4 OUR WORLD

4.1 Introduction

Designers need to be able to predict how people will respond to a finished building.

A satisfactory reaction might be achieved by adhering to a well practiced procedure that has been found to elicit a favourable response from users. Generally such a procedure will be based upon a set of simple a rules. However, there may be many rules for different circumstances and by its very nature such a system of design is likely to develop only quite slowly. This is because new rules can only be made on the basis of trial and error and it is likely that there will be many false trials before a successful modification is proposed by chance.

Alternatively, the designer might try to understand why people respond to their surroundings in the way that they do. The designer must then use or interpret this information so that a prediction can be made about the response of users. This might be done without the designer necessarily being conscious of the experience that users undergo.

Yet another alternative is that designers use their own experience to imagine how a building is going to be perceived by others. Designers are using themselves as the judges of a design proposal. Whilst the designer using this method is able to exploit an intimate understanding of their own awareness and perceptions, there is the possibility that this does not match with other people's feelings. It is therefore quite possible that their designs might be considered to be very successful by some and yet fail with the general population of users.

I suggest that the three design strategies described above might characterise the approach of three different types of designer:

A traditionalist with knowledge of vernacular architecture,
An engineer who has observed outcomes from experiments,
An architect who has noted his own response to different designs.

These approaches are not mutually exclusive and successful designers often incorporate aspects of all three in their own design methodology.

However, an appreciation of the different approaches can go a long way to helping you understand the conflicts that can arise between engineering and architectural designers.

I would suggest that for designers to be able to respond to changing circumstances, they need learn about how people behave in buildings and how they feel about different environments. Behaviour of people in buildings can be directly observed and their feelings discovered by surveying their reactions or using questionnaires. Alternatively, as previously suggested, designers might explore their own responses to different circumstances and building designs by either direct observation or careful introspection.

If designers need to appreciate how people respond to the world about them then they need to understand something of the process of perception; for it is through our perceptions that we are aware of the world. Perception is a complex process, and one that is not yet fully understood. But there is sufficient known for the designer to appreciate just how dependent are their own perceptions and feelings upon the particular circumstances of their experience.

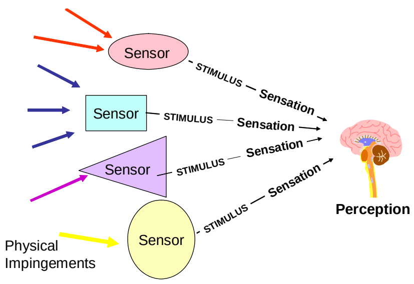

Figure 4.1 Process of perception

Figure 4.1 shows schematically an overview of the process of perception. We are confronted by a physical world that impinges upon our bodies. Our bodies have a whole armoury of sensors that detect different sorts of impingements and some of these provide us with sensations that vary depending upon the intensity of the impingement. The brain then integrates all the different senses into a single perception of the world wherein we perceive ourselves to exist.

4.2 The World about us

We can think of our bodies as continuously being bombarded by many different sorts of physical impingements. These impingements may be described and quantified in terms of their physical characteristics.

4.2.1 Physical impingements

A detailed knowledge of the properties of all the physical systems is not necessary, but a basic appreciation of some physics can help designers avoid problems. Each of the different physical systems usually has its own system of measurement. If calculations are to be undertaken by designers then these systems need to be understood and if you are going to lead an engineering team then you should know all of the most important units of measurement. Some of these are shown listed in Table 4.1, but they will be revisited and added to later in this course.

Physical Impingement	Units of description
Long wave electromagnetic radiation	Watt,W/m^2,wavelength, frequency
Visible electromagnetic radiation	Lumen,lm/m^2,wavelength, frequency
Ultra violet electromagnetic radiation	Watt,W/m^2,wavelength, frequency
Cyclic pressures of air with time	N/m^2,decibels,wavelength, frequency
Velocity of air striking body	m/s
Force of gravity on body	N
Deformation of body tissue	mm
Temperature of contact with body	C, K
Chemical composition of air	O_2 , N , CO_2 ,+

Table 4.1 Some of the physical impingements on a body

4.2.2 The senses

The sensors, or receptors, within the body can be complex and have mechanisms which enable them to cope with extreme ranges of physical impingements, i.e. from very low levels to very high levels.

