

# CHAPTER 21

## AFFECTIVE AND PLEASURABLE DESIGN

**Martin G. Helander**  
Nanyang Technological University  
Singapore

**Halimahtun M. Khalid**  
Damai Sciences  
Kuala Lumpur, Malaysia

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### 1 INTRODUCTION

During the last 10 years there has been a rapid growth in research concerning affect and pleasure. Considering the lack of interest from the psychological community during much of the twentieth century, this comes as a surprise; behaviorism and cognitivism dealt with other issues. One exception in the early part of the century was Titchener (1910), who considered pleasure an irreducible fundamental component of human emotion.

Advances in psychological research were elegantly summarized by Kahneman et al. (1999) in their edited volume: *Well-Being: Foundations of Hedonic Psychology*. In human factors and industrial design there are publications by Helander et al. (2001), Nagamachi (2001), Green and Jordan (2002), and Norman (2004). In human–computer interaction (HCI) there is the classic book *Affective Computing* by Picard (1997) and a recent review by Brave and Nass (2003). New trends

include *funology* in HCI design (Carroll, 2004) and *hedonomics* in human factors (Helander and Tham, 2003; Khalid, 2004; Hancock et al., 2005). As Nielsen (1996) observed, one important challenge in theory as well as application is the design of seductive and fun interfaces. Research in this area is just beginning.

Emotions have since becoming increasingly important in product semantics. The question of which emotions are invoked while using artifacts naturally follows the question of what artifacts could mean to the users (Krippendorff, 2005). In emotional design, pleasure and usability should go hand in hand, as well as aesthetics, attractiveness, and beauty (Norman, 2004). The interplay between user-perceived usability (i.e., pragmatic attributes), hedonic attributes (e.g., stimulation, identification), goodness (i.e., satisfaction), and beauty was considered in the design of MP3-player skins (Hassenzahl, 2004). He found that goodness

depended on both perceived usability and hedonic attributes. The findings are not surprising; the use and user experience of a product are important in product evaluation (Khalid and Helander, 2004).

Jordan (2002) noted that a product or service offering should engage the people for whom it is designed at three abstraction levels: First, it has to be able to perform the task for which it was designed. For example, a car has to be able to take the user from point A to B. The product's functionality should work well and it should be easy to use (i.e., usability function). The second level relates to the emotions associated with the product or service, in the context of the associated tasks. These emotions are part of the "user experience." For example, when using an automated teller machine, feelings of trust and security might be appropriate. Driving a sports car should be exciting, but there should also be a sense of safety. The third level reflects the aspirational qualities associated with the product or service (i.e., persona or social factors). What does owning the product or using the service say about the user? For example, owning the latest, smallest mobile phone may suggest a pretty cool person. Meeting these requirements makes a case not only for the ergonomics of the product or service, but for emotional design and achievement of social status as well.

Emotion affects how we feel, how we behave and think; and it has gained significant attention in interaction design. For example, the iPod is the runaway best seller of MP3 players, although it was marketed late and is more expensive than competing models. To consumers, the iPod is easy to use and aesthetically appealing—it is *cool*, it *feels* good. *Affect* is said to be the customer's psychological response to the design details of the product, while *pleasure* is the emotion that accompanies the acquisition or possession of something good or desirable (Demirbilek and Sener, 2003).

Beyond pleasure, a new debate focused on "fun" is emerging in the human-computer interaction literature. Things are fun when they attract, capture, and hold our attention by provoking new or unusual perceptions and arousing emotions. They are fun when they surprise us, and present challenges or puzzles as we try to make sense of them.

A review of the psychological literature on emotions by Fredrickson (1998) showed that positive emotions such as joy, interest, contentment, and love that share a pleasant subjective feeling have inadvertently been marginalized in research compared to negative emotions. Two reasons for this are (1) that positive emotions are few in number and rather diffuse; and (2) that negative emotions pose problems that demand attention. For example, anger and its management have been implicated in the etiology of heart disease, and so on. Positive emotions should therefore, be tapped to promote individual and collective well-being and health (Fredrickson, 1998).

Affective appreciation is, of course, not new—just the research. People have affective reactions toward tasks, artifacts, and interfaces. These are caused

by design features that operate either through the perceptual system (looking at) or from a sense of controlling (touching and activating) or from reflection and experience. These reactions are difficult if not impossible to control; the limbic system in the brain is in operation whether we want it or not. The reactions are in operation whenever we look at beautiful objects, and they are particularly obvious when we try "emotional matching," such as buying clothes or selecting a birthday card for someone else.

Affective evaluations provide a new and different perspective in human factors engineering. It is not how to evaluate users—it is how the user evaluates. The research on hedonic values and seductive interfaces is, in fact, a welcome contrast to safety and productivity, which have dominated human factors and ergonomics. Consequently, emotions and affect have received increasing attention in recent years (Velásquez, 1998a). Approaches to emotions and affect have been studied at many different levels, and several models have been proposed for a variety of domains and environments.

This raises many research issues: (1) how we can measure and analyze human reactions to affective and pleasurable design, and (2) how we can assess the corresponding affective design features of products. In the end, we need to develop theories and predictive models for affective- and pleasure-based design.

The purpose of this chapter is to summarize various perspectives that have evolved in psychology, human factors, and neuroscience. We provide an overview of the basic neurological functions; define terms such as affect, emotions (the terms *affect* and *emotion* are used interchangeably), and sentiments; review couplings between the cognitive and affective systems in processing information and evaluating decision alternatives; summarize theories dealing with affect and design; and provide an overview of some of the most common measurement methodologies to measure affect and pleasure in design. The main focus is on design: design activates and design evaluation from the user's perspective as well as the designer's.

## 1.1 Neurological Basis of Emotions

The neurological mechanisms are illustrated in Figure 1. In the brain there are three main areas: the thalamus, the limbic system, and the cortex. The thalamus receives sensory input from the environment, which is then sent to the cortex for fine analysis. It is also sent to the limbic system, the main location for emotions, where the relevance of the information is determined (LeDoux, 1995). The limbic system coordinates the physiological response and directs the attention (in cortex) and various cognitive functions. Primitive emotions (e.g., the startle effect) are handled directly through the thalamus-limbic pathway. In this case the physiological responses are mobilized, such as for fight and flight. Reflective emotions, such as pondering over a beautiful painting, are handled by the cortex. In this case there are not necessarily any physiological responses—they are not required to deal with the situation. According to Kubovy

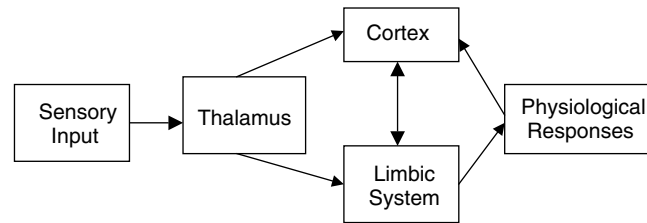


Figure 1 Neurological mechanisms in affect and emotions. (From LeDoux 1995.)

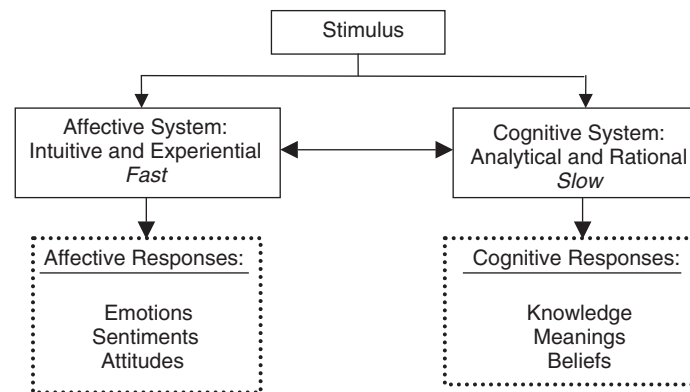


Figure 2 Cross-coupling of affect and cognition.

(1999), pleasures of the mind do not give rise to a physiological response nor to facial expressions.

## 1.2 Cross-Coupling of Affective and Cognitive Systems

The correlation between cognition and affect is an old philosophical problem, but it has not been dealt with to any great extent in cognitive psychology. In our view, cognition must consider affect or emotion, and human behavior is guided by cognition as well as emotions.

Figure 2 denotes the relationship between affect and cognition. Whereas affect refers to feeling responses, cognition is used to interpret, make sense of, and understand user experience. To do so, symbolic, subjective concepts are created that represent the personal interpretations of the stimuli. Cognitive interpretations may include a deeper, symbolic understanding of products and behaviors.

One of the most important accounts of affect in decision making comes from Damasio (1994). In his book *Descartes' Error*, he described observations of patients with damage to the ventromedial frontal cortex of the brain. This left their intelligence and memory intact but impaired their emotional assessments. The patients were socially incompetent, although their intellect and ability to analyze and reason about solutions worked well.

Damasio argued that thought is largely made up from a mix of images, sounds, smells, words, and

visual impressions. During a lifetime of learning, these become "marked" with affective information: positive or negative feelings. These *somatic markers* are helpful in predicting decision making and behavior.

Damasio tested the somatic marker theory in a game of cards where normal subjects and patients drew a card from one of four piles. Each card resulted in a gain or loss of a sum of money, as revealed on the back of the cards. Normal subjects learned to avoid cards with attractive large payoffs but occasional disastrous losses, but the patients did not learn to anticipate future events, and they lost much money on this game.

Clearly, the patients were unable to make decisions effectively: They could not determine where to live, what to buy, and what to eat. Emotions are necessary to enable selection among alternatives, particularly when there is no rational basis.

One of the authors asked a person who suffers from similar problems: "Would you like to go for a walk with me?" The answer was "Yes." "Where would you like to go? We can go to the city park, or to the old town, or to the botanical garden." The answer was "I don't know."

Affect plays a central role in dual-process theories of thinking, knowing, and information processing (Epstein, 1994). There is much evidence that people perceive reality in at least two ways: affective (intuitive and experiential) and cognitive (analytical and rational). Formal decision making relies on the analytical and cognitive abilities; unfortunately, this

mode is slow. The experiential and affective system is much quicker. When a person seeks to respond to an emotional event, he or she will search the experiential system automatically. This is like searching a memory bank for related events, including their emotional contents (Epstein, 1994) (see Figure 2).

Emotions do not cause thinking to be nonrational; they can motivate a passionate concern for objectivity, such as anger at injustice. Rational thinking entails feelings, and affective thinking entails cognition. Rational thinking is more precise, comprehensive, and insightful than is nonrational thinking. However, it is just as emotional.

Separating emotion from cognition is a major weakness of psychology and cognitive science (Vygotsky, 1962). New breakthroughs in neuroscience using functional magnetic resonance imaging (fMRI) validated the assertions that cognition and emotions are unified and contribute to the control of thought and behavior conjointly and equally (LeDoux, 1995). Additionally, cognition contributes to the regulation of emotion. Contemporary views in artificial intelligence are also embracing an integrated view of emotion and cognition. In *Emotion Machine*, Minsky (2004) claimed: "Our traditional idea is that there is something called 'thinking' and that it is contaminated, modulated or affected by emotions. What I am saying is that emotions aren't separate."

Combining the description from contemporary psychology and neuroscience, Camerer et al. (2003) illustrated the two distinctions between controlled and automatic processes (Schneider and Shiffrin, 1977), and between cognition and affect as in Table 1. As described in Table 1, controlled processes have several characteristics. They tend (1) to be serial (employing a step-by-step logic or computations), (2) to be invoked deliberately by the agent when encountering a challenge or surprise, (3) to be associated with a subjective feeling of effort, and (4) typically, to occur consciously. As such, people often have reasonably good introspective access to controlled processes. If people are asked how they solved a math problem or choose a new car, they can usually provide a good account of the decision-making process.

**Table 1 Two-Dimensional Characterization of Neural Functioning**

| Type of Process         | Cognitive | Affective |
|-------------------------|-----------|-----------|
| Controlled processes    |           |           |
| Serial                  |           |           |
| Evoked deliberately     | I         | II        |
| Effortful               |           |           |
| Occurs consciously      |           |           |
| Automatic processes     |           |           |
| Parallel                |           |           |
| Effortless              | III       | IV        |
| Reflexive               |           |           |
| No introspective access |           |           |

Source: Camerer et al. (2003).

Automatic processes are the opposite of controlled processes. Automatic processes (1) tend to operate in parallel, (2) are not associated with any subjective feeling of effort, and (3) operate outside conscious awareness. As a result, people often have little introspective access as to why the automatic choices or judgments were made. For example, a face is perceived as "attractive" or a verbal remark as "sarcastic" automatically and effortlessly. It is only in retrospect that the controlled system may reflect on the judgments and try to substantiate it logically.

The second distinction, represented by the two columns of Table 1, is between cognitive and affective processes. This distinction is pervasive in contemporary psychology (e.g., Zajonc, 1998), and neuroscience (Damasio, 1994; LeDoux, 1995). Zajonc (1998) defined *cognitive processes* as those that answer true–false questions and *affective processes* as those that motivate approach–avoidance behavior. Affective processes include emotions such as anger, sadness, and shame, as well as "biological affects" such as hunger, pain, and the sex drive (Buck, 1999).

Elaborating this further, quadrant I, for example, is in charge when one considers entering a business deal. Quadrant II can be used by "method actors," such as stand-up comedians, who replay previous emotional experiences to fool an audience into thinking that they are experiencing these emotions. Quadrant III deals with motor control and governs the movements of the limbs, such as a tennis player when he returns a serve. Quadrant IV applies when a person jumps because someone says "boo." The four categories are often not so easy to distinguish; most behavior results from a combination of several quadrants.

### 1.3 Positive Effect of Positive Emotions

Research has shown that even moderate fluctuations in positive feelings (emotions) can systematically affect cognitive processing. Isen (1999) found that mild positive affect improves creative problem solving, facilitates recall of neutral and positive material, and systematically changes strategies used in decision-making tasks. Despite these well-documented effects, there are few theories of how positive affect influences cognition.

For a complete theory of positive affect, it is necessary to understand why certain things make people happy. For example, the dopaminergic theory of positive affect postulated by Ashby et al. (1999) assumes that during periods of mild positive affect, there is a concomitant increased dopamine release in the mesocorticolimbic system. The theory assumes further that the resulting elevated dopamine levels influence performance on a variety of cognitive functions and tasks (e.g., olfactory, episodic memory, working memory, creative problem solving).

