Design of Interactive Systems (DIS)

Lecture 13: Foundations of designing interactive systems– Cognition and action

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Part IV Foundations of designing interactive systems

- **Chapter 21**: Memory and attention
- **Chapter 22**: Affect
- **Chapter 23**: Cognition and action
- **Chapter 24**: Social interaction
- **Chapter 25:** Perception and navigation

Introduction

- **Cognition:** The mental action or process of cognition includes all **conscious** and **unconscious** processes by which knowledge is accumulated, such as perceiving, recognizing, reasoning, Judging, imagining, and problem solving.
- **Examples:** Paying attention to something in the environment, learning something new, making decisions, processing language, sensing and perceiving environmental stimuli, and using memory.

Aims

To understand:

- Cognitive psychology and in particular the idea of humans as **information processors**
- The importance of **context** in the design of interactive systems and as a major part of determining the range and type of **actions** we take
- The importance of the **body** to thinking and taking action
- Two more views of cognition and action - **distributed cognition** and **activity theory**

Human information processing

- There is a psychology-based book that discusses how humans interact with computers. The core expression of the books is “A **scientific psychology** should help us in arranging the interface so it is **easy**, **efficient** and **error free** - even enjoyable”.
- The human information processing paradigm characterizes or simplifies people’s abilities into three subsystems: (a) **a sensory input subsystem**, (b) **a central information processing subsystem** and (c) **a motor output subsystem**.
- In this view of HCI, humans and computers are functionally **similar** and form a **closed loop**.