We are all familiar with five of the senses: that of touch, smell, taste, sight and hearing. Each of these senses depends upon a number of receptors that are each specialised and respond to specific physical impingements. Thus our haptic (touch) perceptions depend upon receptors that respond to deep pressure, localised pressure and temperature amongst others.

A list of senses and the sorts of sensations to which they give rise are shown in the Table 4.2 below.

System NAME	FOCAL ACTION	PRIME SENSE ORGAN	IMPINGEMENTS	INFORMATION
Visual	Looking	Eyes and ocular muscles	Photic radiation	Size, shape, location, distance, colour, texture
Auditory	Listening	Cochlea, middle ear	Air vibrations	Nature and location of acoustic sources
Savour	Smelling	Nose	Composition of air	Pungency etc.
	Tasting	Mouth	Composition of material	Palatable attributes
Haptic	Touching Handling Pushing Pulling	Skin, hair, joints, tendons	Deformation of tissue Thermal stimuli	Mechanical encounters Object shapes wetness, dryness softness , hardness coldness, hotness
Orientation	Posture and locomotion	Vestibbular organs Kinesthetic receptors	gravity, acceleration	orientation, motion
Homeostatic	Metabolism	Many internal receptors	Temperature, pressure, CO_2	Comfort, well being

Table 4.2 – The Senses

4.3 Process of perception

There are five distinct aspects of perception to which I wish to draw attention. These are schematically depicted again in Figure 4.2 as:

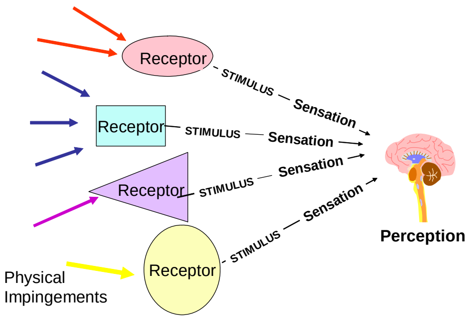

Figure 4.2 Process of Perception

Physical impingement,
Sensor receptive to that form of impingement,
Stimulus provided by the impingement,
Sensation that results from that stimulus,
Perception of the impingement as from the world outside.

Although the general process will be similar for each of the senses, there are quite major differences in particular details. This is very true for the two most complex senses of hearing and sight. With both of these senses the receptors have developed into major organs and they work in a most complex manner. Thus they are not going to be examined in detail immediately.

However, it is useful to briefly consider the various parts of the process of perception from the initial stimulus of the receptor to the complex interpretation of information through perception. The sense of touch will be used to show how the process starts.

4.3.1 Sensory receptor

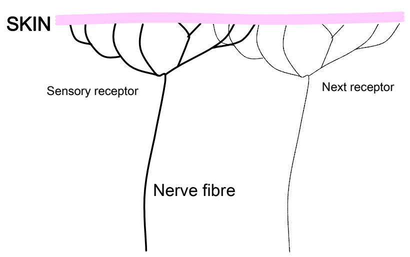

Figure 4.3 – Skin Receptors

Two pressure sensitive receptors are shown diagrammatically in Figure 4.3.

A receptor may not be affected at all by extremely low levels of exposure to a physical field. If there is no change in the physical state of the receptor then it would be expected that it would not respond in any way to the presence of the physical field.

At slightly higher levels of exposure the receptor may be affected, but insufficiently to stimulate the receptor into changing its output.

At even higher levels of impingement the receptor may be affected sufficiently to be activated and forward a signal to other parts of the body. The receptor may now be said to have been stimulated by the physical impingement.