Zajonc (1980) found that when a stimulus is presented to subjects repeatedly, the exposure leads to positive affect, and the more frequent the exposure of a stimulus, the greater the affect. Winkelman et al. (1977) primed participants in an experiment with a very brief 1/250-second exposure to affective

**Table 2** Types of Affect

| Type of Affective Response | Examples of Positive and Negative Affect        | Level of Physiological Arousal | Intensity or Strength of Feeling |
|----------------------------|-------------------------------------------------|--------------------------------|----------------------------------|
| Emotions                   | Joy, love Fear, guilt, anger                    | Higher arousal and activation  | Stronger                         |
| Specific feelings          | Warmth, appreciation<br>Disgust, sadness        | ↑<br>↓                         | ↑<br>↓                           |
| Moods                      | Alert, relaxed, calm Blue, listless, bored      |                                |                                  |
| Evaluations                | Like, good, favorable Dislike, bad, unfavorable | Weaker                         | Lower arousal and activation     |

Source: Peter and Olson (1996).

stimuli. The time was so short that there could be no recognition or recall of the stimuli. Following this they were exposed for 2 seconds to an ideograph. The mean liking for the ideograph was greater when it was preceded by a smiling face.

#### 1.4 Understanding Affect and Pleasure in Different Disciplines

Several definitions and classifications of affect and pleasure exist in the literature, stemming from different traditions: marketing, product design, and psychology. We mention a few that have relevance to human factors design.

##### 1.4.1 Marketing

Peter and Olson (1996), with a background in marketing, defined four different types of affective responses: emotions, feelings, moods, and evaluations, and offered a classification (Table 2). These responses are associated with different levels of physiological arousal as well as different intensities of feeling. There are both positive and negative responses. Some examples are given below.

| Types of Affect | Positive Response | Negative Response |
|-----------------|-------------------|-------------------|
| Emotion         | Love              | Fear              |
| Feeling         | Warmth            | Disgust           |
| Mood            | Alert             | Bored             |
| Evaluation      | Like              | Dislike           |

Emotions are said to be associated with the physiological arousal, while evaluations (e.g., reflections) of products typically encompass weak affective responses, which are accompanied by a low level of arousal.

##### 1.4.2 Product Design

Tiger (1992) identified four conceptually distinct types of pleasure from a product, which were further elaborated by Jordan (see Blythe, 2004). We extended the taxonomy to five. Whether they are used as a source for pleasure depends on the person's needs.

1. *Physical pleasure* has to do with the body and the senses. It includes such things as feeling good physically (e.g., eating, drinking), pleasure from relief (e.g., sneezing, sex), as well as sensual pleasures (e.g., touching a pleasant surface).

2. *Sociopleasures* include social interaction with family, friends and co-workers. This includes the way we are perceived by others, our persona, and status.

3. *Psychological pleasure* has to do with pleasures of the mind, reflective as well as emotional. It may come from doing things that interest and engage us (e.g., playing in an orchestra or listening to a concert), including being creative (e.g., painting) or enjoying the creativity of other people.

4. *Reflective pleasure* has to do with reflection on our knowledge and experiences. The value of many products comes from this and includes aesthetics and quality.

5. *Normative pleasure* has to do with societal values such as moral judgment, caring for the environment, and religious beliefs. These can make us feel better about ourselves when we act in line with the expectation of others as well as our beliefs.

Jordan (1998) defined pleasure with products as the emotional and hedonic *benefits* associated with product use. Coelho and Dahlman (2000) defined displeasure as the emotional and hedonic *penalties* associated with product use. This argument makes an interesting point. Could it be that to understand pleasure, we also need to understand displeasure? However, we think it is not necessary since they may not be related. Take, for example, chair comfort, which has to do with feeling relaxed, whereas chair discomfort has to do with poor biomechanics. The two entities should be measured on different scales. Helander and Zhang (1997) observed that in understanding comfort there is little we can learn from discomfort; they are two different dimensions. Like discomfort, displeasure operates like a design constraint—we know what to avoid—but that does not mean that we understand how to design a pleasurable product. Take the example of chair design. Chair comfort has to do with feeling relaxed, while chair discomfort has to do

with poor biomechanics. Fixing the poor biomechanics and getting rid of displeasure does not automatically generate a sense of relaxation and pleasure. The two entities should be measured on different scales.

With increasing experience the repertoire for emotions becomes larger. In fact, many researchers think that only the startle reflex is innate, whereas most emotions and definitely sentiments are learned over time. Many persons are particularly attracted to the complexity in music and in art. One can listen to a piece of music many times; each time one discovers something new. Similarly with a painting; many modern paintings are difficult to comprehend—each time you look, the interpretation changes. Some pleasures are difficult to appreciate, hence induce an interesting challenge for many people.

### 1.4.3 Psychology

The term *affect* has several meanings in psychology and human factors (Leontjev, 1978; Norman, 2004). *Affect* is the general term for the judgmental system; *emotion* is the conscious experience of affect. Much of human behavior is subconscious, beneath conscious awareness. Consciousness came late in human evolution and also in the way the brain processes information (Norman, 2004). The affective system makes quick and efficient judgments which help in determining if an environment is dangerous—shall I fight or flight? For instance, I may have an uneasy feeling (affect) about a colleague at work, but I don't understand why, since I am not conscious about what I am reacting to. However, I am certainly aware of my strong emotions about finishing this chapter within the deadline given.

*Pleasure*, on the other hand, is a good feeling coming from satisfaction of homeostatic needs such as hunger, sex, and bodily comfort (Seligman and Csikszentmihalyi, 2000). This is differentiated from *enjoyment*, which is a good feeling coming from breaking through the limits of homeostasis of people's experiences: for example, performing in an athletic event or playing in a string quartet. Enjoyment could lead to more personal growth and long-term happiness than pleasure, but people usually prefer pleasure over enjoyment, perhaps because it is less effortful.

Although each discipline has a unique definition, their goals are quite similar. We elaborate further later when we discuss relevant theories of affect and pleasure.

## 2 FRAMEWORK FOR EVALUATING AFFECTIVE DESIGN

Design is a problem-solving discipline. It considers not only the appearance of the designed product, but also the underlying structure of the solution and its anticipated reception by users. Besides specifying characteristics of the solution, a design theory helps designers in identifying the problem and in developing their instincts in choosing the "right" solutions (Cross, 2000).

Affect, as discussed above, is the basis of beliefs, human values, and human judgment. For this reason

it might be argued that models of design process that do not include affect are essentially weakened. Until recently, the affective aspects of designing and design cognition have been substantially absent from formal theories of design process. Affective design, then, is the inclusion or representation of affect (emotions, feelings, etc.) in design processes.

### 2.1 Affective User–Designer Model

The systems model in Figure 3 provides a framework for issues that must be addressed in affective design. There are two parts of the model: the designer's environment and the affective user. The purpose of the model is to illustrate how a designer may achieve affective design and how the user of the design will perceive and react to the design.

In the *designer's environment* there are three main subsystems: artifact, context of use, and society trends. In the *artifact* subsystem we consider that the designed object can incorporate several characteristics, each of which leads to emotional responses: visceral design, behavioral design, and reflective design (Norman, 2004). The designer needs to consider and if possible, predict the user's needs and reaction to all three aspects.

*Visceral design* (also called *reactive design*), appeals to the perceptual senses. It deals with appearance. Although there are no firm guidelines for visceral design, much is known from arts and graphics about what constitutes good design: the golden ratio, symmetry, appropriate use of colors, and visual balance (the use of white space). A beautiful face, a sunset, and rolling hills are examples of this. Everybody seems to agree on this aspect of affective design (Norman, 2004).

*Behavioral design* focuses on what a person can do with an object. If the object affords manipulation, we can develop good design rules. This is where most of the activity in HCI and the usability community is directed. Behavioral design also incorporates Csikszentmihalyi's (1975, 1990) concept of *flow*. An example is when a person manipulates the controls in a computer game. While turning a knob or touching a control, the user feels fully in control and the device always responds as expected. Artists rarely talk about this because their focus is on visual appearance. To them the visual appearance of an interface is more important than the smoothness of operating controls.

*Reflective design* considers a designer's (or user's) thoughts and evaluations of the current design. This is intellectually driven and is influenced greatly by the knowledge and experience of the designer (user), including the person's culture and idiosyncrasies. For judgment of taste and fashion, people of different cultures think differently; it all depends on upbringing, traditions, needs, and expectations.

Some of the best reflective designs are loved by some and hated by others. Such contrasts may be desirable, since controversial designs have often proven to be very successful. This is where the skills and intuition of designers play a large part. One example is Volkswagen Bora; user evaluations

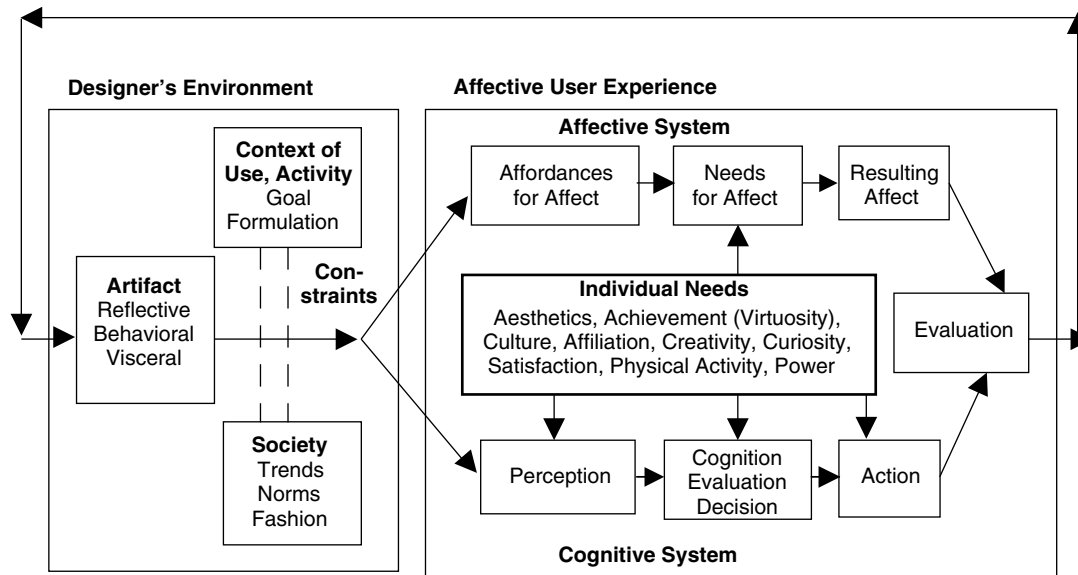


Figure 3 Framework for evaluation of affective design.

include great looks, stupid looks, looks like a baby, not masculine enough, no prestige, environmentally friendly, beautiful symmetry.

**Constraints and Filters** The next issue in the designer's environment deals with design constraints and filters. These are marked in Figure 3 with dashed lines connecting the "context of use" and "society." In the evaluation of an artifact, a designer will consider the context of use and the context of activity of the artifact. For example, will the product be used at work or at home? At work, the aesthetics of an office chair may be less important than pleasant interactions with colleagues. At home, however, a chair with an inspired design may be a means to express one's personality through aesthetic preferences. In addition, the designer must consider society trends, norms, and fashions. These aspects operate like constraints and modify the design of the artifact.

The context of use can be understood through a task analysis. This is a tool often applied in human factors. For example, the design of the new Duet washer and dryer manufactured by Whirlpool (see <http://duet.whirlpool.com/>) applied cognitive task analysis to analyze the context of use and needs of housewives. Although the product is twice as expensive as other washers/dryers, it sells extremely well. Washing clothes has become entertaining.

The context of use is not always easy to consider in design (Mäkelä and Fulton-Suri, 2001). This is because people's experiences result from motivated action in a context; as such, the designer can neither know nor control the user's experience. Similarly, it is not always possible to predict needs, motivation, context, and action which are relevant for the creation

of user experience, leading to design features of an artifact.

Moreover, people have different motivations and needs for using a product. Take, for example, the mobile phone: to keep in touch with loved ones, be efficient at work, and avoid boredom. There are value-added activities of mobile phones, such as games, short messaging system (SMS), alarm clock, and Internet connections. The phone is also used in many contexts: while commuting to work, at home, in recreation, and so on. Use of new digital products is like a situated cognition—the context of use will determine the user experience. It is also impossible to predict the use of the artifact in the individual case (Mäkelä and Fulton-Suri, 2001). The designer's goal then should be to design products that support user creativity in using the product. Equip the mobile phone with many features. It is up to the user to test them out and decide what is important.

Returning to the affective user in Figure 3, we note that perception, cognition, and action are influenced by differences in needs and other idiosyncratic characteristics (knowledge, education, gender, etc.). An experienced person will see things differently from an inexperienced person, resulting in different decisions. In Figure 3 the assumption is that there are two simultaneously operating systems for evaluating design: an affective system and a cognitive system. These are both influenced by individual needs.

Below we examine the consumer process and its relationship to customer satisfaction and pleasure. Studies in industrial design relating to affective user needs are discussed. The aim is to highlight considerations in the design of products that address both customer needs and affect.

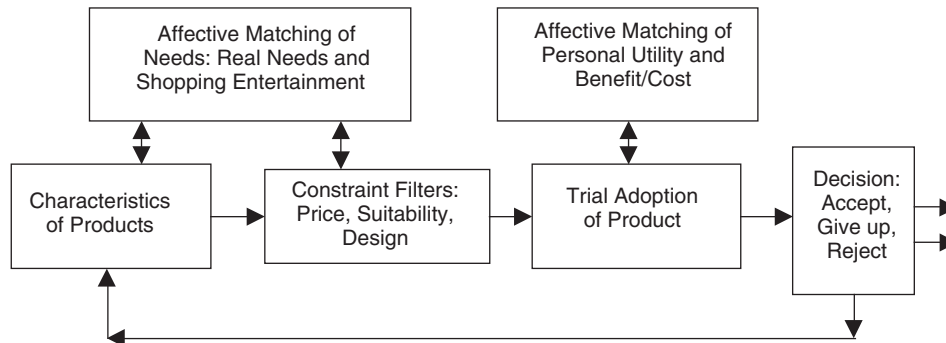


Figure 4 Consumer process.

