James J. Gibson
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Chapter 3
THE MEANINGFUL ENVIRONMENT

The world of physical reality does not consist of meaningful things. The world of ecological reality, as I have been trying to describe it, does. If what we perceived were the entities of physics and mathematics, meanings would have to be imposed on them. But if what we perceive are the entities of environmental science, their meanings can be discovered.

A NOMENCLATURE FOR SURFACE LAYOUT

Consider first the difference between the terms used in describing what I have called the layout of a habitat and the terms used in geometry. *Surfaces* and the *medium* are ecological terms; *planes* and *space* are the nearest equivalent geometrical terms, but note the differences. Planes are colorless; surfaces are colored. Planes are transparent ghosts; surfaces are generally opaque and substantial. The intersection of two planes, a line, is not the same as the junction of two flat surfaces, an edge or corner. I will try to define the ecological terms explicitly. The following terminology is a first attempt at a theory of surface layout, a sort of applied geometry that is appropriate for the study of perception and behavior.

The *ground* refers, of course, to the surface of the earth. It is, on the average, level, that is to say perpendicular to the force of gravity. It is the reference surface for all other surfaces. It is also said to be horizontal, and this word refers to the horizon of the earth, the margin between earth and sky, a fact of ecological optics that has not yet been considered. Note that both gravity and the sky are implied by the ground. A special case of the ground is a floor.

An *open environment* is a layout consisting of the surface of the earth alone. It is a limiting case, only realized in a perfectly level desert. The surface of the earth is usually more or less "wrinkled" by convexities and concavities. It is also more or less "cluttered"; that is, it is not open but partly enclosed.

An *enclosure* is a layout of surfaces that surrounds the medium in some degree. A wholly enclosed medium is a limiting case, at the other extreme from an open environment. It is only realized in a windowless cell that does not afford entry or exit. The surfaces of an enclosure all face inward. An egg or cocoon, to be sure, is a wholly enclosed environment for an embryo or a pupa, but eventually it has to be broken.

A *detached object* refers to a layout of surfaces completely surrounded by the medium. It is the inverse of a complete enclosure. The surfaces of a detached object all face outward, not inward. This is not a limiting case, for it is realized in objects that are moving or are movable. Animate bodies, animals, are detached objects in this sense, however much they may otherwise differ from inanimate bodies. The criterion is that the detached object can

be moved without breaking or rupturing the continuity of any surface.

An *attached object* refers to a layout of surfaces less than completely surrounded by the medium. The substance of the object is continuous with the substance of another surface, often the ground. The surface layout of the object is not topologically closed as it is for the detached object and as it also is for the complete enclosure. An attached object may be merely a *convexity*.

It may be noted that objects are *denumerable*, they can be counted, whereas a substance is not denumerable and neither is the ground. Note also, parenthetically, that an organism such as a tree is an attached object in the environment of animals since it is rooted in the ground like a house with foundations, but it is a detached object, a whole organism, when considered as a plant with roots between soil particles.

A *partial enclosure* is a layout of surfaces that only partly encloses the medium. It may be only a concavity. But a cave or a hole is often a shelter.

A *hollow object* is an object that is also an enclosure. It is an object from the outside but an enclosure from the inside, part of the total surface layout facing outward and the other part inward. A snail shell and a hut are hollow objects.

A *place* is a location in the environment as contrasted with a point in space, a more or less extended surface, or layout. Whereas a point must be located with reference to a coordinate system, a place can be located by its inclusion in a larger place (for example, the fireplace in the cabin by the bend of the river in the Great Plains). Places can be named, but they need not have sharp boundaries. The habitat of an animal is made up of places.

A *sheet* is an object consisting of two parallel surfaces enclosing a substance, the surfaces being close together relative to their dimensions. A sheet should not be confused with a geometrical plane. A sheet may have flat surfaces or curved surfaces, and it may be flexible or freely changeable in shape. A membrane of the sort found in living bodies, permeable or impermeable, is an example of a sheet.