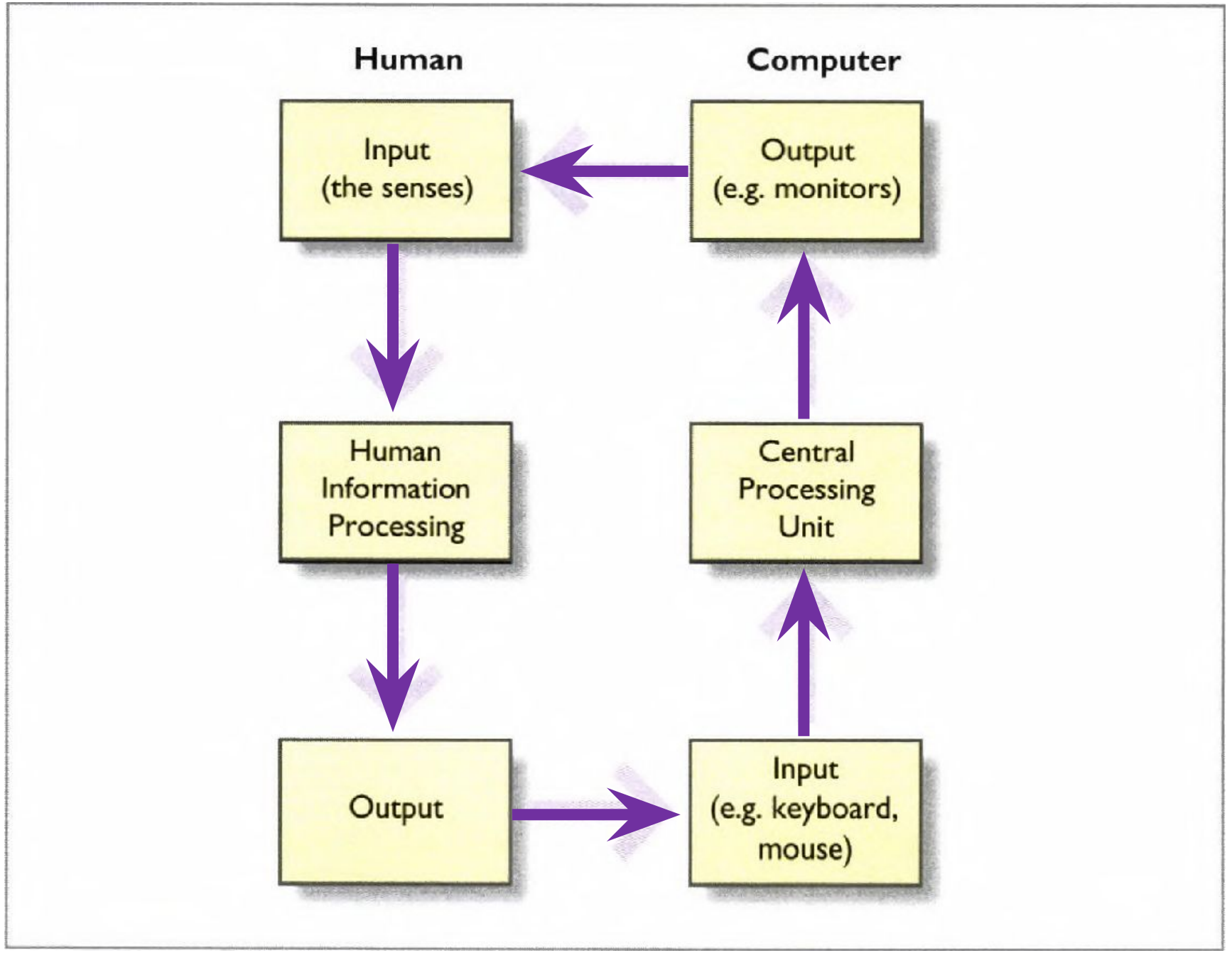

Figure 23.1 The information processing paradigm (in its simplest form)

A seven-stage model of activity

Figure 23.2 is a representation of Norman's seven-stage model of how an individual completes an activity