## 2.2 Consumer Process

The process of buying a product is influenced by two affective processes: (1) affective matching of needs, and (2) affective matching of personal utility (see Figure 4). In the first instance a consumer matches the features of several alternative products to his or her perceived needs. At the same time, the customer has constraints that eliminate many products, due to price, suitability, and aesthetics design. Assume that you are buying a shirt for a friend. You will consider the price, size, style, and color. You will try to imagine how well it fits his personal needs and if he will appreciate the shirt. This “emotional matching” also occurs when you buy a shirt or a blouse for yourself, except that the process is more automatic and you may not consciously reflect on all the details because you understand your own needs much better than you understand your friend’s needs. The evaluation process is therefore quicker and sometimes subconscious. Although you are aware of why you like something, you may not have reflected on exactly what made you reject an item. Consider, for example, going through a rack of blouses in a store. The rejection of an item may take only a second. The affective matching of a blouse is a pattern-matching process with well-developed criteria for aesthetics and suitability.

The constraint filter helps in decision making by eliminating alternatives. It operates in a fashion similar to the “elimination by aspect” decision heuristic (Tversky, 1972). Some products are rejected at an early stage. This can happen for many reasons, such as that: the price is too high, the color is ugly, or the quality is poor. A quick decision is made to reject the product and consider the next product.

If the product is accepted, there will be a trial adoption. A customer may try a blouse or a shirt. A second affective matching takes place, where the personal utility and the benefit–cost trade-off of the purchase are judged. There can be three decision outcomes: reject (search for another product), accept (pay and leave), or give up (walk out of the store).

Customer emotional needs drive designers, but the needs are difficult to measure and analyze. Based on

the results of sales patterns and customer surveys, an existing product may be refined. However, for a new product, it is often not possible to predict customer emotions and the ensuing sales. Below we focus on methods for measuring emotion response to artifacts, an important factor in determining the success of a product.

## 2.3 Satisfying the Customer

Understanding customer needs is the first step in any product development (Chapanis, 1995). We present here models that deal with functional and affective needs.

Kano (1984) was among the first to address the discrepancy between functional and pleasurable design features. He distinguished between two principal types of product features: “must-haves” and “delighters” (Helander and Du, 1999). His approach was actually inspired by Hertzberg’s (1966) two-factor theory, which was formulated to predict job satisfaction. According to Hertzberg, two types of factors affect job satisfaction: motivation factors and hygiene factors. Good salary and a good ergonomic chair are hygiene factors, and if they are present, they may prevent job dissatisfaction but will not increase job satisfaction. Codetermination and good relationships at work are examples of motivation factors, and they create job satisfaction.

Kano developed an analogy with product design features. Some design features are expected; these are called *must-haves* (Figure 5). Their presence in the design does not create satisfaction; they merely avoid dissatisfaction. In Figure 5 these are represented by the transition from *A* to *B*. Some features are not expected—they create a surprising effect and are called *delighters*. Although they are not necessarily crucial to product functionality, they create customer satisfaction. This corresponds to the transition from *X* to *Y*.

Kano exemplified his model by evaluating product features of a television set using a questionnaire. Several response categories were given, including: like it, must-be, no feeling, do not like, and give-up. To evaluate image quality there were two questions:



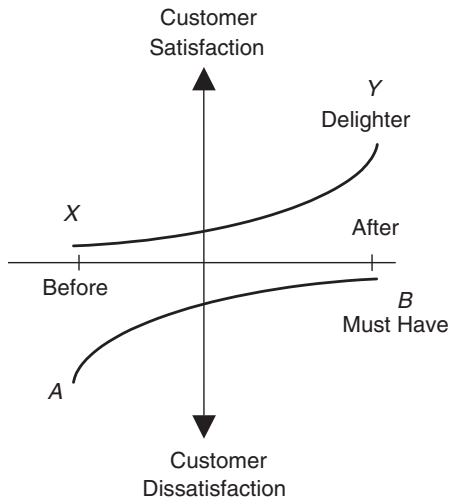


Figure 5 Kano's model for product satisfaction.

(1) How would you feel if the television picture was poor? As expected, most users (774 of 899) responded "do not like." These users then answered a second question: (2) How would you feel if the television picture was good? The results are as follows (Helander and Du, 1999) (Table 3). Of the total respondents, 497 or 64% answered "must-be." These people go from point A to point B in Figure 5, from dissatisfaction to indifference. There were no delighters. The typical response for a delighter would be "no feeling" to question 1, combined with "like" to question 2. In the evaluation of the TV set, there were two product features that were deemed delighters: "remote control" and "feather touch." Both were unexpected (in 1980) and created much satisfaction. These users went from point X to point Y.

Table 3 Responses to Question 2

Of the 774 who responded "do not like" to question 1, the following distribution was obtained for question 2:

| Question 2 Response | Number of Responses | Category                                                   |
|---------------------|---------------------|------------------------------------------------------------|
| Like                | 277                 | Satisfied when fulfilled, dissatisfied when not fulfilled  |
| Must-be             | 497                 | No feeling when fulfilled, dissatisfied when not fulfilled |
| Total               | 774                 |                                                            |

Researchers on job satisfaction would argue that the parallel between job satisfaction and product satisfaction is farfetched, since job satisfaction has a very different set of motivational factors than that of product satisfaction. There is nothing cursory about motivation factors at work, whereas users may forego delighters without thinking twice about it. The parallel between the two models may therefore be coincidental. What seems important, however, is the consideration in product design of satisfying and dissatisfying product features in two (orthogonal) dimensions. Product designers should strive to reduce customer dissatisfaction as well as to increase satisfaction. The means for achieving these goals are quite different.

Similarly, Faulkner and Caplan (1985) at Eastman Kodak categorized product design features using two variables: importance and satisfaction. Test persons rated 14 design features of a clock radio using 5-point scales (Figure 6). They concluded that features that are unimportant but received high customer satisfaction should be promoted through advertising to enhance customers' perception of product quality. Ultimately, they increase in importance, and the items can be transferred from quadrant C to quadrant B. Chances are that such features are the only ones that are different from the competition, and they can therefore

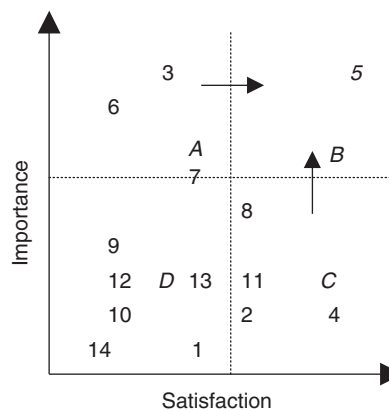


Figure 6 Evaluation of importance and satisfaction of design features of an alarm clock.

1. Sound quality AM
2. Sound quality FM
3. Ease of setting clock
4. Ease of recovery from power failure
5. Snooze alarm features
6. Regular alarm features
7. Overall size
8. Method for selecting station
9. Sleep timer feature
10. Integral electrical outlet
11. Color and finish
12. Area of footprint
13. Styling lines
14. Accommodates headset

be used to promote sales. For example, the item “recovery from power failure” would be a “delighter” in Kano’s terms. One should try to move the items from quadrant *A* to quadrant *B*. High-importance items can also become high-satisfaction items. Consider dropping the items in quadrant *D*, especially the more expensive ones.

## 2.4 Need Structures of an Affective User

The need for affect varies greatly among people. Some persons have a well-developed sense of aesthetics and will seek opportunities to satisfy their needs for beautiful things. Other people do not care about aesthetics. Some people have a need to prove their virtuosity in games and will take challenges as opportunities arise. They will seek to develop great skills so that the game will “flow” effortlessly. Thus, a person’s need structure is essential for purposeful activity. People’s needs therefore drive design. Needs, however, are very different among different persons.

The *need for virtuosity* is a proven basic human need (Kubovy, 1999). An act is performed with virtuosity when it is difficult for most people to do but is carried out with ease and economy. This is what drives many of us to play computer games. However, virtuosity as a source of pleasure does not require extraordinary performance. Kubovy (1999) made reference to a situation where a person learned to improvise jazz on the piano over a period of six years; despite the slow development, it was a very satisfactory experience.

Take another scenario, a skiing resort. While waiting in the lift lines, the latest fashion in skiing outfit and equipment will be much appreciated, but the activity of skiing cannot be displayed, so it is not relevant. While skiing downhill, a great skiing performance with superb control and flow is admired, but in this case, a trendy outfit is beside the point.

On the basis of customer needs, designers select, organize, and size product design variables to satisfy these needs. Understanding customer needs can help companies to develop products that will sell. Information about the needs may be gauged from different consumer groups. Nevertheless, customer needs are difficult to capture. Based on the results of sales patterns and customer surveys, an existing product may be refined. But there are differences between seasoned products and new products. For seasoned products such as cars, radios, and mobile phones, customer needs are well understood because of the past sales record. Companies will often improve such products in incremental steps, and customers follow along. However, for a new product it may not be possible to predict sales with any accuracy. One common example is software design. A new software version 1.0 is put on the market without many expectations, but there will be future upgrades once the sales patterns and customer needs are understood.

A common problem is that although prospective customers may respond in a survey that they like to buy a product, they may change their minds at the point of purchase. There is a long mental step between intention

and behavior (Fishbein and Ajzen, 1972). Hence, the information on customer needs may be sketchy, and designers will proceed by ignoring customer needs and estimate functional requirements as well as they can. The mapping from the designer’s environment to the affective user (Figure 3) will then be based on incomplete information.

In sum, pleasure with products is viewed from three theory-based perspectives: (1) the context of use and activity; (2) categories of pleasure with products, including visceral, behavioral, and reflective; and (3) the centrality of human needs structure in driving both the cognitive and affective evaluation systems. With reference to Figure 3, pleasure with products should be considered in the context of product use—the activity context. The same product can bring forth different levels of pleasure, depending on the goals and expectations of the user and the activity that is being performed. The system has a feedback loop. This implies that if the evaluation of an artifact does not lead to satisfactory experience or to a purchase, the designer may modify the design and the user will again evaluate the design.

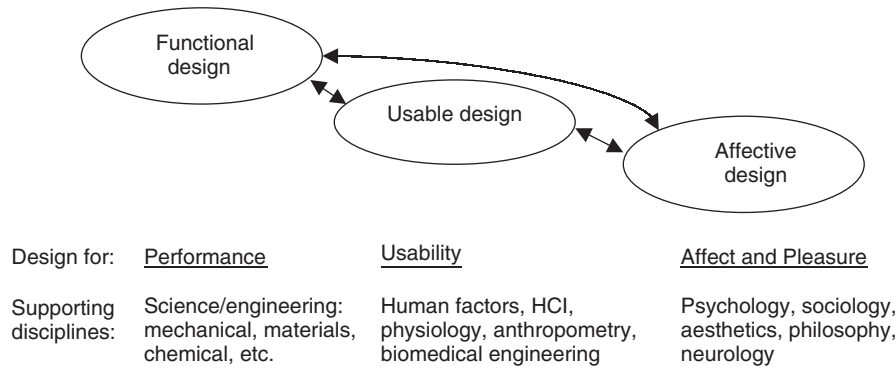
## 2.5 Shift from Usability to User Experience

In evaluating affective design, the relationship to functionality and usability must be considered. In Childs’s (2001) framework there are three parts to design: functionality, usability, and affect (Figure 7). Design for performance and usability is no longer sufficient. Affective design can give a competitive edge and will enhance the design of products as well as user interfaces. So usability is not the ultimate paradigm. Currently, the shift is to user experience models that combine cognition and emotion. In other words, there is a need to understand the gestalt impression—the sum total of the user’s experience with the product, rather than just simplicity and ease of use.

A strong claim to consider the joint effect of usability and affect comes from the research of Kurosu and Kishimura (1995) and Tractinsky et al. (2000). Kurosu and Kishimura experimented with different layouts for automatic teller machines (ATMs). Several versions of the ATM, with controls and buttons in different locations, were compared. Some were arranged in an attractive manner and some were unattractive. They found that the attractive ATMs were easier to use. Tractinsky et al. (2000) replicated the experiment in Israel. They, too, found that usability and aesthetics correlated.

The findings are in agreement with Carroll’s (2004) proposed redefinition of usability to incorporate fun and other significant aspects of user experience. The new concept should rely on an integrated analysis of the *user’s experience*. This is likely to lead to greater technological progress than is merely itemizing a variety of complementary aspects of usability. By so doing, the user experience is unified—it is a gestalt impression.

The importance of user experience and customer needs has been well documented in the design



**Figure 7** Contributing disciplines to evaluating affective design. (From Childs, 2001.)

literature. The next section highlights some past studies that focused on aesthetics, among other needs.

### 3 RESEARCH IN INDUSTRIAL DESIGN AND AESTHETICS

The research on pleasurable design in human factors is fairly recent, although there is a long research tradition in industrial design and aesthetics. We summarize here some issues that have been well investigated: (1) aesthetics and symbolic association, (2) context of use and product semantics, (3) holistic and gestalt design, and (4) familiarity and information value.

#### 3.1 Aesthetics and Symbolic Association

A general concern for aesthetics, that is, for an attractive look, touch, feel, and attention to detail, is common in many cultures. In Asia, for example, three principles guide aesthetic appreciation: (1) complexity and decoration, (2) harmony, and (3) naturalism (Schütte and Ciarlante, 1998). The display of multiple forms, shapes, and colors is found to be highly pleasing to the Chinese, Malays, Thais, and Indonesians, as they value complexity and decoration. But harmony among the elements is regarded as one of the highest goals of aesthetic expression. Japanese and Koreans value naturalism, and images of nature are frequently depicted in the packaging of consumer goods.

There are symbolic associations in all cultures for colors, shapes, numbers, and so on (McManus, 1981). Red means happiness and good luck to the Chinese and is therefore the most appealing, whereas Indians identify red with power and energy. Yellow is considered pleasant and signifies authority, whereas white is linked to death.