A *fissure* is a layout consisting of two parallel surfaces enclosing the medium that are very close together relative to their size. The surfaces of rigid solids often have fissures (cracks).

A *stick* is an elongated object.

A *fiber* is an elongated object of small diameter, such as a wire or thread. A fiber should not be confused with a geometrical line.

A *dihedral*, in this terminology, refers to the junction of two flat surfaces and should not be confused with the intersection of two planes in abstract geometry. A *convex dihedral* is one that tends to enclose a substance and to make an edge; a *concave dihedral* is one

that tends to enclose the medium and to make a corner. You cannot bark your shin on the intersection of two limitless planes or on the apex of an abstract dihedral angle. Neither can you do so on a comer; you can only do so on an edge. A *sharp edge* is an acute convex dihedral. The termination of a sheet will be called a *cut edge*.

Parenthetically, it may be noted that the last five entities, fissure, stick, fiber, and the two kinds of dihedral, convex and concave, are all embodiments of a line in geometry and that all of them are to be distinguished from a margin or border. A line is a sort of ghost of these different entities.

A *curved convexity* is a curved surface tending to enclose a substance.

A *curved concavity* is a curved surface tending to enclose the medium.

The foregoing terms apply to *surface geometry* as distinguished from *abstract geometry*. What are the differences between these two? A surface is substantial; a plane is not. A surface is textured; a plane is not. A surface is never perfectly transparent; a plane is. A surface can be seen; a plane can only be visualized.

Moreover, a surface has only one side; a plane has two. A geometrical plane, that is, must be conceived as a very thin sheet in space, not as an interface or boundary between a medium and a substance. A surface may be either convex or concave, but a plane that is convex on one side is necessarily concave on the other. In surface geometry the junction of two flat surfaces is either an edge or a corner; in abstract geometry the intersection of two planes is a line. A surface has the property of facing a source of illumination or a point of observation; a plane does not have this property. In surface geometry an object and an enclosure can be distinguished; in abstract geometry they cannot.

Finally, in abstract analytic geometry the position of a body is specified by coordinates on three chosen axes or dimensions in isotropic space; in surface geometry the position of an object is specified relative to gravity and the ground in a medium having an intrinsic polarity of up and down. Similarly, the *motion* of a body in abstract geometry is a change of position along one or more of the dimensions of space, or a rotation of the body (spin) on one or more of these axes. But the motion of an object in surface geometry is always a *change in the overall surface layout*, a change in the shape of the environment in some sense. And since environmental substances are often not rigid, their surfaces often undergo deformation, and these motions-—stretching, squeezing, bending, twisting, flowing, and the like-——are not the motions of abstract
bodies.

WHAT THE ENVIRONMENT AFFORDS THE ANIMAL

The environment of any animal (and of all animals) contains substances, surfaces and their layout, enclosures, objects, places, events, and the other animals. This description is very general; it holds true for insects, birds, mammals, and men. Let us now attempt a more particular description, selecting those surfaces, layouts, objects, and events that are of special concern to animals that behave more or less as we do. The total environment is

too vast for description even by the ecologist, and we should select those features of it that are perceptible by animals like ourselves. A further treatment of what the environment affords will be given later, in Chapter 8.

TERRAIN FEATURES

The level ground is only rarely an open environment, as noted a few pages back. It is usually cluttered. An open environment affords locomotion in any direction over the ground, whereas a cluttered environment affords locomotion only at *openings*. These rules refer, of course, to pedestrian animals, not flying animals or climbing animals. The human animal is a pedestrian, although he is descended from arboreal primates and has some climbing ability. The general capacity to go through an opening without colliding with the edges is not limited to pedestrians, however. It is a characteristic of all visually controlled locomotion (Gibson, 1958).

A *path* affords pedestrian locomotion from one place to another, between the terrain features that prevent locomotion. The preventers of locomotion consist of *obstacles*, *barriers*, *water margins*, and *brinks* (the edges of cliffs). A path must afford footing; it must be relatively free of rigid foot-sized obstacles.