That a receptor is stimulated does not necessarily mean that a person is consciously aware it. Some receptors are directly linked with glands that release hormones, but because they are not directly connected to the brain they will not give rise to sensations. Although one may not be directly conscious of this stimulation when it occurs, biological functions or emotional states may be affected by any hormones released into the bloodstream.

Reactions to non-perceived stimuli may be extremely important to body functions. Indeed, there is increasing interest in the response of people to such stimuli. An example of this type of non-perceived response is the effect of light upon the pineal gland. The pineal gland is informed of the general level of light through nerve connections from the retina that do not go via the brain. In response to the exposure to light the pineal controls the release of melatonin into the bloodstream. It has been observed that there is a link between levels of melatonin and the syndrome known as Seasonal Affective Disorder - SAD. This syndrome involves mood swings between the seasons and is thought to be linked with 'Spring Fever' in Nordic countries where there are increased rates of suicide in the Spring.

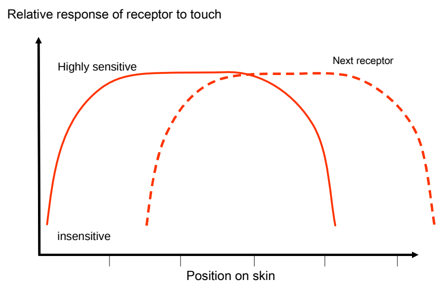

Figure 4.4 –Receptor Sensitivity

Where the output of a receptor is forwarded to your brain, then it still might not impart a noticeable sensation. In psychological research the 'limen' is a sensory interval that observers are just able to discriminate. A 'subliminal' response is where the receptor responds to an impingement but the stimulation forwarded to the brain is insufficient to make someone consciously aware of the response.

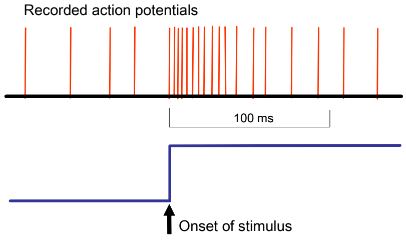

Figure 4.5 –Response over time

This does not necessarily mean that the body is unaffected by the response of the receptor.

Although you might not be consciously aware of a stimulus, the brain may well act upon it. This is the basis of 'subliminal advertising', where brief flashes of text upon a TV screen are used to influence people to either buy particular brands of product or act in particular ways. There is some controversy about the effectiveness of such stimuli but there is a ban on subliminal advertising. Another example of an unconscious response that affects our behaviour is the manner in which an unconsciously perceived movement in the peripheral field of vision can cause us to change our direction of sight.

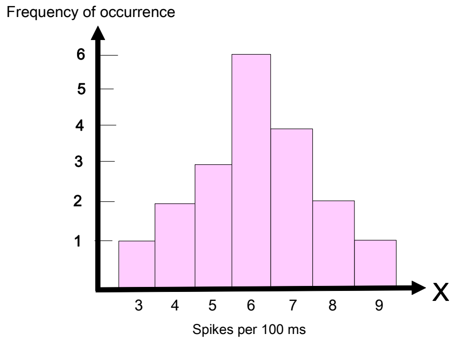

Figure 4.6 – Response at other times to same impingement

Increased levels of stimulation e.g. a longer exposure to the stimulus or perhaps increased levels of attention might lead to a person being made aware of the impingement through a sensation. The level of sensation will be related in some way to the size of the stimulus. However, it is important to realise that the level of sensation may be affected by many factors other than the direct level of stimulus present at a particular time.

Returning to the two touch sensitive receptors shown in Figure 4.3, each receptor is sensitive to touch over a given area of skin and they do not respond to touch outside that area. Thus each receptor responds to touch on a different patch of skin as shown in Figure 4.4.

On first being stimulated the receptor sends off a train of electrical spikes along the nerve fibre connected to the receptor as shown in Figure 4.5. Initially the rapidity of spikes is high, but as the impingement continues the rapidity slackens a little.

