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COMFORT AND PLEASANTNESS

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ABSTRACT

At first, comfort and pleasantness on thermal environment were introduced. Then some examples, open air spa, and so on were explained and this concept was extended to some sorts of environment, roller coaster, gentleness, visual environment and so forth. It was pointed out that sudden change is an important key. Variation of not only space but also time should be considered. Moreover, it was explained that strong pleasantness was very dangerous. Finally, It was claimed that moderate pleasantness should have been planned after elimination of strong discomfort in architectural design.

1. INTRODUCTION

There are pleasant states different from usual comfort in thermal and visual environments. At a comfortably thermally neutral condition the human is less aware of the thermal environment, experiences no discomfort, and does not wish the environment to be warmer or cooler. However, there are situations when we can feel pleasantly cool or warm. McIntyre [1] labels the former as negative thermal pleasure, and the latter as positive thermal pleasure. Hewitt [2] has similarly described experiences of visual pleasantness. He states that an ambient condition without luminance differences is flat, uninteresting, and monotonous. Hewitt recommends variation in luminance with time and space for visual pleasantness.

Kuno [3] developed a Two-dimensional Model on thermal sensation that graphically clarified the differences between thermally induced comfort and pleasantness. This model is described and applied in the following sections. Examples of thermal pleasantness are explained with the model and the concept of it are extended to explain and understand the responses to non thermal environments and situations.

Main parts of this paper have been published as a part of two Japanese books [4][5]. I rewrote this paper, adding some new interpretations.

2. TWO-DIMENSIONAL MODEL ON THERMAL SENSATION

The term, thermal sensation may not be sufficient and completely appropriate for comfort. The meaning used here is not the pure response of thermal receptors but the synthesized human feeling to the thermal environment. The ASHRAE thermal sensation scale is in terms of 'hot,' 'warm,' 'slightly warm,' 'neutral,' 'slightly cool,' 'cool,' and 'cold'. When we enter into an air-conditioned room from outside in hot or cold season, we immediately feel cool in hot season and warm in cold season. If the room temperatures are the same in the two seasons, one would expect

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our feelings to be the same or 'neutral.' But our actual evaluations reverse on the scale. Our physiological state changes along with the ambient thermal condition. A hot condition makes man's skin temperature increase and causes sweating. Gagge [6] conducted an experiment in which subjects moved between neutral and uncomfortable rooms. Subjects' evaluation became comfortable without sufficient recovery of physiological condition. He called this phenomenon 'anticipation.'

Figure 1 is a basic figure of the Two-dimensional Model. Axis A indicates ambient state. Although the thermal environment is defined by 4 factors, air temperature, humidity, air movement, and radiation, consider here for simplification that plus side is high air temperature, and minus side low. Axis P indicates the physiological state. The body is heated on the plus side, and chilled on the minus side. The central box shows the neutral zone. Human physiological function for thermal regulation is not active here, though it is a hypothesis. Generally automatic control systems make large oscillation without appropriate differential, proportional band, or neutral zone. This assumption is different from the Two Node Model [7] and the Comfort Equation [8]. The outer box is the boundary between the life zone and the fatal zone. No one can stay for a long time in the fatal zone. The dashed line indicates steady state. The plane in Figure 1 is called the A-P plane. In this figure, a person has constant normal clothing and activity levels.

Figure 2 shows 3 types of movement of the point S, that indicates ambient and physiological states simultaneously. Locus(a) is the case when ambient state changes very slowly. Physiological state follows without delay. So, S moves on the dashed line. Locus(b) is the case when ambient state changes quickly. Because physiological state delays to ambient change, S curves to outside. Locus(c) is for a discontinuous change, for example, as occurs in movement between different spaces.

A linguistic plane is supposed corresponding to the A-P plane. It is called the L plane. Figures 3(a) and 3(b) indicate expected standard L planes of Japanese and English languages, respectively. Dialects can be treated by changing the L plane. For instance, S of (b) or (c) in the upper side of the dashed line of Figure 2 moves on 'kan,' 'dan,' and then 'sho' in Japanese L plane or on 'cold,' 'comfortably warm,' and 'hot' in English. S never passes through 'ryou' in Japanese or 'comfortably cool' in English. The above-mentioned reverse phenomenon on one-dimensional scale was explained without contradiction by this system. Chinese and Korean students in Japan said their languages were the same as Japanese. In Figure 3(a), the 4 terms evenly divide the plane into 4 parts. On the other hand, English terms, 'warm' and 'cool' may not alone discriminate comfortable and uncomfortable states well. Eastern Asian languages however have a more two-dimensional aspect to thermal sensation than English.