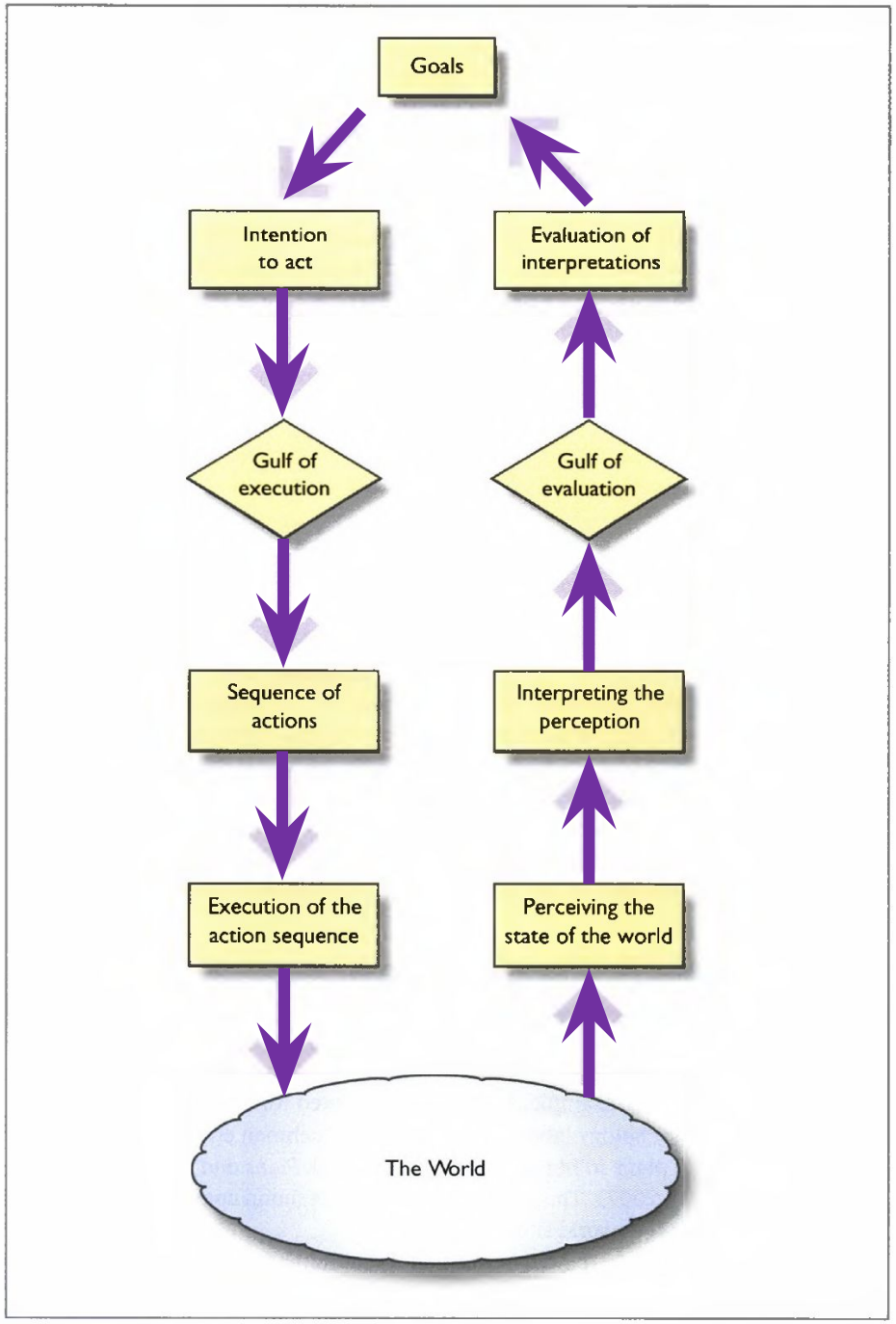

Figure 23.2 Norman's seven-stage model of activity

A seven-stage model of activity

- We begin with a **goal,** e.g. checking sports results on the Web
- Our next step is to form a set of **intentions** to achieve this goal, e.g. finding a computer with a browser,
- This is translated into a **sequence of actions** to be executed, e.g. go to a computer lab or Internet cafe, then log on to a PC, double-click on a Web browser, type in the URL, hit return, read sports results.
- At each step on the way we perceive the **new state** of the world, **interpret** what we see, and **compare** it against what we intended to change.
- We may have to **repeat** these actions if our goals were not met.