An *obstacle* can be defined as an animal-sized object that affords collision and possible injury. A *barrier* is a more general case; it may be the face of a cliff, a wall, or a man-made fence. Note parenthetically that a barrier usually prevents looking-through as well as going-through but not always; a sheet of glass and a wire fence are barriers, but they can be seen through. A cloud, on the other hand, may preventlooking-through but not going-through. These special cases will be treated later.

A *water margin* (a margin is not to be confused with an edge in this terminology) prevents pedestrian locomotion; it permits other kinds, but let us postpone consideration consideration of the various affordances of water.

A *brink*, the edge of a cliff, is a very significant terrain feature. It is a falling-off place. It affords injury and therefore needs to be perceived by a pedestrian animal. The edge is dangerous, but the near surface is safe. Thus, there is a principle for the control of locomotion that involves what I will call the *edge* of danger and a *gradient* of danger, that is, the closer to the brink the greater the danger. This principle is very general.

A *step*, or stepping-off place, differs from a brink in size, relative to the size of the animal. It thus affords pedestrian locomotion. A stairway, a layout of adjacent steps, affords both descent and ascent. Note that a stairway consists of convex edges and concave corners alternating, in the nomenclature here employed.

A *slope* is a terrain feature that may or may not afford pedestrian locomotion depending on its angle from the surface of the level ground and its texture. A ramp with low inclination can be negotiated; a cliff face with high inclination cannot.

Humans have been altering the natural features of the terrain for thousands of years, constructing paths, roads, stairways, and bridges over gorges and streams. Paths, roads, stairways, and bridges facilitate human locomotion and obviate climbing. Humans have also been constructing obstacles and barriers to *prevent* locomotion by enemies, human or animal. Humans have built walls, moats, and fences to prevent access to an enclosure, that is, to their camps and fortresses. And then, of course, they had to build doors in the walls, drawbridges over the moats, and gates in the fences to permit their own entry and exit.

SHELTERS

The atmospheric medium, it will be remembered, is neither *entirely* homogeneous nor *wholly* invariant. Sometimes there is rain in the air, or hail, or snow. Sometimes the wind blows, and in certain latitudes of the earth the air periodically becomes too cold for warm-blooded animals, who will die if they lose more heat to the medium than they gain by oxidizing food. For such reasons, many animals and all human beings must have shelters. They often take shelter in caves or holes or burrows, which are animal-sized partial enclosures. But some animals and all humans of recent times *build* shelters, constructing them in various ways and of various materials. These are generally what I called hollow objects, not simply cavities in the earth. Birds and wasps build nests, for example, especially for sheltering their young. Human animals build what I will call *huts*—a generic term for simple human artificial shelters. A hut has a site on the ground, and it is an attached object from the outside. But it also has an inside. Its usual features are, first, a *roof* that is "get-underneath-able"and thus affords protection from rain and snow and direct sunlight; second, *walls*, which afford protection from wind and prevent the escape of heat; and third, a *doorway* to afford entry and exit, that is, an *opening*. A hut can be built of sticks, clay, thatch, stones, brick, or many other more sophisticated substances.

WATER

The margin between land and water stops the pedestrian. But animals can wade if the water is shallow, float if their specific gravity is not too high, or skitter over the surface if they are insects. Some terrestrial animals can swim on the surface of water, as the human animal can after a fashion, and dive under the surface for a short time. But water does not afford respiration to terrestrial animals with lungs, and they are always in danger of drowning. Considered as a substance instead of a surface or a medium, water is a necessity for terrestrial life, not a danger. Animal tissue consists mainly of solutions in water, and the fluids of the body have to be replenished. Animals must drink. Only the intake of fresh water prevents death by desiccation, or what we call thirst. So they need to recognize water when they meet with it. Water causes the wetting of dry surfaces. It affords bathing and washing, to elephants as well as to humans. Streams of water can be dammed, by beavers as well as by children and hydraulic engineers. Ditches can be dug and aqueducts built. Pots can be made to contain water, and then it affords pouring and spilling. Water, in short, has many kinds of meaning.