In this model, it is supposed that there is an evaluation plane, E plane between the A-P plane and the L plane like Figure 4. The space or plane between the A-P and L planes is psychological. The E plane is restricted by the A-P and L planes. The binding power of the A-P and L planes against the E plane is the strongest at the neutral zone, next strong on the dashed line, and weak on other areas indicating unsteady state. This flexible structure enables psychological aftereffects, hue-heat effects, inner individual difference, and so on more understandable.

Figure 5 shows the structure of thermal comfort. The lower figure is a 3-dimensional expression by axonometric projection of which the third dimension is bipolar comfort scale. Hatched areas are called the pleasant zone in this model. The central box is the neutral zone. Comfortable zone consists of the pleasant zone and the neutral zone. Other areas are the uncomfortable zone. The further S is from the neutral zone, the stronger discomfort and pleasantness are. We must experience the uncomfortable zone in order to enter into the pleasant zone. We cannot move from the neutral zone to the pleasant zone. In short, the stronger discomfort was, the stronger pleasantness will be. Because the pleasant zone is an unsteady state,

we cannot stay there for a long time. In other words, pleasantness disappears by and by. The upper figure indicates the influence of sudden shock by drastic change of ambient conditions. Strong pleasantness and discomfort by sudden shock may coexist with pain on upper left and lower right corner areas. Usually, pain will be superior to pleasantness. Masochism might be thought of as a reverse case. Gagge's 'anticipation' is a seeming description. The psychological state is not anticipatory to physiological state, but the situation is pleasant when the uncomfortable condition disappears and physiological state recovers to neutral one.

The aspects of thermal pleasantness described are summarized as; 1)Pleasantness occurs when discomfort disappears, 2)It does not continue for a long time, and 3)It may accompany sudden shock.

I wish to supplement the property of the 3 planes. As Axis A is physical index, it is completely rigid. Because P indicates physiological state, time delays can occur due to changes. This can be explained with the concepts of elasticity and viscosity on P direction. Axis P is also changed by illness, drug, aging, rehabilitation, training, seasonal acclimatization and so on. This is explained by the concept of plasticity. Moreover, no stimulus for a long time causes deterioration of physiological function even for healthy people. In other words, the outer box changes. Repetition of plastic transformation eventually causes fatigue destruction of Axis P finally. This means death. The L plane is a sort of society. Unless it is held in common, communication cannot be done well. So, the L plane must be rather rigid. As well-known, American English is slightly different from British. Although American people often use the term, 'hot,' British people use 'very warm' in the same situation. Therefore, the L plane is not completely rigid and can have also plastic transformation during a very long time.

3. SOME EXAMPLES AND EXTENSION

3.1 Open air spa

Japan has many hot spas. Pleasantness in an open air spa is striking in the season of which climate is cool or slightly cool. If it is not so cool, the resulting pleasantness may be diminished.

The situation is shown in Figure 6. Usually it begins under cool atmosphere and unclothed conditions. S is at lower left area of the model and our feelings are cool or cold. Then we enter into the spa. Only our heads are over the water surface. S jumps to upper left area and we feel warm and pleasant. Time passing, we will sweat and feel hot. S moves to the upper right area. To reduce the thermal stress one must bring their shoulders or chest out of water. The heat balance changes, and we will feel cool and pleasant. S moves to lower right area, and then will go to left horizontally. We return to the starting point and can repeat the cycle. One can enjoy bathing for a long time and experience pleasantness many times. If it is a hot season, the body is not cooled and the experience is not very pleasant. A closed and enough insulated bathroom is also the same. When the body becomes too hot, there is no way for relief except stopping bathing.

There are some cases where an artificial roof is built over a natural open air spa and/or a bathhouse is annexed as shown in Figure 7. Moreover, many Japanese open air spas are made artificially. Here is a contrivance not to let visitors feel cold, when they take off their clothes. In a rainy or snowy day, they can ever enjoy it under the roof, seeing nice view and sometimes drinking. Japanese people know enjoying open air spas and inconvenience of quite natural ones. Pleasantness has been already designed here.

Finnish sauna has a similar nature. Cold shower after sauna brings pleasantness. Walking on the snow with bare feet and jumping into a lake are often seen.