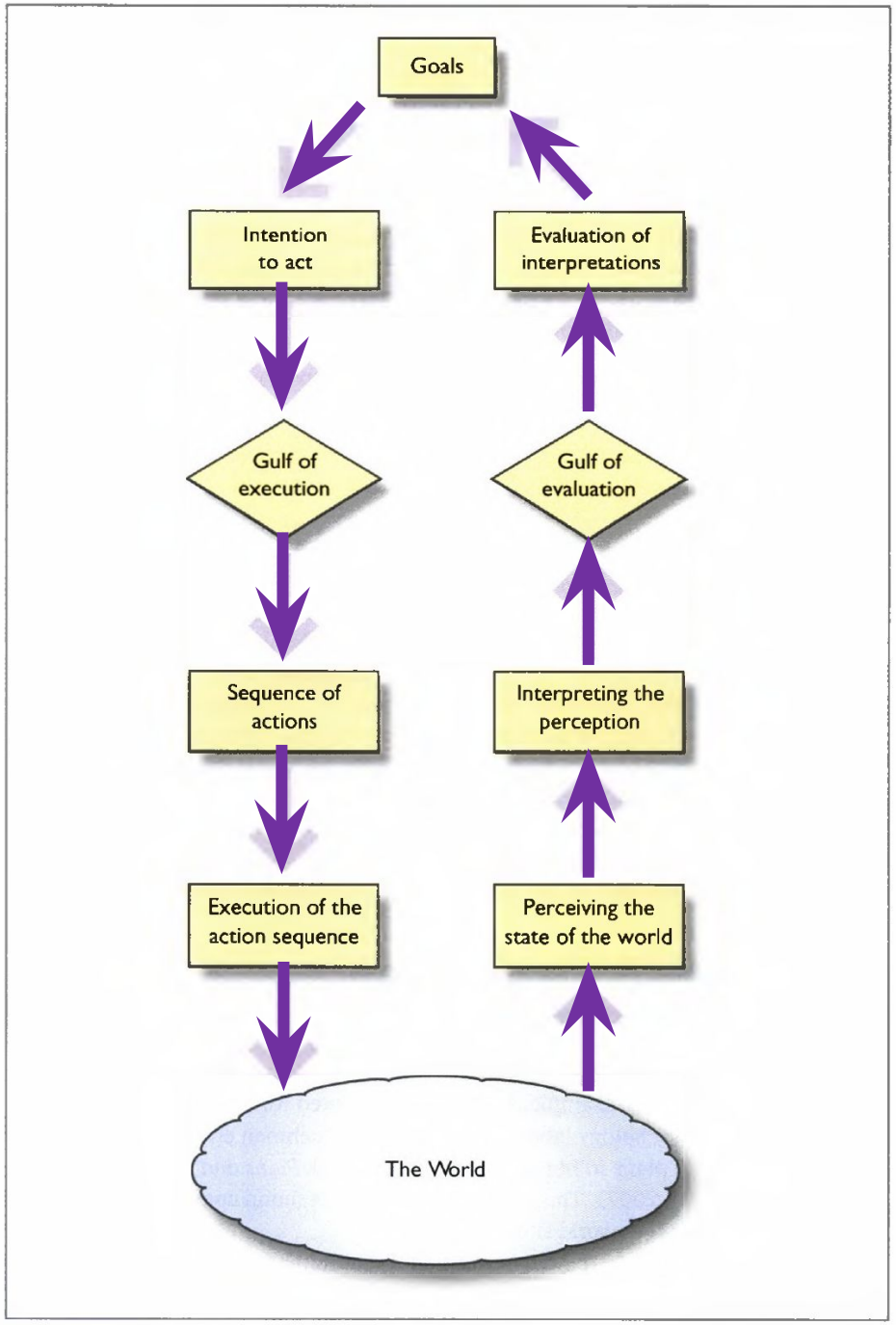

Figure 23.2 Norman's seven-stage model of activity

A seven-stage model of activity

- The **gulf of execution** refers to the problem of how an individual translates intentions into action.
- The **gulf of evaluation** refers to how an individual understands, or evaluates, the effects of actions and knows when his or her goals are satisfied.

Class activity

1. Identify instances of the gulf of execution and the gulf of evaluation in devices or systems which you (or other people) have difficulty using.

Why HIP is not enough

- The popularity of HIP has diminished dramatically in recent years, for the following reasons:
- **It is too *simple*.** We are much more complex and cannot be represented meaningfully as a series of boxes, clouds and arrows.
- ***HIP arose from laboratory studies.*** The physical and social contexts of people are many and varied and conspicuous by their absence from these diagrams.
- ***HIP models assume that we are alone in the world.*** Human behaviour is primarily social and hardly ever solitary. Work is social, travel is usually social. Where are these people represented in the block and arrow models of cognition?

Creativity and cognition

- Emotion, social interaction, intention and volition (will power) all have a part to play in **creativity**
- **Convergent thinking** is directed at finding the best solution to a problem
- **Divergent thinking** is concerned with bringing diverse ideas together and exploring many unusual ideas and possibilities (brainstorming).

Situated action

- People respond constructively and perhaps unpredictably to real-world situations.
- Situated action refers to the learners' responsiveness to their environments and their ability to engage in real-life activities. It involves problem-solving and inquiry-based learning in authentic and spontaneous situations, rather than being teacher-guided.
- Situated action claims that **humans and their interactions with the world cannot be understood** using symbol-system models and methodology but only by observing them within real-world contexts or building nonsymbolic models of them.

Situated action

- There is significant difference between treating people as merely a **set of cognitive systems** and **subsystems** (which is implied by the term ***human factors***) and respecting people as autonomous participants, **actors**, with the capacity to govern their own behaviour.
- Bannon argues that it involves moving from **narrow experimental** studies of individual people working on a computer system to the **social setting of the workplace**.
- Change in technique will be required from **cognitive and experimental** approach to less intrusive and more **observational**.

Distributed cognition

- On 20 July 1969, astronauts Neil Armstrong and Buzz Aldrin landed on the Moon
- At Mission Control, Charlie Duke followed the process closely
- Transcript of the last few seconds of the landing

  Aldrin: *‘4 forward. 4 forward. Drifting to the right a little. 20 feet, down a half* Duke: *'30 seconds.’*

  Aldrin: *'Drifting forward just a little bit; that’s good.’*

  Aldrin: *‘Contact Light.’*

  Armstrong: *’Shutdown.’*

  Aldrin: *’Okay. Engine Stop.’*

  Aldrin: *'ACA out of detent’*

  Armstrong: *'Out of detent. Auto.’*

  Duke: *’We copy you down, Eagle.’*

  Armstrong: *’Engine arm is off. Houston, Tranquillity Base here. The Eagle has landed.’*

  Duke: *Roger, Tranquillity.* We *copy you on the ground. You got a bunch of guys about to turn blue.* We're *breathing again. Thanks a lot.'*

Distributed cognition

- Ed Hutchins has developed the theory of **distributed cognition** to describe such situations.
- The theory argues that both the cognitive process itself and the knowledge used and generated are often distributed across **multiple people**, **tools** and **representations**.
- Everyday examples would include:
  - A driver and passenger **navigating a foreign city** using **maps** and **road signs**
  - The homely **task of shopping** with the **aid of a list** and the reminders presented by the **supermarket shelves**
  - Colleagues rationalizing a project budget using an Excel spreadsheet and some unintelligible printouts from Finance.

