed window, or about the *action* of closing (which action may be misapplied, so that the user may accidentally close the wrong window)?

Therefore, while both concepts, signifiers and feedforward, appear to offer important insights, their exact meanings, relation to affordances, and implications for analysis and design need to be explored further.

5.3 Is there a future for affordances as an HCI concept?

What developments in HCI research on affordances can be expected in the future? Which (if any) of the current interpretations of affordances is going to play a central role in the field? Will the term be abandoned in favor of other concepts, such as signifiers or feedforward? While, probably, none can answer these questions with

certainty, it would be safe to say that the future of affordances and related concepts in HCI will mostly depend on whether or not they can be clearly defined and shown to be practically relevant.

As argued above, a major problem with current explorations of affordances in HCI is the uncertainty resulting from diverse interpretations of the term in the field. To be a useful conceptual tool, new interpretations of affordances, as well as other proposed concepts, such as signifiers or feedforward, need to be clearly presented and explicitly compared to other interpretations, especially the original Gibsonian meaning, and positioned in a specific research context.

Another important challenge is to make sure a concept is practically relevant and useful, that it provides new insights that help practitioners deal with concrete problems of analysis, design, evaluation, and appropriation of interactive technologies.

When affordance was first proposed as a design concept, it was immediately found practically useful. It suggested, for instance, that making a user interface object look like a familiar physical object can help the user figure out how to operate the object. But this is no longer a new idea: modern interfaces abound with various on-screen buttons, knobs, sliders, and so forth. It appears that the concept of affordances as it

was initially introduced to HCI is already well familiar to design practitioners.

Analyses of affordances in HCI research proposed a number of advanced conceptual distinctions, which allow for defining affordances more specifically. Different types and components of affordances can be identified by applying the notions of sequential and nested affordances, degree of affordance, the structure of instrumental affordances, and so forth. These insights open up new possibilities for designers to help people deal with problems associated with modern uses of interactive technologies. Arguably, nowadays users are not particularly puzzled by individual interface objects (e.g., buttons). Instead, they may find it challenging to discover and learn complex configurations of affordances, organized in time and space, assess the effort needed to act out an affordance, and relate mutual affordances of a tool and object of interest to see what action possibilities are offered by the tool. A limitation of advanced theoretical analyses of affordances is that they seldom result in the development of analytical tools suitable for concrete tasks of analysis, design, and evaluation of technology in practical contexts. Operationalizing new theoretical insights in HCI research on affordances is a way to make the research more relevant to practitioners.

In sum, the main challenges for employing new conceptualizations of affordances (or related concepts) in HCI include clarifying the meaning of the concept, as well as its place within a certain research agenda, and making it useful and relevant to designers and other HCI practitioners. Whether or not it can be achieved appears to be critical for determining the future of affordances as an HCI concept.

CHAPTER 6

Where to learn more

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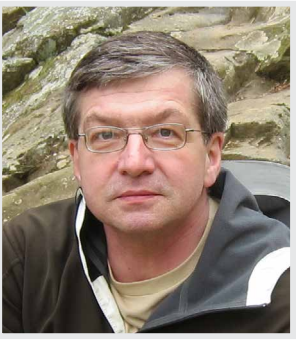

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