3.2 Café in town and high-class tea lounge

Excessive air-conditioning is often used at cafés in town during hot or cold seasons. Visitors feel strong pleasantness at the beginning, and then they will feel discomfort of opposite side after a half or one hour as shown in Figure 8(a) which causes them to go out. So, rotation of visitors

is very fast, and the owner earns more money. Waiters and waitresses wear a long sleeve in hot season, and a short sleeve in cold season.

On the other hand, neutral condition is provided at tea lounges of high-class hotels. Although there is no strong pleasantness, visitors can relax and stay there for a long time as shown in Figure 8(b). Because the charge is expensive, fast rotation is not necessarily required. Visitors enjoy a high-class atmosphere, and the hotel gets good reputation.

3.3 Intermittent wind

Figure 9 shows the case when we face an oscillating fan. Generally wind feels cool in hot season, though it becomes warmer with high temperature and humidity. At present, this unsteady state cannot be theoretically calculated. Perspiration and evaporation responses in those situations are not yet known well. However, there is the possibility for this pleasantness to persist in the uncomfortable zone due to the oscillating thermal condition.

3.4 Roller coaster

Getting on a roller coaster, we receive intense acceleration change. We are carried in every direction at a terrific speed. Blood flow changes and organs intend to move. It is repetition of strain and relaxation. If acceleration is adopted instead of temperature in Axis A, it is nearly the same as the example of open air spa.

However, everyone cannot enjoy roller coaster. It is very dangerous for aged or sick people or infants. On the other hand, highly trained people like astronauts, fighter pilots, and F-1 racers may not feel much pleasantness. Because each outer box is different as shown in Figure 10. Roller coaster is being designed for usual healthy people. Open air spa is also dangerous for those who have heart trouble and so on. There is extreme pleasantness near the outer box. So, pleasantness itself has a very dangerous aspect, because to require strong pleasantness has a possibility to exceed the outer box unconsciously. It must be designed with the greatest circumspection.

Recent roller coasters have various types, and new types are developed one after another. This means that people want new pleasantness and indicates that they cannot forget pleasantness they have already known.

3.5 Warm heart

The terms of hot, warm, and so on are often used to express personality. Replace the meaning of Axis A to the influence that a partner gives us. The plus side is the case when that person gives us heat, and the minus side when he or she takes it. Axis P is our mental state. Let us imagine the situation when someone encourages us, when we are dispirited. We will judge the person as being warm. If the person criticizes or is indifferent toward us, he must be regarded as being cold and an offensive fellow. Further, when one remains calm during excitement, one is said to be cool. Figure 3(a) can be used for expressions of personality.

3.6 Gentleness

The following is a very famous scene in 'Playback' by Raymond Chandler [9].

'How can such a hard man be so gentle?' she asked wonderingly.

'If I wasn't hard, I wouldn't be alive. If I couldn't ever be gentle, I wouldn't deserve to be alive.'

A private detective, Philip Marlowe answered the question of a woman who was a very important person in this story. Why did she ask wonderingly?

Here gentleness has two aspects. Gentleness is something to give to the other. One is to protect other person's comfort or central box as shown in Figure 11(a). All outer forces are eliminated, and he or she is kept comfortable. But too much comfort or absence of challenge may inhibit personal growth, and moreover, he may ever lose resistivity to the outer forces gradually. Another may be to watch the person's growth as shown in Figure 11(b) Only fatal outer forces are obstructed. Otherwise, he may be dead. This level of gentleness guards the outer box, but

does not prevent discomfort. When the person is aware of his own growth and success to challenges, he will experience pleasure simultaneously. Everyone should have the outer box sufficient to live alone. Mother's affections for her infant and care of a seriously sick person are examples of the former. Their outer box is small, only slightly larger than the central box. They therefore need more protection. Rehabilitation and training are examples of building strength and hardness. Minutely planned program should be done, otherwise dangerous.

This gentleness may require power in order to be able to protect the other person. If strength is insufficient when a big wave comes, the partner will feel shaky. The will to use strong power rightly is important. It must be Marlowe's belief. The woman began to notice gentleness, but did not yet understand it sufficiently. So, she asked wonderingly. An explanation to her is in vain at this stage, so Marlowe must have thought.