The same level of physical impingement does not always produce exactly the same electrical response from receptor. Figure 4.6 shows the varied response of a receptor to the same level of impingement. The receptor may even respond when there is no impingement at all.

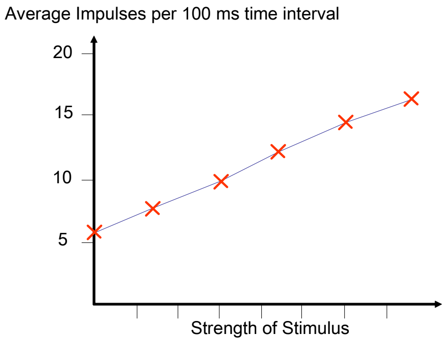

Figure 4.7 – Average response to different impingements

The average response to different levels of impingement is shown in Figure 4.7, and it can be seen that the response rate increases with the level of impingement. But the figure also shows that even when there is no impingement, the receptor will forward an average of 6 spikes per 100ms.

Because of the variability of the signal, a given response or signal from the receptor might be the result of no impingement or a small impingement. This can be appreciated by looking at Figure 4.8. There is thus an uncertainty as to whether or not the response is due to some stimulus or is just noise in the system.

Thus, from the outset of the perceptual process there are uncertainties.

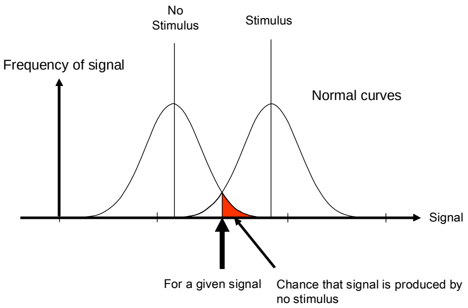

Figure 4.8 – Response to a real impingement and no signal - Noise

4.3.2 Stimulus

A stimulus is an impingement that activates a receptor sufficiently for it to forward a signal to the brain. If this stimulus is to be quantified then it is necessary to take into account how sensitive is the receptor to the different types of impingements.

Particularly with visual and auditory receptors, the sensitivity of the receptor depends upon the wavelength of the impingement. If the wavelength of the impingement is λ, then the impingement at λ_1 may be described as $Imp_{\lambda 1}$. At the same wavelength λ_1, the sensitivity of the receptor may be described as $S_{\lambda 1}$.

The stimulus caused by the impingement at wavelength λ_1, will therefore be given by:

$$\text{Stimulus at } \lambda_1 = Imp_{\lambda 1} \times S_{\lambda 1} \ .$$

And the total stimulus will be found by summing the stimuli from all the different wavelengths over which the receptor is sensitive:

$$\text{Total Stimulus} = \Sigma\, Imp_{\lambda} \times S_{\lambda}$$

The Greek symbol (sigma) Σ is used as shorthand for ' Sum over all wavelengths' .

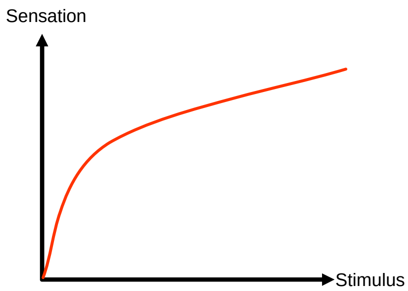

Figure 4.9 – Sensation vs Stimulus

4.3.3 Sensation

A sensation is something that we experience. Thus we experience the sensations of light and dark, of loudness and quietness, of warmth and cold. These sensations are not at all difficult to understand because we use those very words to describe to others how we are experiencing the world about us:

It is dark; I find the noise too loud; the sun is hot on my skin. Thus a sensation is the subjective reaction to particular level of stimulus.

We as designers are particularly interested in people's subjective reactions to our designs:
is our building going to be sensed as too hot or too cold ?
will the light level be seen as being too bright or too dim ?
will the sound level be thought of as too loud or too quiet ?