To achieve a “good” design, the attributes must be relatively stable across time and cultures. A good design is a visual statement that draws on shared symbolic expression of a certain subset of people in a given culture and that maximizes life goals (Csikszentmihalyi, 1995). In each culture, public taste develops, as visual qualities are eventually linked with values. Visual values can be unanimous

or contested, elite or popular, strong or vulnerable, depending on the integration of the culture.

#### 3.2 Context of Use and Product Semantics

Products are always seen in a context, and the context is construed cognitively. Product semantics connects the attributes of a product and its context of use into a coherent unity (Krippendorff, 1995). A starting point for developing product semantics is to observe what objects people surround themselves with, what the objects are used for, and how they are referred to (Krippendorff, 1995). Objects can have several meanings to customers, as identified by Bih (1992): as functional and utilitarian (e.g., radio), with religious cultural value (e.g., statues), to mark personal achievements (e.g., degree), to extend memory (e.g., photographs), for social exchange (e.g., gifts), to illustrate shared experience (e.g., travel), and to extend self and personal values (e.g., antiques).

Khalid (1999) uncovered product semantics for watches. In addition to measure time, watches are used to enhance prestige, to portray aesthetics values of the user, as fashion statements, and costume accessory. Preference for a watch depends on a holistic assessment of attributes, such as the type of casing, precision in time, and strength of material.

#### 3.3 Holistic and Gestalt Features in Design

A *gestalt* is a whole, an organization of parts, whether these are graphic elements, tones, or colors. There is an inherent tendency in perception toward achieving a parsimonious gestalt, that is, to render a structure as simple rather than complex. Simple structures have characteristics such as unity, symmetry, regularity, and harmony (Crozier, 1994). Kreidler and Kreidler (1972) claimed that there is widespread preference for good gestalt, particularly in children’s products. Objects that are symmetrical and have an even weight distribution are regarded as more balanced and are preferred over other objects (Margolin and Buchanan, 1995). This is termed here *holistic design*, a global organization of the form. It is clearly important to explore people’s judgments of attributes, such as simplicity, balance,

and symmetry, as these attributes have long been considered to be basic to design. However, people are also drawn to complexity: They look more at complex figures than at simple ones (Berlyne, 1974).

### 3.4 Familiarity and Information Value

Crozier (1994) observed that preference is correlated with exposure; the more experience we have with an object, the better we like it; people tend to prefer what is familiar. But Martindale and Uemura (1983) claimed that preference diminishes with increased familiarity because of habituation, and that aesthetic preference is linked to the physiological arousal potential of an artifact. Purcell (1986) also argued that emotional responses to objects are greater if the object is different from what was expected. To some, informativeness is more important than either novelty or familiarity. Teigen (1987) proposed that intrinsic interest in an object is related to its information value, which is a function of the joint presence of novel and familiar elements.

## 4 THEORIES OF AFFECT AND PLEASURE

Several theories in psychology support the notions that we have raised, and some provide directions for future research and methods development. These theories are summarized below.

### 4.1 Activity Theory

Activity theory employs a set of basic principles and tools—object-orientedness, dual concepts of internalization/externalization, tool mediation, hierarchical structure of activity, and continuous development—which together constitute a general conceptual system (Bannon, 1993). In human activity theory, the basic unit of analysis is human (work) activity. Human activities are driven by certain needs, where people wish to achieve a certain purpose (Bannon and Bødker, 1991). The activities are usually mediated by one or more instruments or tools, such as a photographer using a camera. Thus, the concept of mediation is central to activity theory.

Leontjev (1978) distinguished between three different types of cognitive activities: (1) simple activity, which corresponds to automated stimulus-response; (2) operational activity, which entails perception and an adaptation to the existing conditions; and (3) intellectual activity, which makes it possible to evaluate and consider alternative activities. Note that these activities are in agreement with Rasmussen's model of skill-based, rule-based, and knowledge-based behavior (Rasmussen et al., 1994). For each of the cognitive stages there are corresponding emotional expressions: affect, emotion, and sentiments.

*Affect* is an intensive and relatively short-lasting emotional state. For instance, as I walk down colorful Orchard Road in Singapore and look at items displayed in the shop windows, there are instantaneous reactions to the displayed items; most of these reactions are unconscious, and I have no recollection of them afterward. Through affect, we can monitor routine

events. Many events are purely perceptual and do not require decision making but there is an affective matching of events that are stored in memory. This helps in understanding and interpreting their significance.

*Emotions* are conscious. When I stop to look at some item in one of the shop windows, I am aware of why I stopped. Emotions go beyond the single situation and typically remain in memory for one or several days.

*Sentiments* or *attitudes*, according to Leontjev (1978), are longer lasting and include intellectual and aesthetic sentiments, which also affect my excursion along Orchard Road. I know from experience that some stores are impossible; on the other hand, there are a few that are clearly very interesting. Sentiments and attitudes are learned responses.

Feelings are an integral aspect of human activity and must be investigated as psychological processes that emerge in a person's interaction with his or her objective world. Their processes and states guide people toward achieving their goals (Aboulafia and Bannon, 2004). Feelings should not be viewed merely as perturbances of underlying cognitive processes. Predicting affect is likely to be easier than predicting emotions or sentiments. To evoke affective reactions in a user, the artifact could be designed to provide people with a variety of sudden and unexpected changes (visual or auditory) that cause excitement and joy or alarm. Designing toys for children has given us ideas about such design space.

Predicting emotional responses that extend over several situations can be more difficult. Emotions are not dependent on the immediate perceptual situation. The emotional state of a computer user is not usually oriented toward the mediating device itself but to the overall activity in general (either work activity or pleasure). The artifact is merely a mediating tool between the motive and the goal of the user (Aboulafia and Bannon, 2004).

Leontjev (1978) emphasized that emotions are relevant to activity, not to the actions or operations that realize it. In other words, several work or pleasure situations influence the emotion of the user. Even a successful accomplishment of one action or another does not always lead to positive emotions. For example, the act of sneezing in itself usually evokes satisfaction. However, it may also evoke fear of infecting another person. Thus, the affective and emotional aspects of objects are capable of changing, depending on the nature of the human activity (the overall motive and goal). As such, stressed Aboulafia and Bannon (2004, p. 12), "objects or artifacts—in and of themselves—should not be seen as affective, just as objects in and of themselves should not be defined as 'cognitive' artifacts, in Norman's (1991) sense. The relation between the object (the artifact) and the human is influenced by the motive and the goal of the user, and hereby the meaning or personal sense of the action and operation that realize the activity."

We note that Norman (2004) would object to these notions. In fact, he proposed that domestic robots need affect in order to make complex decisions, and Velásquez (1998b) talked about robots that weep. Equipped with only pure logical functions, a robot would not be able to make decisions—just like Damasio's (1994) patients.

#### 4.2 Emotions versus Pleasures of the Mind

Ekman (1992, 1994) stated that there are a number of fundamental emotions that differ from one another in important ways: anger, fear, sadness, disgust, happiness. Evolution played an important role in shaping the features among these emotions as well as their current function.

The pleasures of the mind have been neglected by contemporary psychology (Cabanac, 1992). Kubovy (1999) argued that pleasures of the mind are different from basic emotions. Pleasures of the mind are not accompanied by any distinctive facial expression. Take for example, a person viewing a painting. She may feel elated, but nothing is revealed on her face, and there is no distinctive physiological response pattern. This is very different from social interaction, such as a conversation with a colleague at work, where half of the message is in the person's face. Since one may not be able to use either physiological measures or facial expressions, one is left with subjective measures. There is nothing wrong with asking people; subjective methods, interviews, questionnaires, and verbal protocols provide valuable information. The problem is: What questions should be asked in order to differentiate between products?

The notion of the pleasures of the mind dates back to Epicurus (341–270 b.c.), who regarded pleasures of the mind as superior to pleasures of the body, because they were more varied and durable. Kubovy (1999) also noted that pleasures of the mind are quite different from pleasures of the body—tonic pleasures and relief pleasures. Ekman's eight features of emotion are summarized in the left-hand column of Table 4 the right-hand column shows pleasures of the mind.

#### 4.3 Reversal Theory: Relationship between Arousal and Hedonic Tone

Arousal is a general drive rooted in the central nervous system. According to common arousal theories, organisms fluctuate slightly about a single preferred point. Reversal theory, on the other hand, focuses on the subjective experiences of humans. The central concept of reversal theory is that the preferred arousal level fluctuates (Apter, 1989). Reversal theory claims that people have two preferred points, and they frequently switch or reverse between them. The theory therefore posits bistability rather than homeostasis. People can be in one of two states. In the first state, which is called *telic*, low arousal is preferred, whereas high arousal is experienced as unpleasant. In the *telic* state, calmness (low arousal, pleasant) is contrasted with anxiety (high arousal, unpleasant). The opposite is true when the person is in the *paratelic* state. In the *paratelic* state, low

**Table 4 Features of Emotions and Pleasures of the Mind**

| Emotions ...                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Pleasures of the mind ...                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• have a distinctive universal signal (such as a facial expression).</li> <li>• are almost all present in other primates.</li> <li>• are accompanied by a distinctive physiological response.</li> <li>• give rise to coherent responses in the autonomic and expressive systems.</li> <li>• can develop rapidly and may happen before one is aware of them.</li> <li>• are of brief duration (on the order of seconds).</li> <li>• are quick and brief; they imply the existence of an automatic appraisal mechanism.</li> </ul> | <ul style="list-style-type: none"> <li>• do not have a distinctive universal (facial) signal.</li> <li>• may be present at least some of them in other primates.</li> <li>• are not accompanied by a distinctive physiological response.</li> <li>• do not give rise to coherent responses.</li> <li>• are relatively extended in time.</li> <li>• are usually not of brief duration.</li> <li>• even though neither quick nor brief, may be generated by an automatic appraisal mechanism.</li> </ul> |

Source: Kubovy (1999, p. 137).

arousal is experienced as boredom (unpleasant) and high arousal as excitement (pleasant).

A given level of arousal may therefore be experienced as either positive or negative. One may experience a quiet Sunday afternoon as serene or dull. One may also experience a crowded and noisy party as exciting or anxiety provoking. The perceived level of pleasantness, called *hedonic tone*, is different for the two states. The *paratelic* state is characterized as an arousal-seeking state and the *telic* state as arousal avoiding. When in the *telic* state, people are goal oriented; they are serious-minded and try to finish their current activity to attain their goal. On the other hand, to have a good time, the *paratelic* state is appropriate. Goals and achievements are not of interest; rather, this is the time to play, have fun, and be spontaneous.

#### 4.4 Theory of Flow

*Flow* is a state of optimal experience, concentration, deep enjoyment, and total absorption in an activity (Csikszentmihalyi, 1992). Csikszentmihalyi (1975) described the flow state accordingly: "Players shift into a common mode of experience when they become absorbed by their activity. This mode is characterized by a narrowing of the focus of awareness so that irrelevant perceptions are filtered out; by loss of self consciousness, by responsiveness to clear goals and unambiguous feedback, and by a sense of control over the environment—it is this common flow experience that people adduce as the main reason for performing an activity." The experience of flow is associated with positive affect; people remember these situations as

pleasurable. It may be participation as a violin player in an orchestra, solving math problems, or playing chess. All of these cases may involve a sense of total attention and accomplishment which the person thinks of as a pleasurable experience.

Flow has been studied in a broad range of contexts, including sports, work, shopping, games, hobbies, and computer use. It has been found useful by psychologists, who study life satisfaction, happiness, and intrinsic motivations; by sociologists, who see in it the opposite of anomie and alienation; by anthropologists, who are interested in the phenomenon of rituals.

Webster et al. (1993) suggested that flow is a useful construct for describing human-computer interactions. They claimed that “flow represents the extent to which (1) the individual perceives a sense of control over the interactions with technology; (2) the individual perceives that his or her attention is focused on the interaction; (3) the individual’s curiosity is aroused during the interaction; and (4) the individual finds the interaction interesting.”

In e-commerce, a compelling design of a Web site should facilitate a state of flow for its customers. Hoffman and Novak (1996) defined flow as “the state occurring during network navigation which is: (1) characterized by a seamless sequence of responses facilitated by machine interactivity, (2) intrinsically enjoyable, (3) accompanied by a loss of self-consciousness, and (4) self-reinforcing.” To experience flow while engaged in any activity, people must perceive a balance between their skills and the challenges of the interaction, and both their skills and challenges must be above a critical threshold.

Games promote flow and positive affect (Johnson and Wiles, 2003). The study of games can inform the design of nonleisure software for positive affect. Bergman (2000) noted that “the pleasure of mastery only occurs by overcoming obstacles whose level of frustration has been carefully placed and tuned to not be excessive or annoying yet sufficient to give a sense of accomplishment.” Thus, an interface may be designed that can improve a user’s attention and make the user feel in total control as well as free of distractions from nonrelated tasks, including poor usability.

#### 4.5 Affect Heuristic

Research in decision making was for many years dominated by normative models, where probabilities of outcome and the associated values in terms of losses and gains could be optimized. Lately, there has been much research on how people make decisions in real life. It turns out that people usually do not try to maximize the outcome but are often driven by their intuition, which may or may not be optimal. The reason is that people cannot hold all the facts and figures in short-term memory, which is easily crowded by all the detailed information. People could, of course, calculate the optimal solution using a computer, but in real life this is not done. Decisions are made on the spin. Since the capacity of the short-term

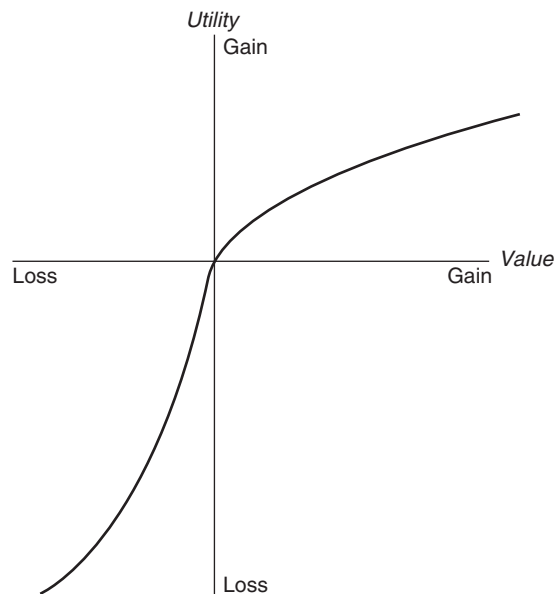
memory is easily exceeded, there are other ways of coping with decisions: namely, to use heuristics or “rules of thumb.” In other words, people try to “wing” decisions.