Internal and external representation

- In distributed cognition, resources include the **internal representation** of knowledge (human memory, sometimes called knowledge in the head) and **external representations** (knowledge in the world).
- This is potentially anything that supports the cognitive activity, but instances would include gestures, the physical layout of objects, notes, diagrams, computer readings and so forth.
- Team-working situations, such as Pacific islanders wayfinding between far distant islands, the navigation of US naval ships, aircraft cockpits

Different ways in which processes might be distributed

- Three different kinds of distribution emerge:
  - Cognitive processes may be distributed across the **members of a social group.**
  - Cognitive processes may involve coordination between **internal** and **external structures.**
  - Cognitive processes may be distributed **through time** in such a way that the products of **earlier events** can transform the **nature of later events.**

Embodied cognition

- An **affordance** is a resource or support that the environment offers an individual; the individual in turn must possess the capabilities to perceive it and to use it.
- Examples of affordances include, **objects** that can be **manipulated**, **substances that can be eaten**.
- If we were able to design interactive systems which immediately presented their affordances, **usability Issues would be banished**
- An **affordance** thus **exists**, whether it is **perceived or used or not**. It may be detected and used without explicit awareness of doing so.
- Affordances are both **in the world** and **in the mind of the observer**.

Figure 23.4 An affordance in the world

Embodied cognition

- Norman elaborated the concept of affordance: people are said to **perceive the intended behaviour** of the **interface widgets** such as the knobs and dials of a range of software applications.
- These intended and perceived behaviours are usually very simple, including sliding, pressing and rotating.

Embodied cognition

- “real affordances are not nearly as important as perceived affordances: it is perceived affordances that tell the user what actions can be performed on an object and, to some extent, how to do them. [Perceived affordances are] often more about conventions than about reality”.