FIRE

Fire was the fourth of the "elements" that constituted the world, in the belief of the Greek thinkers. They were the first analyzers of the environment, although their analysis depended on direct observation. They observed earth, air, water, and then fire. In our chemical sophistication, we now know that fire is merely a rapid chemical reaction of oxidation, but nevertheless we still perceive a fire as such. It is hardly an object, not a substance, and it has a very unusual surface. A fire is a terrestrial *event*, with a beginning and an end, giving off heat and consuming fuel. Natural fires in the forests or plains were and still are awesome to animals, but our ancestors learned very early how to control fire—how to begin it (with a fire drill, for example), how to make it persist (by feeding it fuel), how to conserve it (with a slow match), and how to quench it. The controlling of fire is a unique human habit. Our primitive hunting ancestors became very skilled at it. And as they watched the fire, they could see a prime example of persistence with change, of invariance under transformation.

A fire affords warmth even in the open but especially in a shelter. It provides illumination and, in the form of a torch, can be carried about, even into the depths of a cave. But a fire also affords injury to the skin. Like the brink of a cliff, one cannot get too close. There is a gradient of danger and a limit at which warmth becomes injury. So the controlling of fire entails the control of motor approach to fire and the detecting of the limit.

Once this control is learned by the adult and the child, fire affords many benefits besides warmth and illumination. It allows the cooking of food substances and the boiling of water in pots. It permits the glazing of clay and the reduction of minerals to metals. Fire, like water, has many kinds of meaning, many uses, many values.

OBJECTS

The term *object* as used in philosophy and psychology is so inclusive as to be almost undefinable. But as I have defined it above, it refers only to a persisting substance with a closed or nearly closed surface and can be either detached or attached. I always refer to a "concrete" object, not an "abstract" one. In this restricted sense, the surface of an object has a definite texture, reflectance, color, and layout, the surface layout being its shape. These are some of the distinguishing features of an object in relation to other objects.

An *attached* object of the appropriate size permits a primate to grasp it, as a monkey grasps a tree branch. (A bird can grasp with its claws in the same way.) Such an object is something to hold on to and permits climbing. A *detached* object of the appropriate size to be grasped is even more interesting. It affords carrying, that is, it is portable. If the substance has an appropriate mass-to-volume ratio (density), it affords throwing, that is, it is a missile.

A hollow object such as a pot can be used to contain water or wine or grain and to store these substances. An object with a level surface knee-high from the ground can be used to sit on. An elongated object, a stick, if the substance is elastic and flexible, affords bending and thus can be made into a bow for launching arrows. A rigid, straight stick, not

bent or curved, can be rotated on its long axis without wobbling; it can be used as a fire drill or as an axle for a wheel. The list of examples could go on without end.

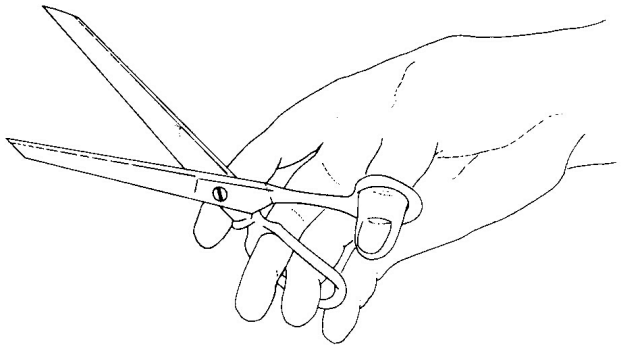
THE DETECTING of A LIMIT AND THE MARGIN OF SAFETY

The mathematical concept of a variable, an asymptote, and a limit is an intellectual achievement Of great complexity. But the perceiving of a limit of action is quite simple. Terrestrial animals perceive a brink as a limit of approach, and the mathematical complexity is not a problem for the visual system. The observer, even a child, sees the distance between himself and the brink, the 50~called margin of safety.