In most cases the quality of decision making produced by heuristics is good enough; there is rarely a need for exacting decisions, but there are also exceptions (Gilovich et al., 2002). Several common heuristics have been identified, including the availability heuristic, the anchoring heuristic, the confirmation bias, the framing effect, and the as-if heuristic. The most famous is prospect theory, which was the basis for Kahneman’s Nobel Prize in Economics in 2002 (Kahneman and Tversky, 1984) (see Figure 8).

According to this heuristic, people will make unexpected choices. The positive utility of increasing your wealth is fairly small. But the negative utility of losing money is much greater. Note the asymptotic curve for gain—once you have \$1 million, the potential gain of another million has less utility, and the opposite is true for losses. To illustrate these notions, assume that you are given the choice of gambling. There are two options:

- A. You will obtain \$10 with 100% certainty.
- B. You will obtain \$20 with 50% certainty and nothing with 50% certainty.

Would you choose option A or B? Although both options carry equal value according to the normative school, option A is chosen by 75%, and option B with 25% probability. People will rather take a certain win than gamble.



**Figure 8** Prospect Theory. A marginal gain in wealth has fairly small positive utility. Losses are however much more consequential and carry heavy negative utility.

Assume that you are given another choice of gambling. There are two options:

- A. You will lose \$10 with 100% certainty.
- B. You will either lose \$20 with 50% certainty or nothing with 50% certainty.

About 30% of a population selects option A and 70% option B. The prospect of losing 10% for sure makes alternative A less attractive.

These findings have great implications for financial decision making; people are not logical decision makers and they need advice. In proposing the *affect heuristic*, Slovic et al. (2002) claimed that many decisions are based on emotional criteria. Kahneman (2002), in agreement, said that had he understood about the emotional basis of decision making, he would have reformulated the prospect theory.

Slovic et al. (2002) explained on how decisions are made. The *analytic system* uses algorithms and normative rules, such as probability calculus, formal logic, and risk assessment. It is relatively slow, effortful, and requires conscious control. The *experiential system* is not very accessible to conscious awareness but is intuitive, fast, and mostly automatic. The challenge now is to understand how we can design information systems so that they appeal to the emotional and experiential system with fast and intuitive processing of information as a result.

#### 4.6 Endowment Effect

Research on the *endowment effect* has shown that people tend to become attached to objects they are endowed with, even if they did not have any desire to own the object before they got possession of it (Thaler, 1980). Once a person comes to possess a good, he or she values it more than before possessing it. This psychology works well for companies that sell a product and offer a two-week return policy. Very few return the product. Put simply, this means that people place an extra value on the product once they own it.

Lerner et al. (2004) extended the endowment effect by examining the impact of negative emotions on the assessment of goods. As predicted by appraisal-tendency theory, disgust induced by a prior, irrelevant situation carried over to unrelated economic decisions; thereby reducing selling and choice prices and eliminating the endowment effect. Sadness also carried over, reducing selling prices but increasing choice prices. In other words, the feeling of sadness produces a *reverse endowment effect* in which choice prices exceeded selling prices. Their study demonstrates that incidental emotions can influence decisions even when real money is at stake, and that emotions of the same valence can have opposing effects on such decisions.

#### 4.7 Hierarchy of Needs

According to Maslow (1968), people have hierarchies of needs that are ordered from physiological needs through safety, love/belonging, and esteem, to self-actualization. They are usually depicted using a pyramid or a staircase, such as in Figure 9. The hierarchy affects how needs are prioritized. Once a person has fulfilled a need at a lower level, he or she can progress to the next level. To satisfy the need for self-actualization, a person would have to fulfill the lower four needs, which Maslow (1968) referred to as *deficiency needs*. These needs are different than self-actualization in nature. Many authors have pointed out that the hierarchy is not a strict progression. For example, some people may deemphasize safety but emphasize the needs for love/belonging.

Hancock et al. (2005) presented a hierarchy of needs for ergonomics and hedonomics (Figure 9). The ergonomic needs address safety, functionality, and usability; in Maslow's reasoning they would be referred to as deficiency needs. The two upper levels, pleasure and individuation, deal with self-actualization. Individuation, at the top of the pyramid, is concerned with ways in which a person customizes his or her engagement and priorities, thereby optimizing pleasure as well as efficiency.

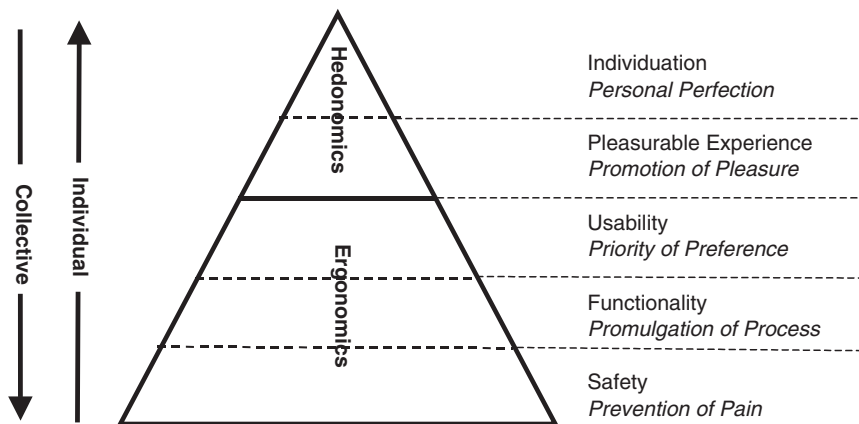


Figure 9 Hierarchy of ergonomics and hedonomics needs. (From Hancock et al., 2005.)



One may question if there is really a hierarchy or if the elements of Figure 9 are independent of each other. If so, there would not be a progression from bottom to top, but rather, in parallel. Helander and Zhang (1997) found that comfort and discomfort are orthogonal concepts, and it is necessary to use two different scales to measure them. Similarly, it may be necessary to use several scales in Figure 9 to measure each of the five concepts. Essentially, a combination of subjective and objective measures is needed to capture the various dimensions of emotion.

## 5 MEASUREMENT OF AFFECT AND PLEASURE

Several studies have proposed methods for measuring affect. Nagamachi (1989) is in the forefront with the development of questionnaire scales for assessment of what he refers to as *Kansei* (feeling) engineering. Picard (1997) has published extensively on the use of various methodologies for measurement of affect in computing. More recently, Jordan (2000) and Desmet (2003) introduced questionnaires and measurement instruments to assess emotional responses to consumer products. Whatever the method, emotions are difficult to assess, especially when several emotions blend (Scherer, 1998). At this stage the measurement of emotions poses one of the most challenging aspects to human factors.

### 5.1 Measurement Issues

Larsen and Fredrickson (1999) proposed four pertinent aspects of emotion assessment: dynamics, context, reliability, and validity. We add a fifth issue, measurement error.

#### 5.1.1 Dynamics

Emotions are generated by different systems in the brain with different timing mechanisms, and they evolve over time. Therefore, they are difficult to capture. This raises three critical measurement issues: (1) how to identify the onset of a particular emotion (when does it start and when does it end?), (2) how to ensure that a measure of emotion can capture the dynamic aspects, and (3) how to relate in time the subjective emotion experience to the experience measured.

#### 5.1.2 Context

Emotions occur in a context. Activity theory, for example, emphasizes the ongoing work activity. Therefore, it is important to capture the context and the peculiarities of the scenario in which the emotions were generated. Emotions also vary from person to person and are related to personality, experience, mood, and physiological arousal. In addition, the 24-hour circadian rhythms influence the emotion experience.

#### 5.1.3 Reliability

The purpose here is to find measurements that are stable from time to time. For some situations, a test-retest correlation is a good estimate of reliability.

However, in estimating reliability, we must consider that a person's mood changes frequently and it may be difficult to reproduce the emotive experience a second time for a retest. Emotion can also be measured for members in a group. The interest here may be differences between people in their reactions to emotion-provoking events.

#### 5.1.4 Validity

The question here is whether a measure that we use to evaluate emotion(s) measures what we intend to measure. One complicating factor is that emotions are complex responses. Larsen and Fredrickson (1999) were of the opinion that measurement of an emotion cannot be reduced to one single measure.

Construct validity is important to consider; is there a theory that drives our research interest? If so, we need to define measure(s) that can be linked to the theory. This simplifies measurement since we have an "excuse" to focus on only a few types of measures. For example, let us assume that we would like to measure pleasures of the mind. From what we understand, these do not necessarily generate a facial expression or physiological response. Therefore, we would neither consider physiological variables nor facial measures. In this case, a theory of emotional expression restricts the selection of dependent variables.

#### 5.1.5 Measurement Error

There are two types of measurement error: random error and systematic error. To overcome random error, one can take many measures instead of a single measure and estimate a mean value. Therefore, multiple items or mathematical measurement models can be used to control or eliminate random measurement error. However, this approach is not suitable for methods, which require assessments at certain times, such as experience sampling.

Another problem is that some types of assessments are intrusive (Schimmack, 2003). By asking a person to respond to a question, the contextual scenario of the emotional experience is disrupted, which may reduce the validity of the data. To minimize disruption, one can reduce the number of questions. Another way is to seek measures that are less intrusive: for example, physiological responses and facial expressions.

For heterogeneous scales that sample a broad range of affects (e.g., PANAS scales), many items are needed. Watson et al. (1988) used 10 items and obtained item-factor correlations ranging from 0.75 to 0.52. Systematic measurement error does not pose a problem for within-subject analysis, because the error is constant across repeated measurements. However, it can be misleading to use average values for calculation of correlation coefficients.

### 5.2 Measurement Methods

Despite much development in human factors research, the methods for measuring affect are entrenched in psychology. Various research in consumer behavior, marketing, and advertising have developed instruments



**Table 5 Overview of Human Factors Methods to Measure Affect**

| Methods                                           | Techniques                                                                                                                                                                                                                                                                                  | Research Examples                                                                                                                                                                                                                                                                                                                                                                  |
|---------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Subjective measures                               |                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                    |
| Subjective rating of emotional product attributes | Kansei engineering<br>Semantic scales                                                                                                                                                                                                                                                       | Nagamachi (2001), Helander and Tay (2003)<br>Küller (1975), Chen and Liang (2001), Karlsson et al. (2003), Khalid and Helander (2004)                                                                                                                                                                                                                                              |
| Subjective rating of emotions — general           | Self-report<br>Emotional well-being report<br><br>Experience sampling method<br><br>Affect grid<br>Checklist (MACL)<br>Multiple affect adjective check list<br>Activation–deactivation adjective check list<br>Differential emotional scale<br>Interview<br>Aesthetic development interview | Rosenberg and Ekman (1994)<br>Brown and Schwartz (1980), Sandvik et al. (1993)<br>Larson and Csikszentmihalyi (1983), Singer and Salovey (1988), Feldman-Barrett (1998), Eid and Diener (1999), Schimmack (2003)<br>Russell et al. (1989), Warr (1999)<br>Nowlis and Green (1957)<br>Zuckerman and Lubin (1965)<br>Thayer (1967)<br>Izard (1977)<br>Jordan (2000)<br>Housen (1992) |
| Subjective rating of emotions induced by artifact | PANAS scale<br>Philips questionnaire<br>Product emotion measurement instrument                                                                                                                                                                                                              | Watson et al. (1988)<br>Jordan (2000)<br>Desmet (2003)                                                                                                                                                                                                                                                                                                                             |
| Objective measures                                | Facial action coding system<br>Maximally discriminative affect coding system<br>Facial electromyography<br>Emotion judgment in speech<br>Psychoacoustics and psychophonetics                                                                                                                | Ekman and Friesen (1976), Ekman (1982)<br>Izard (1979)<br>Davis et al. (1995)<br>Scherer (1986), Maffiolo and Chateau (2003)<br>Larsen and Fredrickson (1999)                                                                                                                                                                                                                      |
| Psychophysiological measures                      | Galvanic skin response and other ANS measures<br>Wearable sensors                                                                                                                                                                                                                           | Larsen and Fredrickson (1999)<br>Picard (2000)                                                                                                                                                                                                                                                                                                                                     |
| Performance Measures                              | Judgment task involving probability estimates<br>Lexical decision task                                                                                                                                                                                                                      | Mayer and Bremer (1985), Ketelaar (1989)<br>Challis and Krane (1988), Niedenthal and Setterlund (1994)                                                                                                                                                                                                                                                                             |

for measuring emotional responses to advertisement and consumer experiences of products. Here we focus on methods that may be applied to affective design of products. We classify the methods into four broad categories: (1) subjective, (2) objective, (3) physiological, and (4) performance. The subjective methods are further categorized into three classes of measures: (1) user ratings of product characteristics, (2) user ratings of emotions and/or reporting of user experience without specific reference to an artifact, and (3) user ratings of emotions as induced by artifacts. The methods are summarized in Table 5.

### 5.2.1 Subjective Measures

**Ratings of Product Characteristics** These subjective methods involve user evaluations of products. There are two established techniques: Kansei engineering and semantic scales.

**Kansei Engineering** Developed by Mitsuo Nagamachi 20 years ago, Kansei engineering centers on the notion of *Kansei*, customer's feelings for a product (Nagamachi, 1989, 2001). The word *Kansei* encompasses various concepts, including sensitivity, sense, sensibility, feeling, aesthetics, emotion, affection, and intuition—all of which are conceived in Japanese as mental responses to external stimuli, often summarized as psychological feelings (Krippendorff, 2005). Nagamachi validated several scales for assessment of different products. To build a scale, the following procedure was used: (1) collect Kansei words; (2) correlate design characteristics with Kansei words (e.g., using Osgood's semantic differential technique); and (3) perform factor analysis on Kansei words to determine similarity; (4) analyze product features to predict emotions.