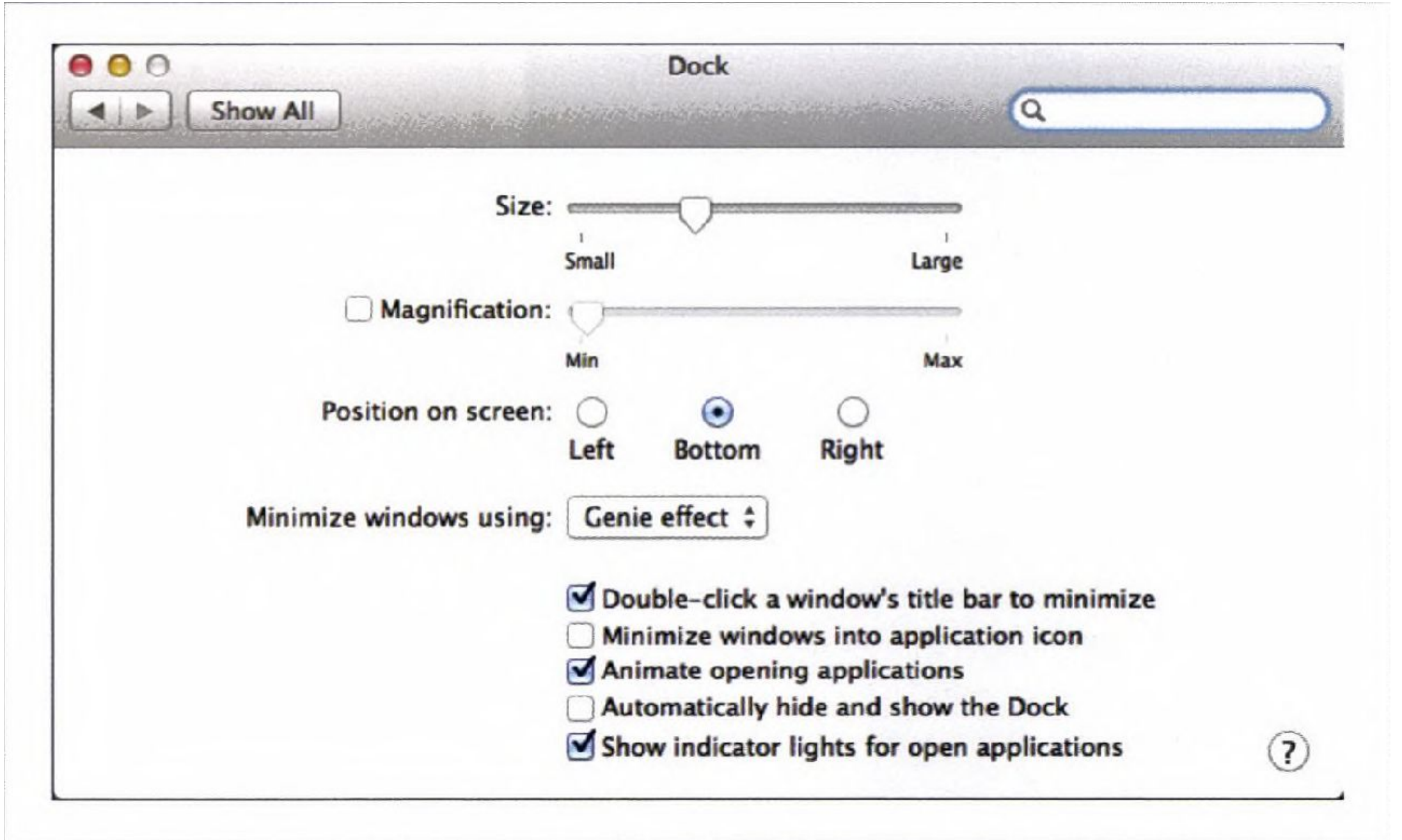

Figure 23.5 A perceived affordance at the user interface

Enactive interaction

- In every-day life **people interact with their surroundings** in a direct manner.
- Whenever we handle an object, we get an **intuitive feeling** of its **properties** and its **affordances**.
- Likewise, the **object is influenced directly by our actions**: when an object is picked up by a person, this object moves according to the energy created and forces exerted by this person.
- In fact, a loop can be identified between the person and the object, more precisely between the **gestures** (actions) and the **feedback**.
- This implies that the consequences of **one's action** have an **immediate feedback**. This forms the **basis for enactive knowledge**

Enactive interaction

- An example of the use of enactive knowledge is playing a musical instrument, such as a guitar.
- When playing a guitar, a musician exerts energy, which makes the strings vibrate and produces sound waves.
- The musician gets feedback by feeling which strings are being touched and in what place.

Embodied interaction

- Embodied interaction is concerned with two main features: meaning and coupling.
- Meaning may be about **ontology**, **inter-subjectivity** or **intentionality**.
- **Ontology** is concerned with how we describe the world, with the entities and relationships with which we interact.
- **Inter-subjectivity** is about how meaning can be shared with others. This involves both the communication of meaning from **designers** to **other people**, so that the system can reveal its purpose, and the communication between people through the system.
- The third aspect of meaning is **intentionality**. This is to do with the **directedness of meaning** and how it relates one thing to another.

Embodied interaction

- **Coupling** is concerned with making the relationship between **actions** and **meaning** effective.
- Dourish uses the familiar example of a hammer to illustrate coupling.
- When you use a hammer it becomes an extension to your arm (it is coupled) and you act through the hammer onto the nail. You are engaged in the activity of hammering.
- From this theory of embodied interaction - ‘not just how we act *on* technology, but how we act *through* it’

Activity theory

The structure of an activity:

- Central to activity theory is the concept that all purposive human activity can be characterized by a triadic interaction between a ***subject*** (one or more people) and the group's ***object*** (or purpose) mediated by ***artefact****s* or tools.
- The **subject** is the individual or individuals carrying out the activity,
- The **artefact** is any tool or representation used in that activity, whether external or internal to the subject,
- The **object** encompasses both the purpose of the activity and its product or output.

Internal structure of an activity

- **Activities** are realized by way of an **aggregation of *mediated actions,*** which, in turn, are achieved by a series of low-level **operations**.
- Consider the process of learning to use a complex interactive device such as a motor car
- The object of the activity is quite complex, ranging from need to drive due to work commitment, peer pressure, or participating in robbery.
- The activity is realized by means of an aggregation of actions (i.e. obtain driving license; insure car; take driving lessons;)
- These individual actions in their turn are realized by a set of operations (i.e. get driving license application form, complete form,

Internal structure of an activity

- This is an incomplete, *static* description of the activity whereas **humans are constantly learning** with practice
- The intricacies of the manual gear shift, the process of disengaging the engine, shifting gear and re-engaging the engine are under conscious control
- Thus the **action of changing gear** is realized by the following **operations**: depress clutch, shift to the top left, release clutch).
- Thus the focus of attention is at the operations level but with practice attention will tend to slide down the hierarchy as the action becomes automatic
- Over time, actions become automatic and the activity itself is effectively demoted to that of an action - unless circumstances change (left or right drive, change in vehicle, danger).

Class activity

2. Find some more affordances in everyday objects. How is the affordance 'presented'? Also, try to identify apparent affordances that are misleading.