3.7 Can passive systems win active systems?

Active systems in architecture control indoor environments by using machine power. On the contrary, passive system adopts not machines but architectural devices such as the simple use of water evaporation or solar energy, and so on. The latter inevitably contributes to energy conservation. The object of the active system is to provide and maintain the neutral state. Our recent technology makes it possible. It corresponds to the former type of gentleness, that is Figure 11(a). On the other hand, passive system cannot eliminate discomfort completely. The situation is shown in Figure 12(a). If the degree of discomfort is used for evaluation of environment, the passive system can never be superior to the active system. Pleasantness must be evaluated to compare passive system with active system. Neutral environments have no pleasantness. Passive systems produce a little discomfort and therefore can bring pleasantness. It does not mean the simple extension of the comfort zone. Methods to make people feel pleasantness must be considered, otherwise the discomfort becomes conspicuous due to the absence of fluctuation as Figure 12(b). Wind in summer and warm radiation in winter and so on can be used.

Is this environment acceptable for those who have already known that neutral one can be made? Even if energy conservation and the issue of global environment are added to it, my answer is negative. Another concept is needed and it is health. It is better for healthy people to experience a little discomfort. Needless to say, sick, aged, or handicapped people must be defended. In this way passive systems may be beneficial and preferred to active systems. Because even language changes, the public opinion must change.

3.8 Visual and sound environment

Visual and sound environments have much more information than thermal ones. Moreover, eye adaptation changes in the visual environment. The Two-dimensional Model is not simply applied. However, sudden change is one of factors to create pleasantness. Direct sunlight into a room in the morning causes not only glare but also pleasantness. The scene at a seashore in the evening has silhouettes of palm trees, yachts, and lovers and the sun glitter of sea's surface. We cannot see all of them simultaneously thus the contrast brings pleasantness. Hewitt suggested the existence of 'acceptable' glare. When we see a night view from inside suddenly, it is pleasantness [10]. At first, we can see only lights. But with passing time, we become to be able to see other objects, and the pleasantness decreases. Similarly, when the orchestra suddenly makes full sound, it brings not discomfort but pleasantness.

3.9 Urban environment

Enormous cities have various problems and discomfort due to concentration of population. But the concentration and largeness lead to greater diversity and the opportunity for pleasantness. Because there is much discomfort, much pleasantness is created to negate it. They cannot be alive without pleasantness. In contrast, small cities have less discomfort, but also less pleasantness. Pleasantness is not necessary there, because they can be alive without it.

Hayashi [11], a famous statistician, explained the nature of urban residents by using two Japanese proverbs. One was that they adapted themselves to their living place. Another was that they wanted things unable to get. The former is similar to eye's function. They look as if they have not so much dissatisfaction. However, strain remains in this case and the latter indicates that they require pleasantness. Kuno analyzed the chain structure of dissatisfaction of urban residents by using Guttman scale [12]. It was clarified that dissatisfaction of indoor space aroused ones of outdoor environments. Taking it the other way round, the urban inhabitants seem to intend to hope good outdoor environments, because they cannot improve their own houses in Japanese situations. Resignation and desire are mixed in the mind of the urban residents. This result seems to be interpreted as they seek pleasantness.

4. CONCLUSIONS

Some interpretations of comfort and pleasantness have been given, extending the spectrum of thermal comfort. They do not explain all aspects of comfort and pleasantness, but give suggestions. One point important to the design of pleasantness is sudden change and its aftereffect. Variation of not only space but also time is a key, and moreover, the balance between pleasantness and discomfort is very important. Another point is that the stimulus associated with strong pleasantness may be dangerous and should be considered appropriately. Therefore, elimination of strong discomfort should be firstly considered, and then moderate pleasantness should be designed. These also keep us functioning and healthy.

Some contents of this paper may have been discussed. The Two-dimensional Model is an original work, and one series of fine figures is superior to thousands sentences. Hopefully this paper gave its readers pleasure.