There are all sorts of questions that need to be answered if we are going to make predictions about how people are going to feel in our buildings. Those questions are not answered simply and cannot always be answered with a high degree of certainty or accuracy.

It is vital for you to appreciate that our reactions to the physical world are complex and the theoretical picture presented to you must inevitably be a simplification.

One observation that can be made about the relation between a sensation and the stimulus evoking that sensation is that it takes the form shown in Figure 4.9. From this can be drawn the conclusion that ever increasing stimuli are needed in order to increase the sensation experienced.

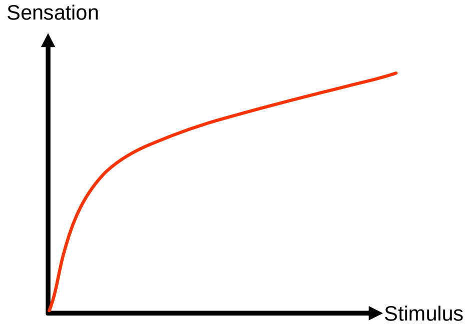

Figure 4.9 Sensation vs Stimulus

A simplification of the relationship between sensation and stimulus that is useful to keep in mind is that:

$$\log(\text{SENSATION}) \quad \alpha \quad \log(\text{STIMULUS})$$

This is shown diagrammatically in Figure 4.10.

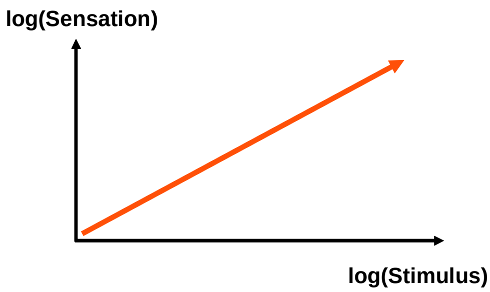

Figure 4.10 logarithmic relation

As a designer, the most important aspect to keep in mind, is that it is often the case that a small increase in the stimulus is unlikely to make a significant difference to the sensation. An so, if a room has a smallish window and you want to significantly increase the brightness of the room, then you will need to at least double the size of the window before there is a noticeable difference in the brightness of the room.

4.3.4 Perception

The purpose of our perceptions is to inform us of the world.

Our senses are stimulated by impingements and we experience sensations that inform us about the level of those impingements. However, raw sensation of itself does not imply perception. The term perception expresses the fact that a meaning has been assigned to sensory input, and that sensations have been understood within the context of an accepted model of reality.

Designers wish that those people experiencing their buildings perceive them in particular ways. Therefore designers need to be aware of some of the complexities of perception in order that these can be taken into consideration when designing.

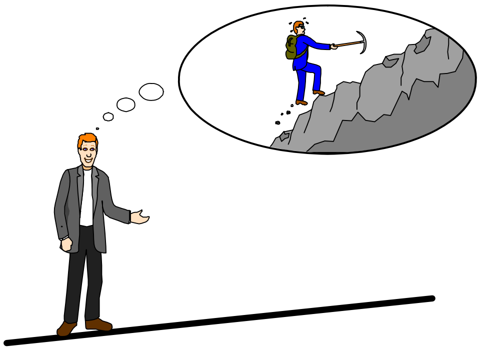

Figure 4.11 Bathwick Hill

Figure 4.12 What do you see?

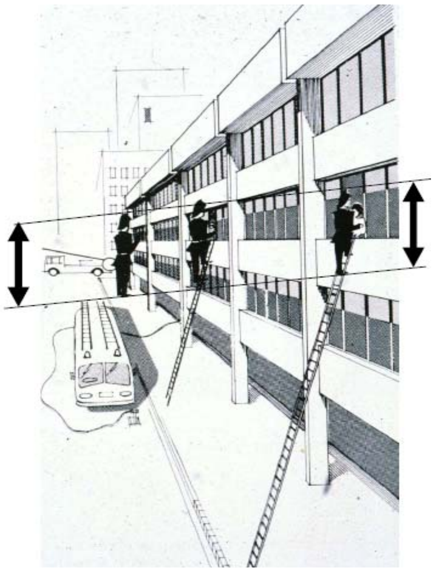

Figure 4.13 A distortion of size

Perception may be thought of as a hypothetical framework that enables the sensory information from all the body's receptors to be interpreted without contradiction. Where contradictions do occur then disorientation or misperceptions may be the result.