A Kansei database of descriptors has been developed for various products: beautiful, cheerful, citylike,

**Table 6 Results from Factor Analyses of Four Kitchen Appliances<sup>a</sup>**

| Descriptor            | Curvy Toaster |       | Square Toaster |       | Round Coffeemaker |        | Tubelike Coffeemaker |       |
|-----------------------|---------------|-------|----------------|-------|-------------------|--------|----------------------|-------|
| Stylish               | 1             | 0.587 | 1              | 0.839 | 2                 | 0.706  | 1                    | 0.839 |
| Modern                | 1             | 0.544 | 1              | 0.801 | 1                 | 0.736  | 1                    | 0.756 |
| Fashionable           | 1             | 0.771 | 1              | 0.702 | 2                 | 0.603  | 1                    | 0.631 |
| Cool                  | 1             | 0.540 | 1              | 0.805 | 1                 | 0.697  | 1                    | 0.606 |
| Attractive            | 1             | 0.798 | 1              | 0.821 | 1                 | 0.708  | 1                    | 0.844 |
| Beautiful             | 1             | 0.798 | 1              | 0.702 | 1                 | 0.697  | 1                    | 0.814 |
| Elegant               | 1             | 0.533 | 1              | 0.645 | 1                 | 0.608  | 1                    | 0.717 |
| Likeable              | 1             | 0.598 | 1              | 0.723 | 1                 | 0.737  | 1                    | 0.675 |
| Luxurious             | 4             | 0.724 | 6              | 0.602 | 2                 | 0.707  | 1                    | 0.564 |
| Lively                | 1             | 0.779 | 1              | 0.642 | 1                 | 0.628  | 1                    | 0.691 |
| Interesting           | 1             | 0.578 | 1              | 0.546 | 2                 | 0.743  | 1                    | 0.718 |
| Unique                | 3             | 0.699 | 1              | 0.548 | 2                 | 0.800  | 1                    | 0.569 |
| Cheerful              | 1             | 0.734 | 1              | 0.656 | 1                 | 0.593  | 1                    | 0.689 |
| Urban                 | 5             | 0.516 | 1              | 0.762 | 1                 | 0.681  | 3                    | 0.713 |
| Unusual               | 3             | 0.666 | 2              | 0.531 | 2                 | 0.714  | 2                    | 0.365 |
| Cute                  | 2             | 0.767 | 5              | 0.558 | 2                 | 0.522  | 1                    | 0.580 |
| Curvy                 | 2             | 0.789 | 3              | 0.430 | 1                 | 0.710  | 3                    | 0.590 |
| Homely                | 2             | 0.541 | 3              | 0.729 | 3                 | 0.568  | 3                    | 0.630 |
| Natural               | 6             | 0.722 | 3              | 0.776 | 3                 | 0.684  | 4                    | 0.670 |
| Friendly              | 2             | 0.568 | 4              | 0.658 | 3                 | 0.565  | 1                    | 0.592 |
| Compact               | 5             | 0.604 | 3              | 0.639 | 3                 | 0.576  | 4                    | 0.509 |
| Ordinary              | 6             | 0.689 | 2              | 0.744 | 3                 | 0.699  | 3                    | 0.592 |
| Loud                  | 1             | 0.491 | 5              | 0.800 | 5                 | 0.821  | 2                    | 0.492 |
| Complex               | 3             | 0.735 | 2              | 0.697 | 2                 | 0.495  | 5                    | 0.804 |
| Masculine             | 4             | 0.708 | 4              | 0.699 | 4                 | 0.859  | 4                    | 0.636 |
| Feminine              | 2             | 0.656 | 4              | 0.684 | 4                 | -0.525 | 2                    | 0.747 |
| Explained variance(%) | 68.0          |       | 68.7           |       | 66.2              |        | 65.0                 |       |

<sup>a</sup>Varimax rotation was used. In each column the number of the factor and the factor loadings are given.

delightful, enjoyable, fashionable, friendly, happy, natural, pretty, rich, and stimulating. One question is if the descriptors are generic enough to be used across products. Also, can Kansei engineering predict feelings of cultures other than Japanese? The qualities of feelings are not universal or literally caused by particular forms (Krippendorff, 2005).

Helander and Tay (2003) investigated if the same Kansei words could be used to describe four different types of kitchen appliances. A list of 26 descriptors was generated from an original list of 200 descriptors. Table 6 shows the set of Kansei words that was used. Each product was then rated by 100 test persons using a 7-point Likert scale ranging from 1 (absolutely not) to 3 (not really) to 5 (much) to 7 (very much) (see Table 6). From the table we can see that the factor analyses for the four kitchen appliances generated similar factors, and it explained about 68% of the variance. From this analysis we can conclude that for kitchen appliances it is possible to use the same set of Kansei words.

**Semantic Scales** Semantic scales are similar to Kansei scales. The main difference is that the scales rely on the methodology proposed in Osgood's semantic differential technique (Osgood et al., 1967). This technique makes it possible to assess semantic differences between objects. Adjective pairs of opposite meanings are created, such as light—heavy,

open—closed, and fun—boring. Subjects then rate objects using, for example, a 5-point scale, such as 1 (very fun), 2 (fun), 3 (neutral), 4 (boring), and 5 (very boring). A main problem is to validate the word pairs. In the first place, it is not trivial to assess if the two words constitute semantic opposites. One would also need to demonstrate that the word pair chosen is appropriate to evaluate the artifact in question.

Küller (1975) was one of the first to develop semantic scales for design, in his case for architectural appreciation. His interest was driven by the observation that a pleasant environment increases calmness and security and reduces aggressiveness. He validated 36 adjectives (in Swedish) which constituted seven factors. The factors and adjectives were *pleasantness* (stimulating, secure, idyllic, good, pleasant, ugly, boring, brutal); *complexity* (motley, lively, composite, subdued); *unity* (functional, of pure style, consistent, whole); *enclosedness* (closed, demarcated, open, airy); *potency* (masculine, potent, fragile, feminine); social status (expensive, well-kept, lavish, simple); *affection* (modern, new, timeless, aged); and *originality* (curious, surprising, special, and ordinary).

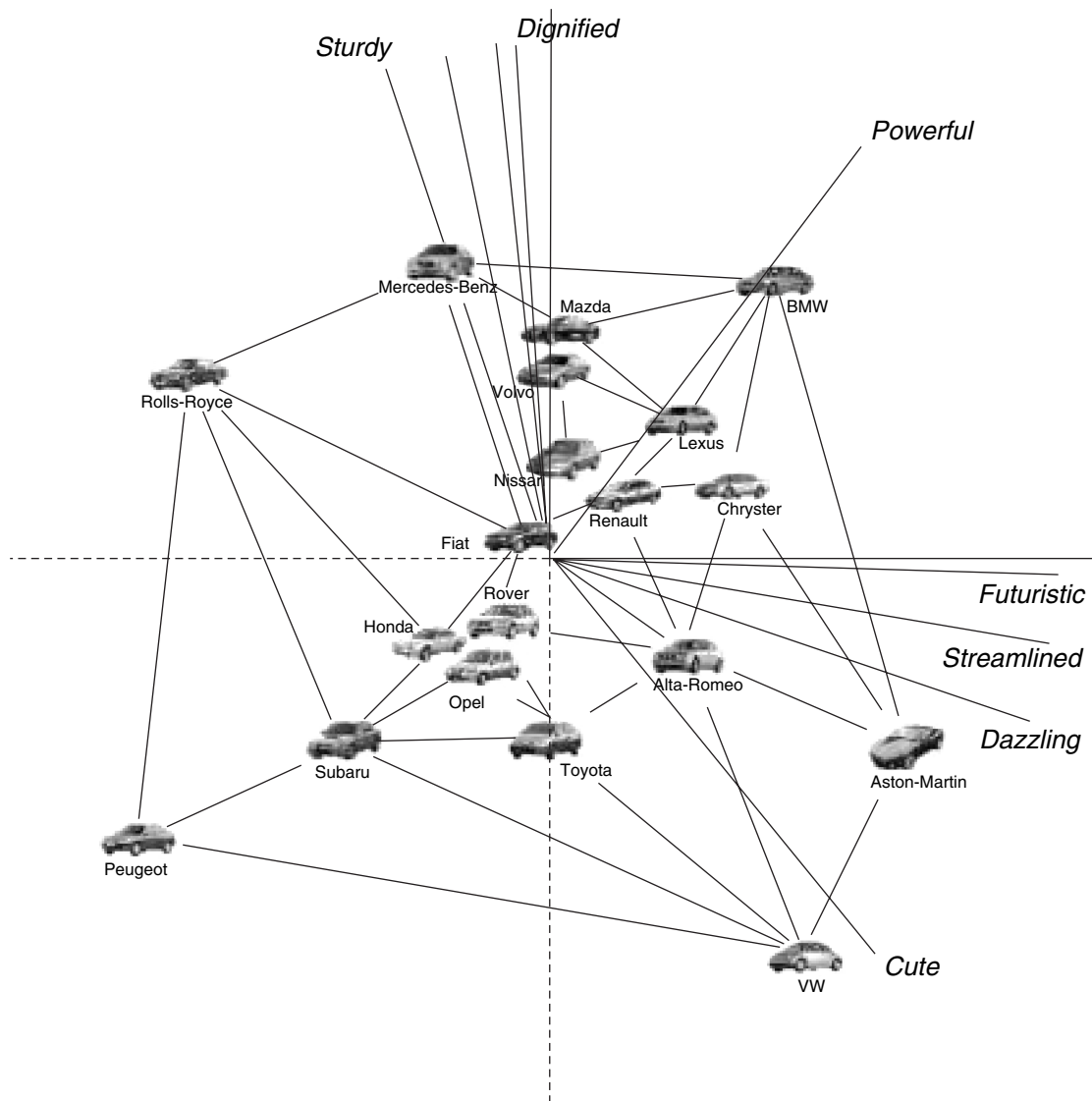
Karlsson et al. (2003) used Küller's method for evaluation of automobiles. They obtained significant results that discriminated among the designs of four passenger cars: BMW 318 (more complex and potent), Volvo S80 (more original and higher social status),

Audi A6 (less enclosed), and VW Bora (greater affect). Considering the significant results, one may debate whether formal validation is necessary; the significant results carried much face validity! Obviously, this methodology works well with cars as well as architecture.

Chen and Liang (2001) evaluated 19 cars using six adjectives: streamlined, futuristic, cute, dazzling, comfortable, dignified, sturdy, powerful, and mature. Each car was rated by 48 subjects using a scale. The adjectives used by subjects were factor analyzed to extract the underlying dimensions of the attributions. This technique was used to obtain measures of semantic differences between existing cars, but it

could be used to measure how a proposed design deviates from those on the market. The data were evaluated using multidimensional scaling, and the results as represented in Figure 10. Chen and Liang then used image morphing to evaluate the various dimensions. For example, visualization of the vector “cute” can be calculated as one goes from a source image (Volkswagen Bora) to the destination image (Mercedes-Benz). This affective evaluation of the attractiveness of a car, combined with an interpolation of shapes, has proven to be a valuable design tool.

Still on cars, Khalid and Helander (2004) developed a rating tool to measure user responses to four future electronic devices [cell phone, personal digital



**Figure 10** Multidimensional scaling similarity of various cars. (From Chen and Liang, 2001.)

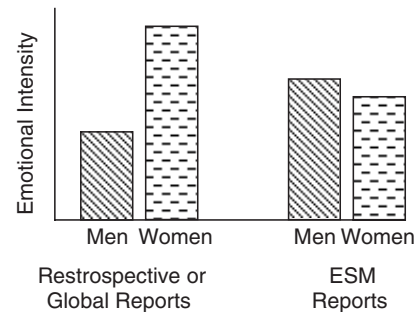
assistant, radio, and geographical positioning system (GPS)] for an instrument panel of a car. Users had to imagine the products and rated their affective preferences for 15 product attributes on 10-point semantic differential scales. These attributes comprised functional and affective customer needs derived from a customer survey. Using factor analysis, three generic factors were extracted: *holistic attributes*, *styling*, and *functional design*. Depending on the familiarity of the device, there were clear differences among users. Devices that were unfamiliar to the test persons, such as GPS, were assessed using holistic attributes. Familiar designs, such as car radio and cell phone, were assessed using styling and functionality attributes.

**Subjective Ratings of Emotions** These include techniques that report a person's subjective experience, such as self-reports and experience sampling method, or rating of one's own emotions in the form of affect grid, checklist, and interview. These methods have more general applicability to products as well as tasks and scenarios.

**Self-Reports** This technique requires participants to document their subjective experiences of the current situation. A self-report can reflect on one's present state and compare it to the past state. As such, the self-reporting technique relies on the participant's ability to report experiences and to reflect accurately on their experiences. The measures may be instantaneous or retroactive. Instantaneous reports refer to the emotion as first experienced, whereas retrospective reports refer to a situation after-the-fact. Such assessments can be accomplished using a video as a reminder. For example, Rosenberg and Ekman (1994) asked participants to stop a video when they wanted to describe their emotions. In addition to a verbal report, they also responded to a questionnaire.

Because self-report procedures ask people to remember and summarize their experiences over longer or shorter intervals of time, a major limitation of self-report is that it relies exclusively on the person's cognitive labels of his or her emotions. But emotion, as argued above, is a multichannel phenomenon and is not limited to the cognition of emotion. In addition, there are physiological, facial, nonverbal, behavioral, and experiential elements (Diener, 1994). Self-reports of emotional well-being, such as happiness, tend to reveal greater consistency than do many other types of emotion (Brown and Schwartz, 1980). There is also agreement between self-reports of emotional well-being and interview ratings, peer reports, and memory for pleasant events (Sandvik et al., 1993).

**Experience Sampling Method (ESM)** Coined by Larson and Csikszentmihalyi (1983), ESM measures people's self-reported experiences close in time to the occurrence of the scenario that evoked the emotion. Typically, ESM uses a combination of online and short-term retrospective question formats in which people report what is presently or recently occurring (e.g., "How do you feel *right now*? How did you feel *this past hour*?"). As such, these procedures measure



**Figure 11** Comparisons between other self-reports and ESM reports. (From Feldman-Barrett, 1998.)

subjective experience that is episodic in nature. A comparison of retrospective emotion reports with ESM reports for men and women is shown in Figure 11. In retrospective reports of emotional intensity, women give higher ratings than a concurrent ESM rating, while men give a lower rating.