ACKNOWLEDGMENT

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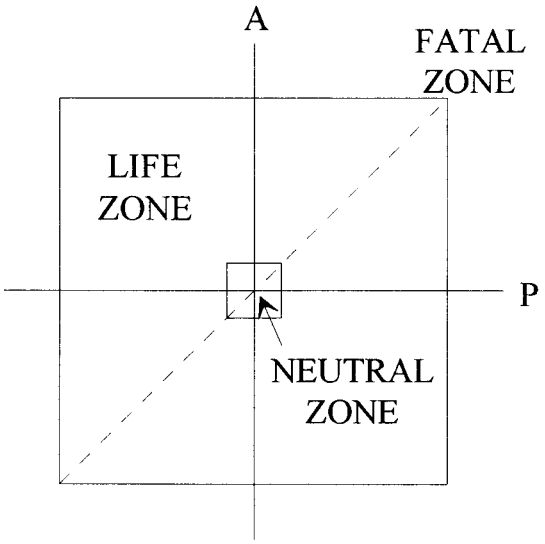
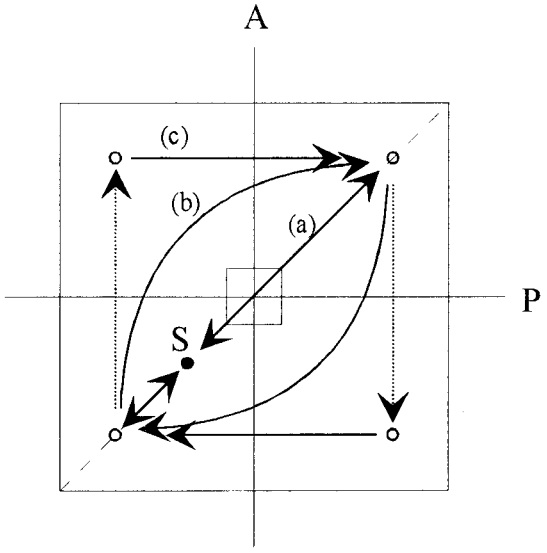


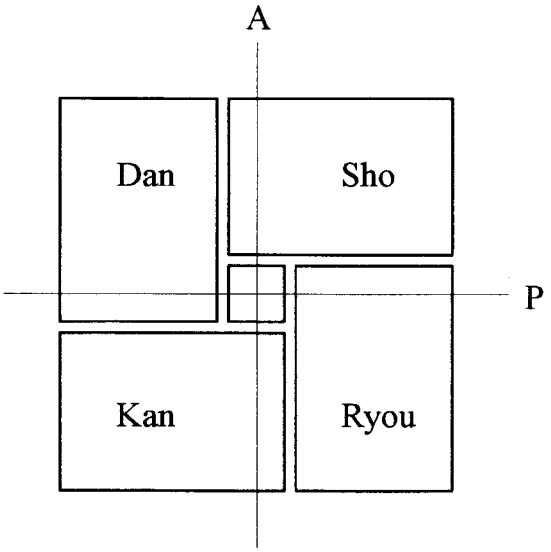
A: Ambient condition
P: Phyisiological condition
The dashed line indicates steady state.

Figure 1. Basic figure

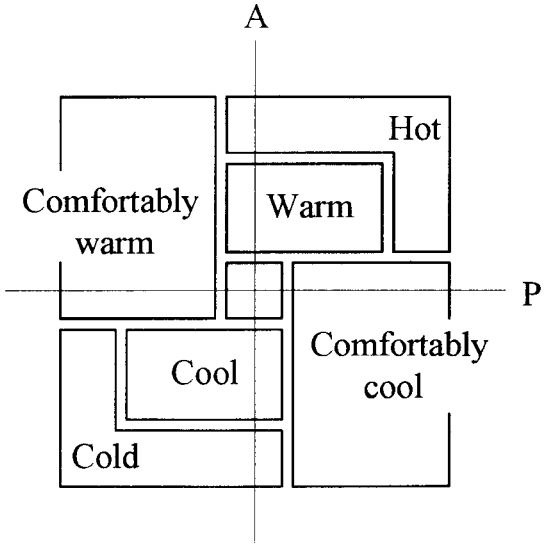


The point S represents certain ambient and physiological conditions.
(a): Very slow change
(b): Quick change
(c): Discontinuous change