It is amusing and interesting to consider two particular perceptions that can help us appreciate the complexities of perception:

In Figure 4.11 is shown to scale a cross section the slope of Bathwick Hill. The maximum incline is 1 in 10 or about 10%. Clearly the appearance of the incline on the drawing appears to be nothing like the incline experienced when walking up the hill. You as designers should therefore be aware of how different an impression a drawing can give to the reality of experience. If you communicate through drawing you MUST be aware of this issue.

In Figure 4.12, there is a drawing that can be interpreted in two ways, i.e. the same visual stimuli can be perceived in two ways. One might ask whether one perception is more correct than the other. The perceptual system will try to make up a perception even when there is limited or conflicting information. As designers we normally try to avoid creating such situations because they can be disorientating and even dangerous e.g. when driving along a motorway at speed.

An important aspect of perceiving the world about us, is to be aware of those attributes of the world that are constant. Two important aspects are size and shape constancy. The size of objects appear constant whether viewed from near or afar, and they retain their characteristic shape independently of from which direction they are viewed. An optical illusion that partly depends upon the perceptual system's attempt to impose a form of size constancy is shown in Figure 4.13, where however much your intellect tells you the firemen in the drawing are all the same size, without aids it is impossible to believe it to be so.

Another perceptual constancy is our ability to judge the lightness or reflectance of objects independently of the level of light. Because lightness constancy is a part of our perceptual system that we exercise whenever we look at something, it is difficult to appreciate how remarkable is the phenomenon. However, just think of a lump of coal lit by sunlight, it appears to be black. A piece of paper under moonlight appears white, and yet there is far more light reflected off the coal than the white paper seen under moonlight.

The physiological processes of Adaption and Inhibition play an important part in helping us to recognise the lightness of objects. They will be considered in more detail when the lighting of buildings is considered.

4.3.5 Comfort

It is quite difficult for experts to agree on the exact definition of comfort. However it is not too difficult to appreciate that generally it refers to a state of well being. Also it is important to realise that increased levels of sensation do not necessarily always result in improved comfort. Generally there is a range of conditions that are accepted as comfortable. Outside those conditions people's satisfaction with their environment will fall as shown in Figure 4.14.

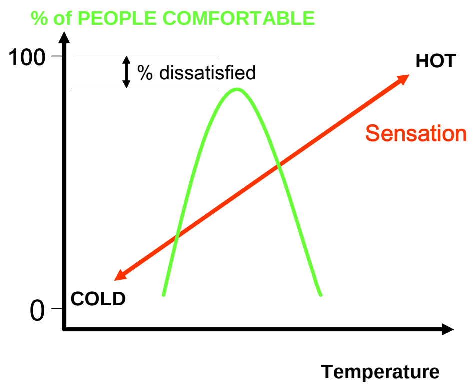

Figure 4.14 Comfort

Comfort does not only depend upon the physical conditions to which we are exposed. People's past experiences, their current mental state, their age and their expectations are among some of the factors that also influence people's comfort. Thus it may be important for designers to properly note which population it is that they are trying to make comfortable.
4

4.3.6 General Conclusion

If we are designing for people then it is important for us to realise that whatever they experience occurs through the process of perception. In order for us to make generalisations from our own experiences, we should have some appreciation of how the perceptual systems work so that allowance can be made for the distortions that inevitably occur. Designs intended for the general population must suit their needs. Therefore, as well as our own experience, there is a need for information about how the general population respond to different environmental stimuli.