Advantages of ESM over other self-report methods are:

- **Immediacy:** reduces retrospective memory bias of mood (Singer and Salovey, 1988) and reduces beliefs and theories about experiences (Ross, 1989).
- **Multiple assessments over time:** makes it possible to study ongoing processes in a person. Thereby, one can (1) understand the patterns and relations among variables for a given person, and (2) understand how a person reacts to the situation.
- **Natural reporting context:** improves the validity of the reports and makes it possible to model experiences that would not show up in a controlled laboratory setting.

The ESM method has been applied to studies on flow (Csikszentmihalyi, 1990), mood variability (Eid and Diener, 1999), and hedonic balance (Schimmack, 2003). In particular, Schimmack (2003) found that pleasant affects and unpleasant affects had high discriminant validity. Extraversion is highly related to aspects of pleasant affects, and neuroticism to unpleasant affects.

**Affect Grid** Developed by Russell et al. (1989) the technique measures single-item affect in the form of a grid. On the basis of subjective feelings, a subject places an X along two dimensions: pleasantness and arousal. Both aspects will be rated; if both are rated highly, the subject feels great excitement. Similarly, there are feelings of depression, stress, and relaxation. The affect grid displays strong evidence of discriminant validity between the dimensions of pleasure and arousal. Studies that used the affect grid to assess mood provided further evidence of construct validity. However, the scale is not an all-purpose

scale and is slightly less reliable than a multiple-item questionnaire for self-reported mood.

Similarly, Warr (1999) used the same scale to measure well-being along a two-dimensional framework of well-being, as shown in Figure 12. A person's well-being may be described in terms of the location in this two-dimensional space of arousal and pleasure. A particular degree of pleasure or displeasure may be accompanied by high levels of mental arousal or a low level of arousal (sleepiness), and a particular level of mental arousal may be either pleasurable (pleasant) or unpleasurable (unpleasant) (Warr, 1999).

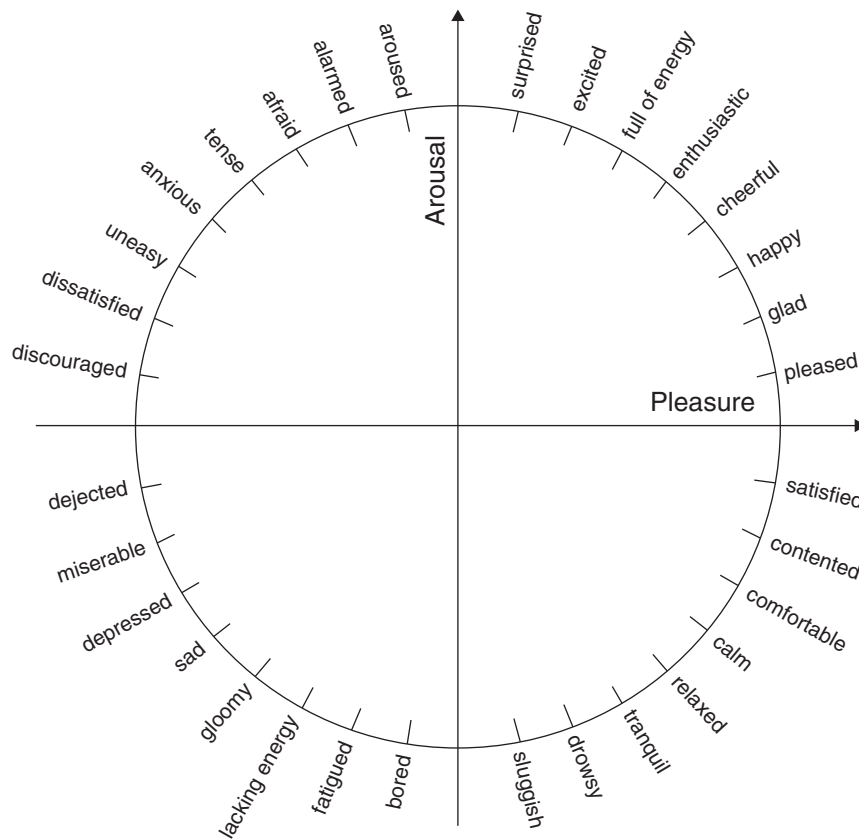
**Checklists** Mood checklists comprise lists of adjectives that describe emotional states. Subjects are required to check their emotions. The mood adjective check list (MACL) developed by Nowlis and Green (1957) contains 130 adjectives with a 4-point scale: "definitely like it," "slightly," "cannot decide," and "definitely not."

Zuckerman and Lubin (1965) developed the multiple-affect adjective checklist (MAACL) comprising 132 items, which they revised in 1985 (MAACL-R). The revised version allowed scoring of several

pleasant emotions, taking into account global positive and negative affect as well as sensation seeking.

Thayer (1967) then developed the activation-deactivation adjective checklist (A-DACL), which contained adjectives relating to valenced arousal states (i.e., energetic, lively, active, sleepy, tired-tense, clutched-up, fearful jittery, calm, quiet, and at rest). They used a 4-point scale from "definitely do not feel" to "definitely feel." Izard (1977) developed the multi-item differential emotional scale (DES) with the purpose of assessing multiple discrete emotions.

**Interviews** Interviews may be performed to assess product pleasure or pleasure from activities or tasks. It is a versatile method and can be performed face to face or through phone conversation. Subjects are asked questions that can be structured, unstructured, and semistructured (Jordan, 2000). A structured interview has a predetermined set of questions, whereas an unstructured interview uses a series of open-ended questions. A semistructured interview allows the investigator to improvise by making unplanned diversions into topics of interest. This method requires that the investigator master the topic



**Figure 12** Two-dimensional view of well-being. (From Warr, 1999.)

so that he or she can improvise and understands what to ask for.

Housen (1992) used a nondirective, stream-of-consciousness interview. Participants are asked simply to talk about anything they see as they look at a work of art, to say whatever comes into their minds. There are no directed questions or other prompts to influence the viewer's process. Called the *aesthetic development interview*, it provides a window into a person's thinking processes, and in addition to being empirical, minimizes researcher biases or assumptions. The interviews are often examined by two independent coders to ensure reliability and consistency, and the coding is then charted graphically by computer to enable a comprehensive representation of all thoughts, which also depicts the subject's pattern of thinking.

**Subjective Ratings of Emotions Induced by Artifacts** These rating scales have been used to document how artifacts make a person feel. By asking a question such as "What does the look of this car makes you feel?" the user is expected to evaluate his or her emotions in relation to the artifact. This approach clearly differs from the general rating methods as used by Helander and Tay (2003) and Khalid and Helander (2004).

**PANAS Scales** Watson et al. (1988) developed the positive affect negative affect schedule (PANAS). The purpose of PANAS is to measure positive and negative mood states of a person during different times or contexts: today, in a week, a year, and so on. PANAS uses mood adjectives on a 5-point scale: "not at all" or "slight," "a little," "moderately," "quite a bit," and "very much." *Positive affect* (PA) refers to feelings of enthusiasm, alertness, and activeness. A high PA score reflects a state of "high energy, full concentration and pleasurable engagement" (Watson et al., 1988). *Negative affect* (NA), on the other hand, refers to feelings of distress and unpleasurable engagement.

To describe PA, 10 descriptors were used: attentive, interested, alert, excited, enthusiastic, inspired, proud, determined, strong, and active. NA is measured on the following 10 descriptors: distressed, upset, hostile, irritable, scared, afraid, ashamed, guilty, nervous, and jittery. The 10-item scales are shown to be highly internally consistent, largely uncorrelated, and stable at appropriate levels over a period of two months. When used with short-term instructions (e.g., *right now* or *today*) they are sensitive to fluctuations in mood, but when longer-term instructions are used (e.g., *past year* or *general*) they exhibit traitlike stability.

**Philip's Questionnaire** Jordan (2000) developed a questionnaire for measuring pleasure from products. It has been used by Philips Corporate Design in evaluating their products. The questionnaire has 14 questions, focusing on user's feelings: stimulated, entertained, attached, sense of freedom, excited, satisfaction, rely, miss, confidence, proud, enjoy, relax, enthusiastic, and looking after the product. Using a 5-point scale, ranging from disagree (0) to neutral (2) and strongly agree (4), the close-ended items in

the questionnaire covered most of a user's possible responses. To measure pleasure, open-ended items were used as an option. This was particularly useful when the investigator does not know how a product affects the user's evaluation of pleasure.

### Product Emotion Measurement Instrument

Desmet (2003) developed the product emotion measurement instrument (PrEmo) to assess emotional responses to consumer products. PrEmo is a nonverbal, self-report instrument that measures 14 emotions that are elicited by product design. Participants report their emotions by selecting animations that correspond to their felt emotions. Each emotion is portrayed using an animated cartoon character, with a dynamic facial and bodily expression. It is presented on a computer interface, as illustrated in Figure 13. There are seven faces with positive expressions: inspiration, desire, satisfaction, pleasant surprise, fascination, amusement, admiration, and seven negative faces: disgust, indignant, contempt, disappointment, dissatisfaction, boredom, and unpleasant surprise. These animations were developed with the aim of making them unambiguous and recognizable across cultures. As such, PrEmo was validated in the Netherlands, Japan, Finland, and the United States.

From the results of PrEmo, a tool, called the *emotion navigator*, was developed to assist designers in grasping the emotional potency of their designs (Desmet and Hekkert, 2002). The [product & emotion] navigator is an anecdotal database of some 250 photos of products that elicit emotions. The tool is structured in accordance with a model of product emotion and visualized in an open-ended manner that aims to be inviting and alluring. The model distinguishes important variables in the eliciting conditions of product emotions that can be used to explain how products elicit emotions, and why particular products elicit particular emotions.

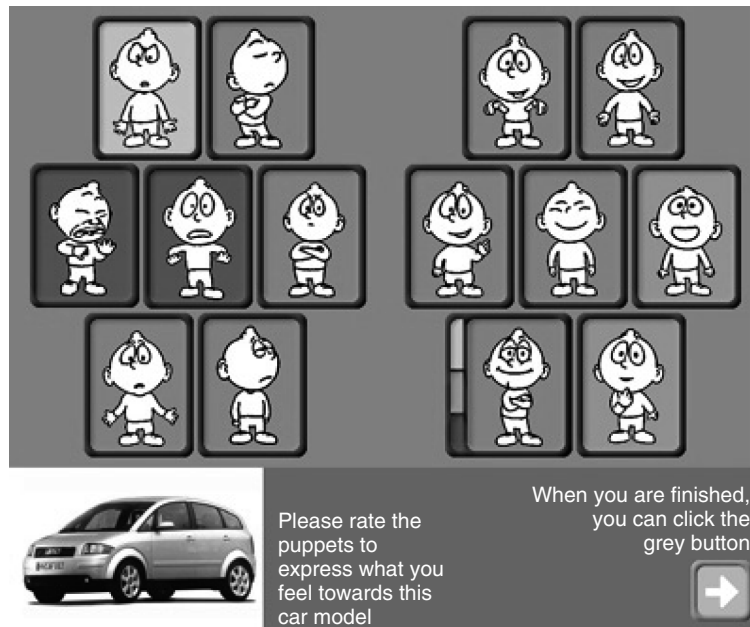
### 5.2.2 Objective Measures

Objective measurements can be obtained either directly or indirectly using measurement techniques. We present two popular methods to record emotions: analysis of facial expressions, and vocal content of speech or voice expressions.

**Facial Expressions** Numerous methods exist for measuring facial expressions (Ekman, 1982). Facial expressions provide information about (1) *affective state*, including emotions such as fear, anger, enjoyment, surprise, sadness, and disgust, and more enduring moods, such as euphoria, dysphoria, and irritableness; (2) *cognitive state*, such as perplexity, concentration, and boredom; and (3) *temperament and personality*, including such traits as hostility, sociability, and shyness.

Ekman and Friesen (1976) identified five types of messages conveyed by rapid facial signals:

1. *Emotions*: including happiness, sadness, anger, disgust, surprise, and fear



**Figure 13** Product emotion measurement tool. (From Desmet, 2003.)

2. *Emblems*: culture-specific symbolic communicators such as the wink
3. *Manipulators*: self-manipulative associated movements such as lip biting
4. *Illustrators*: actions accompanying and highlighting speech such as a raised brow
5. *Regulators*: nonverbal conversational mediators such as nods or smiles

Measurement of facial expressions may be accomplished by using the facial action coding system (FACS). The method, developed by Ekman and Friesen (1975, 1976), captures the facial changes that accompany an emotional response to an event. FACS was developed by determining how the contraction of each facial muscle (singly and in combination with other muscles) changes the appearance of the face. Videotapes of more than 5000 different combinations of muscular actions were examined to determine the specific changes in appearance and how best to differentiate one appearance from another.

Measurement with FACS is done in terms of action units (AUs) rather than muscular units, for two reasons. First, for a few changes in appearance, more than one muscle is used to produce a single AU. Second, FACS distinguishes between two AUs for the activity of the frontalis muscle that produces wrinkles on the forehead. This is because the inner and outer portion of this muscle can act independently, producing different changes in appearance. There are 46 AUs that account for changes in facial expression, and 12 AUs that describe gross changes in gaze direction and head

orientation. To use FACS, the investigator must learn about the appearance and the muscles of the face for each AU. This demands much time and effort.

The maximally discriminative affect coding system (MAX) developed by Izard (1979) measures visible appearance changes in the face. The MAX units are formulated in terms of facial expressions that are relevant to eight specific emotions rather than in terms of individual muscles. Unlike FACS, MAX does not measure all facial actions, but scores only facial movements that relate to the eight emotions.

Facial changes can also be registered using electromyography (EMG). EMG measures nerve impulses to muscles, which produce facial changes or expressions. This measure assumes that emotions are visible through facial expressions, which is the case when people interact with each other.

Davis et al. (1995) compared facial electromyography with standard self-report of affect. He obtained a good correlation between activity of facial muscles and self-report of affect. The pattern of muscular activation could be used to indicate categories of affect, such as happy and sad, and the amplitude of electromyographic signals gave information on degree of emotions. In other words, Davis et al. (1995) was able to categorize as well as quantify affective states using facial electromyography.