Figure 2. Loci of the Point S



(a) Japanese



(b) American English

Figure 3. Standard L planes

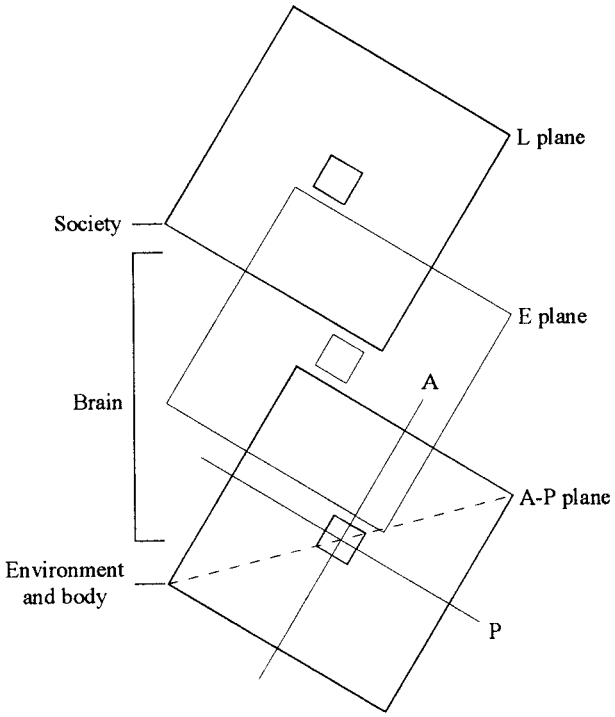


Figure 4. Psychological architecture

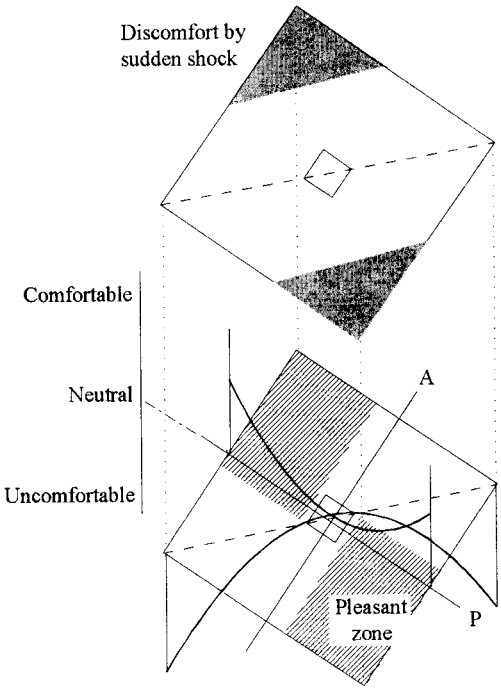


Figure 5. Thermal comfort: The neutral and pleasant zones and sudden shock

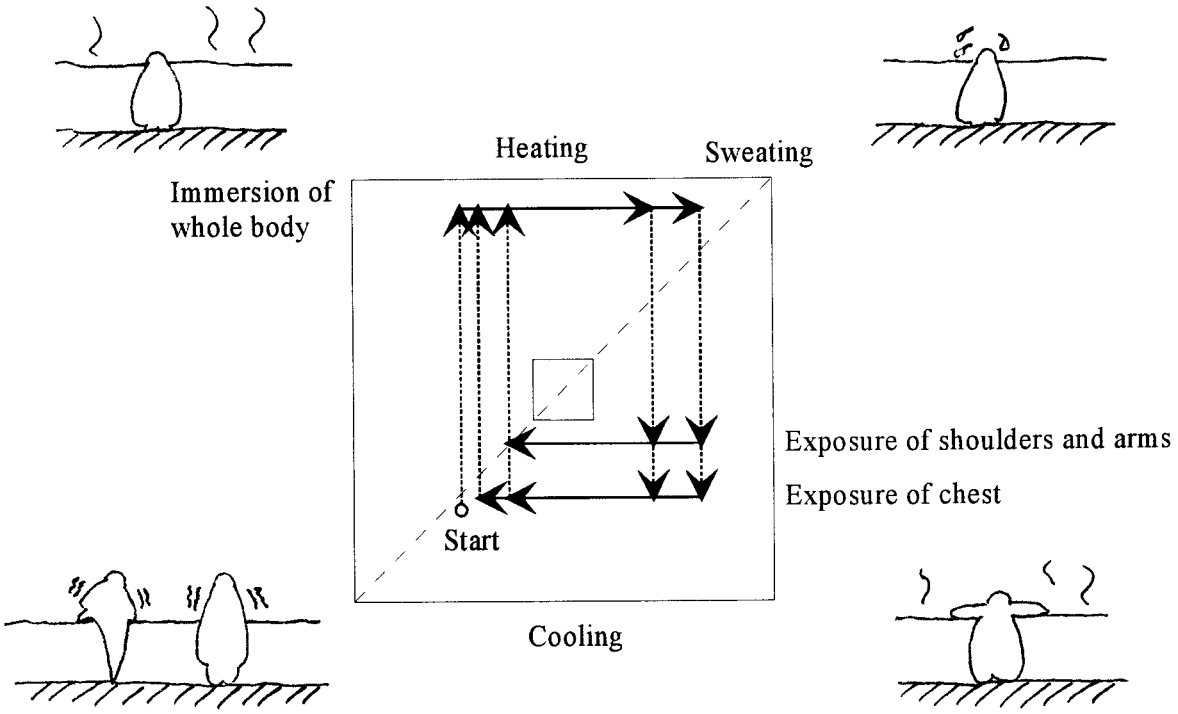


Figure 6. Variation in bathing at an open air spa

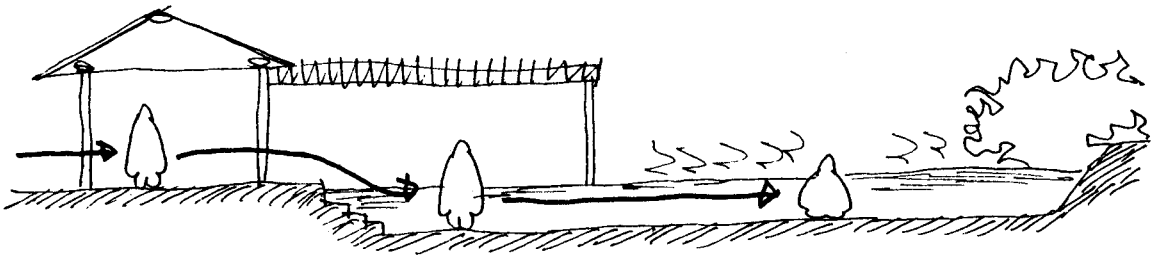
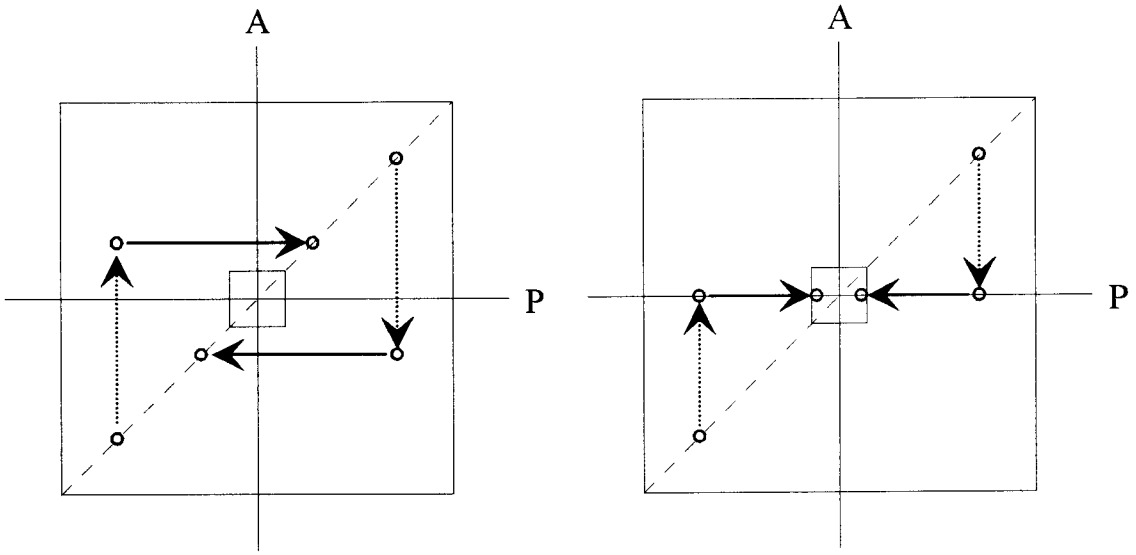