**Vocal Measures of Emotion** Most of the emotions conveyed in speech are from the verbal content. Additionally, the style of the voice, such as pitch, loudness, tone, and timing, can convey information about the speaker's emotional state. This is to be expected because vocalization is "a bodily process

sensitive to emotion-related changes” (Larsen and Fredrickson, 1999). A simple and perhaps also the best way to analyze the emotional content would be to listen to recordings of voice messages. Scherer (1986) noted that judges seem to be rather accurate in decoding emotional meaning from vocal cues. Some emotions are easier to recognize than others. Sadness and anger are easiest to recognize, whereas joy, disgust, and contempt are difficult to recognize and distinguish from one another.

Maffiolo and Chateau (2003) investigated the emotional quality of speech messages used by the France Telecom Orange. Each year, vocal servers were used to respond to hundreds of millions of phone calls. The audio messages can be help messages, navigation messages, and information messages. The purpose of the study was to create a set of voice messages that were perceived as friendly, sincere, and helpful.

In their experiment, listening tests were conducted using messages with 20 female speakers, who pronounced two sentences in five elocution styles. Twenty criteria were used to characterize the speech: welcoming, pleasant, aggressive, authoritative, ordinary, warm, clear, shrill, dynamic, exaggerated, expressive, happy, young, natural, professional, speedy, reassuring, sensual, smiling, and stressful. The speech was classified in terms of global impression as well as the hedonic impressions experienced by listeners.

For example, one of the 20 speakers was classified as cheerful, pleasant, clear, and lively, lots of changes that make the message friendly, something is missing, a bit too sharp (but not too much), sympathetic (in a good way, not exaggerated), simple, and convincing. In short, this person’s voice was viewed as “pleasant and lively, with expression.”

A higher-tech method is to digitize voice recordings and analyze the voice by decomposing the speech sound waves into a set of acoustic parameters and then analyzing the psychoacoustics and psychophonetics content (Larsen and Fredrickson, 1999). This includes analysis of pitch, small deviations in pitch, speaking rate, use of pauses, and intensity. *Emotive Alert*, a voicemail system designed by Inanoglu and Caneel of the Media Lab at the Massachusetts Institute of Technology (Biever, 2005), labels messages according to the caller’s tone of voice. It can be installed in a telephone exchange or in an intelligent answering machine. It will analyze incoming messages and send the recipient a text message along with an emoticon indicating whether the message is urgent, happy, excited, or formal. In tests on real-life messages, the software was able to tell the difference between excited and calm and between happy and sad, but found it harder to distinguish between formal and informal, and urgent and nonurgent. This is because excitement and happiness are often conveyed through speech rate and volume, which are easy to measure, whereas formality and urgency are normally expressed through the choice of words and are not easy to measure (Biever, 2005). At the present time the first method, listening to speech, is probably the more reliable.

Regardless of the method used, vocal measures of emotion are sometimes difficult to use since (1) voice is not a continuous variable (people do not speak continuously, thus, vocal indicators of emotion are not always present), (2) positive and negative emotions are sometimes difficult to distinguish and (3) the voice can reflect both emotional/physiological and sociocultural habits, which are difficult to distinguish (Scherer, 1998).

### 5.2.3 Psychophysiological Measures

Emotions often affect the activity of the autonomic nervous system (ANS) and thereby the activation level and arousal. At the same time, there are increases and decreases in bodily functions, such as in heart functions, electrodermal activity, and respiratory activity (Picard, 1997). Thus, there is a variety of physiological responses that can be measured, including blood pressure, skin conductivity, pupil size, brain waves, and heart rate frequency and variability. For example, in situations of surprise and startle, the electrical conductivity of certain sweat glands is increased momentarily. This is referred to as a galvanic skin response (GSR). These sweat glands are primarily found on the inside of the hands and on the soles of the feet. Electrodes are then attached to measure the electrical conductivity (Helander, 1978). The nerve signals take about 1.5 seconds to travel from the brain to the hand; therefore, the response is a bit delayed.

Researchers in the field of affective computing are actively developing “ANS instruments,” such as IBM’s emotion mouse (Ark et al., 1999) and a variety of wearable sensors (e.g., Picard, 2000). With these instruments, computers can gather a multitude of psychophysiological information while a person is experiencing an emotion, and learn which pattern is most indicative of which emotion.

ANS responses can be investigated in experiments, for example, by using film clips to induce the type of emotions investigated (e.g., amusement, anger, contentment, disgust, fear, sadness) while electrodermal activity, blood pressure, and electrocardiogram (ECG) are recorded. Therefore, it is possible to associate a variety of emotions with specific physiological reactions.

Although autonomic measures are fruitful, it is important to note the following consideration.

1. Autonomic measures vary widely in how invasive they are. The less invasive measures include pulse rate and skin conductance, whereas measures of blood pressure are often invasive since they use pressure cuffs which are deflated. This may distract a person, so that the emotion is lost.

2. The temporal resolution of various autonomic measures varies widely. Some measures are instantaneous, such as GSR, whereas impedance cardiography, for example, requires longer duration for reliable measurement (Larsen and Fredrickson, 1999).

3. Different measures have different sensitivity. Depending on the emotion that is recorded, it is best



first to validate the particular physiological measures so as to understand if it is sensitive enough to record differences in the intensity of the emotion.

### 5.2.4 Performance Measures

Performance measures typically indicate the effect of emotions on decision making. Emotion-sensitive performance measures may be obtained through judgment tasks. One popular task is to have participants make probability estimates of the likelihood of various good and bad events. It has been shown that persons in unpleasant emotional states tend to overestimate the probability of bad events (Johnson and Tversky, 1983). Ketelaar (1989) showed that people in a good mood also overestimated the probability of pleasant events. Another useful performance task is to ask participants to generate associations to positive, neutral, and negative stimuli. Mayer and Bremer (1985) showed that a change in a person's mood correlated with changes in performance in affect-sensitive tasks involving cognitive and psychomotor skills.

A second category of performance measures involves information-processing parameters. Reaction times in lexical decision tasks have been shown to be sensitive to affective states (Challis and Krane, 1988). The task involves judging if a string of letters presented on the computer screen represents a word or nonword. Participants in positive affective states are quicker and sometimes more accurate at judging positive words as words compared to participants in neutral states, and vice versa for unpleasant moods (Niedenthal and Setzlund, 1994).

### 5.3 Conclusions

The use of subjective methods such as self-report, single-item, and multiple-item measures has their drawbacks. Such methods rely heavily on the use of words and adjectives. The subject's vocabulary should be taken into account, because some people may have little comprehension of some of the words used in the methods mentioned above. The subject should be allowed to use his or her principal language, or else some feelings might be misinterpreted. The words or adjectives must be concise and easy to understand and take into account cultural as well as contextual factors (Larsen and Fredrickson, 1999).

A major advantage of physiological methods (or nonverbal instruments) is that they are language independent and can be used in different cultures. A second advantage is that they are unobtrusive and do not disturb participants during the measurement (Desmet, 2003). There are however limitations to the physiological measures. They can assess reliably only a limited set of "basic" emotions and cannot assess mixed emotions. For pleasures of the mind, it is doubtful if any of the psychophysiological methods will be sensitive enough to capture the subtleness of emotions.

Objective methods such as vocal content and facial expressions can be used to measure mixed emotions, but they are difficult to apply between cultures. It would be important to make cultural comparisons between vocal and facial expressions. For this purpose

a multimedia database can be developed and shared by the research community. The database could contain images of faces (still and motion), vocalizations and speech, psychophysiological correlates of specific facial actions, and interpretations of facial scores in terms of emotional state, cognitive process, and other internal processes. This would facilitate an integration of research efforts by highlighting contradictions and consistencies, and suggest fruitful avenues for new research.

## 6 DISCUSSION

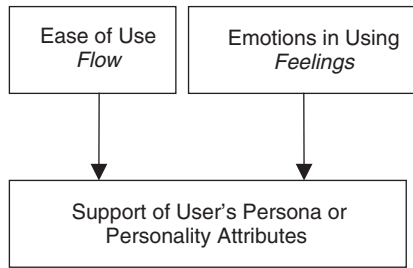
Emotions are often elicited by products, such as art, clothing, and consumer goods; therefore, designers must consider affect and emotion in design. Today, many corporations challenge designers to manipulate the emotional impact of designs. Nokia design is an example. Emotional responses induce customers to pick a particular model among many; emotions thus influence purchase decisions. In practice, user emotions toward products are well established and sometimes difficult to manipulate.

Emotion may be the strongest differentiator in user experience. It triggers both conscious and unconscious responses to a product or an interface. There are many important reasons to consider emotion in product design, such as to increase sales and keep customers happy. This is done by maximizing positive emotions while minimizing negative emotions. Understanding and reducing users' anxiety and fears (negative emotions) can help to increase satisfaction with products. Poor usability will also induce negative responses such as frustration, annoyance, anger, and confusion.

On the other hand, even moderate fluctuations in positive emotions can systematically improve cognitive processing. A happy person has an open mind, whereas a negative person is restrained in processing of information. When products result in positive user experiences, the emotional effects are often more important to the customer than gains in productivity, efficiency, and effectiveness. Negative emotions such as frustration, anxiety, and so on, should definitely be avoided in conceptualizing product design.

However, emotion is not an exclusive factor in defining a successful user experience. Every single product feature affects the "experience," which can be complex and multifaceted. Furthermore, emotions are culturally specific and variable. Because there is no such thing as a neutral interface, any design will elicit emotions from the user and the designer (Gaver, 1996). The designer should aim to "control" the user experience through a deliberate design effort, thus bridging the gap between the affective user and the designer's environment, as outlined in our framework. However, measuring affective responses to designed objects can be problematic. So is designing affect into a product. Desmet's (2003) *PrEmo* tool is a good start at supporting designers.

Separating emotion from cognitive functions does not seem helpful from a research perspective or from a design perspective. Instead, an integrated view of emotion and cognition is taking hold, not



**Figure 14** Ease of use and emotions in using support the user's persona.

only in neuroscience but also in product design. A product should be designed to support customer needs, including the customer's persona or personality attributes. This can be done by providing flow—or ease of use—and inducing feelings—or emotions—in interacting with the product (Figure 14).

We can illustrate the model in Figure 14 by using a computer game as an example. An application software that is designed with a good flow will be easy to use and has novel and adaptive controls enabling quick moves and perceived situational control, thus inducing positive emotions of fun, enjoyment, and satisfaction. The pleasures derived from the optimal experience of seamless interaction and usable functions are considered *hedonic benefits* that can enhance the “skillful” and “confident” persona of the user. They also enhance the sense of virtuosity in interaction, a common need among users.

On the other hand, a poorly designed application with complex user interface and controls impedes natural interaction, leading to negative emotions such as quitting the game, becoming moody, swearing at the machine, or even kicking it (Luczak et al., 2003). Such displeasures constitute *hedonic penalties* and will lead to sentiments of anger and frustration. In other words, hedonic affordances invite an emotional reaction from the user through the product's physical attributes that result in the user's appraisal or frustration. Pleasurable interaction may be derived by integrating adaptability into designs and providing design features that enhance user control.

In sum, customers tend to make decisions based on their feelings, perceptions, values, and reflections that usually come from gut feelings rather than logical or rational thinking. As such, designers and manufacturers should consider emotional design a bottom line in product design.

Measuring affective responses to designed objects can be problematic. Further research is needed to develop expressions of emotions that are quantifiable so that they can easily be verified. Various issues warrant further investigation, and we raise a few below.

1. *Lack of facial and physiological signals.* Pleasures of the mind are not accompanied by any distinctive facial expression (Kubovy, 1999). For example, a person viewing the *Mona Lisa* may feel elated, but

nothing is revealed on his or her face, and there is no distinctive physiological response pattern. This is very different from social interaction, such as a conversation with a colleague at work, where half of the message is in the person's face. Since one may not be able to use either physiological measures or facial expressions, one is left with subjective measures. There is nothing wrong with subjective methods; the data come directly from the user. In many instances, verbal or written reports provide the most valuable information. Asking people in interviews and questionnaires can generate very informative data. The forever-pressing problem is what questions we should ask that can differentiate between products.

2. *Design for context of use and activity.* In affective design, our primary goal may be to design a product. However, products are used in a context—an envelope of product semantics surrounds the product itself. Products communicate with users and can never be contextually neutral. This makes a designer's task an even greater challenge. To increase human enjoyment or engagement, perhaps the entire setting (activity, context of use) needs to be designed, not just the artifact (Aboulafia and Bannon, 2004). Is it realistic to ask designers to live up to this challenging perspective?

3. *Tapping positive emotions.* The expectations of users in terms of customer needs are changing: Functionality, attractiveness, ease of use, affordability, and safety are taken for granted. The new trends are for objects or artifacts that inspire users, enhance their lives, and evoke emotions and dreams in their minds (Demirbilek and Sener, 2003). This requires research into the thoughts and dreams that are related to positive emotions and pleasurable experiences. The “method” as described by Jordan (Blythe, 2004) may provide an introspective approach. The product concept prospecting approach, based on realistic scenarios, may be another (Cayol and Bonhoure, 2004).

4. *Designing affect into a product.* The notion that human feel or touch can be designed into a product has led to Kreifeldt's (2001) “physics” of emotion. He claimed that it is necessary to build sensors that can transduce the weight and moment of inertia for the person to feel an object, thereby making it pleasurable. But researchers (e.g., Loewenstein and Schkade, 1999) are quick to lament that the mechanics of hedonics (what makes people happy) are not fully understood. For example, the effects of satiation and ownership of objects in relation to pleasure have been reasonably well researched. Yet there are conflicting results. Some studies found that subjects' feelings did change substantially over time, but they had little idea, at the outset, about how they would change.

In conclusion, then, this chapter is just a beginning of a very promising and challenging research area. It opens a minefield of conceptual and methodological issues for research and development. Much needs to be done to develop predictive models of affect and pleasure for design of products and interfaces. The current methodology is still immature. In the future,

when we understand the mechanics of hedonomics, there will be significant rewards in terms of monetary benefits for developers of pleasurable products, as well as many happy customers and users.

The desire for informed knowledge drew human factors professionals, industrial designers, engineers, and behavioral and social scientists to the 2001 International Conference on Affective Human Factors Design in Singapore (Helander et al., 2001). An outcome of a meeting of minds is a change of hearts—a welcome paradigm shift in human factors and ergonomics: from pain and performance to pleasure.

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