Figure 7. An example of designed open air spa



(a) Café in town (b) Tea lounge at high-class hotel

Figure 8. Café in town and tea lounge at high-class hotel

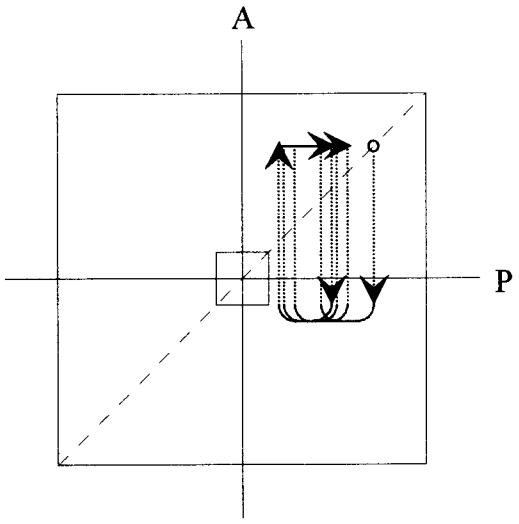


Figure 9. Intermittent wind

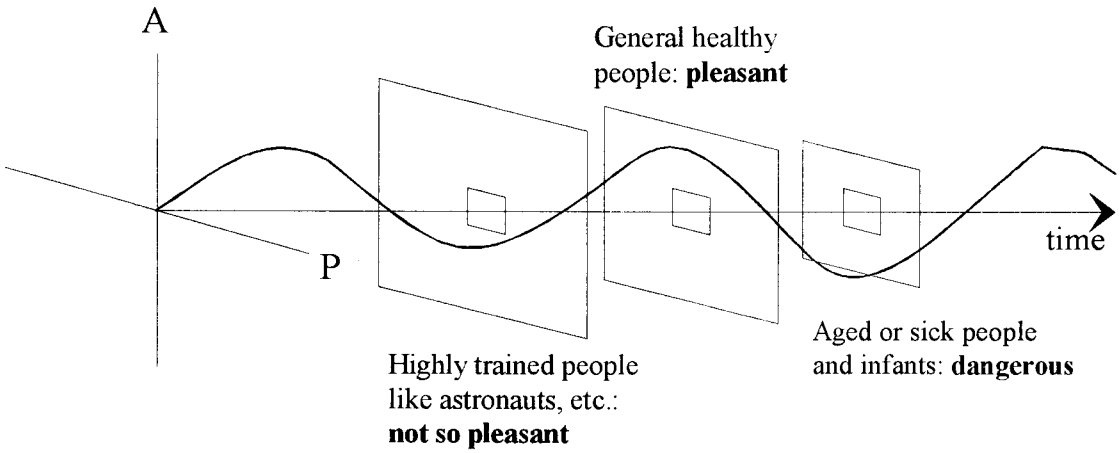
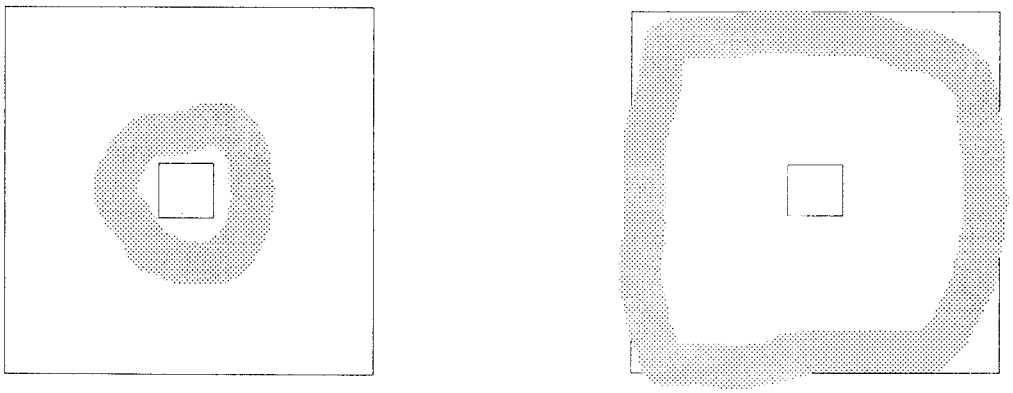
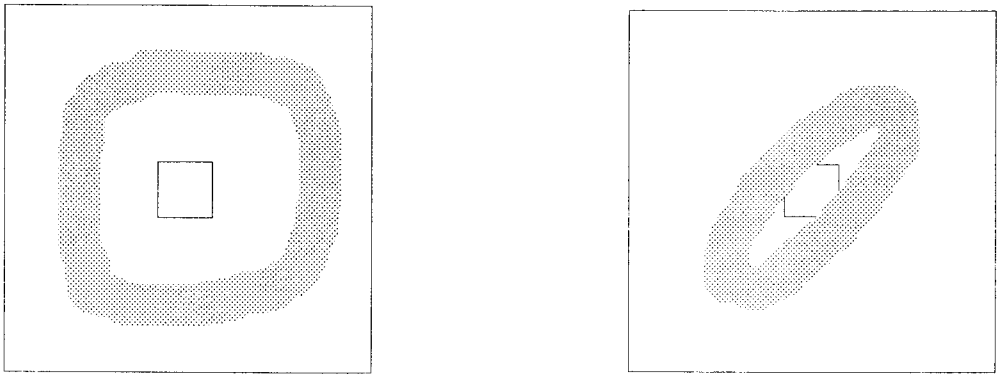


Figure 10. Roller coaster



(a) Protecting the neutral zone (b) Protecting the outer box

Figure 11. Two kinds of gentleness



(a) Passive systems (b) Simple extension of the comfort zone

Figure 12. Passive and active systems