TOOLS

Tools are detached objects of a very special sort. They are graspable, portable, manipulatable, and usually rigid. The purposive use of such objects is not entirely confined to the human animal, for other animals and other primates take advantage of thorns and rocks and sticks in their behavior, but humans are probably the only animals who make tools and are surely the only animals who walk on two feet in order to keep the hands free. The missile that can be thrown is perhaps the earliest of tools. When combinedwith a launching device, it can become very versatile. The discovery of missiles was surely one of the factors that made the human animal a formidable hunter as compared to the animals with teeth and claws. Soon after that discovery, presumably, came the invention of striking tools, edged tools, and pointed tools. An elongated object, especially if weighted at one end and graspable at the other, affords hitting or hammering (a club). A graspable object with a rigid sharp edge affords cutting and scraping (a knife, a hand axe, or a chopper). A pointed object affords piercing (a spear, an arrow, an awl, or a needle). These tools may be combined in various Ways to make other tools. Once again it may be noted that users of such tools must keep within certain limits of manipulation, since they themselves may be struck or cut or pierced.

Figure 3.1A tool is a sort of extension of the hand.This object in use affords a special kind of cutting, and one can actually feel the cutting action ofthe blades.



When in use, a tool is a sort of extension of the hand, almost an attachment to it or a part of the user's own body, and thus is no longer a part of the environment of the user. But when not in use, the tool is simply a detached object of the environment, graspable and portable, to be sure, but nevertheless external to the observer. This *capacity to attach something to the body* suggests that the boundary between the animal and the environment is not fixed at the surface of the skin but can shift. More generally it suggests that the absolute duality of "objective" and "subjective" is false. When we consider the affordances of things, we escape this philosophical dichotomy.

When being worn, clothing, even more than a tool, is a part of the wearer's body instead of a part of the environment. Apart from the utility of modulating heat loss, clothing permits the individual to change the texture and color of his surface, to put on a second skin, as it were. When not being worn, a body covering is simply a detached object of the environment made of fabric or the skin of a dead animal—a complex, flexible, curved sheet in our terminology. But the article objectively affords wearing, as a tool affords using. And when it is worn it becomes attached to the body and is no longer a part of the environment.

Much more could be said about tools, but this will serve as an introduction. Note that the discussion has been limited to relatively small or portable tools. Technological man has made larger tools, machines, for cutting, boring, pounding, and crushing, and also for earth-moving and for construction and also, of course, for locomotion.

OTHER ANIMALS

Animate objects differ from inanimate objects in a variety of ways but notably in the fact that they move spontaneously. Like all detached objects, animate objects can be pushed and displaced by external forces, they can fall when pulled by the force ofgravity—in short, they can be passively moved—but they also can move actively under the influence

of *internal* forces. They are partly composed of viscoelastic substances as well as rigid skeletons, and their movements are always deformations of the surface. Moreover the style of movement, the mode of deformation, is unique for each animal. These special objects differ in size, shape, texture, color, odor, and in the sounds they emit, but above all they differ in the way they move. Their postures change in specific modes while their underlying invariants of shape remain constant. That is to say, animals have characteristic behaviors as well as characteristic anatomies.

Animals are thus by far the most complex objects of perception that the environment presents to an observer. Another animal may be prey or predator, potential mate or rival, adult or young, one's own young or another's young. Moreover, it may be temporarily asleep or awake, receptive or unreceptive, hungry or satiated.

What the other animal affords is specified by its permanent features and its temporary state, and it can afford eating or being eaten, copulation or fighting, nurturing or nurturance. What the other animal affords the observer is not only behavior but also social interaction. As one moves so does the other, the one sequence of action being suited to the other in a kind of behavioral loop. All social interaction is of this sort—sexual, maternal, competitive, cooperative—or it may be social grooming, play, and even human conversation.

This brief description does not even begin to do justice to the power of the notion of affordances in social psychology. The old notions of social stimuli and social responses, of biological drives and social instincts are hopelessly inadequate. An understanding of life with one's fellow creatures depends on an adequate description of what these creatures offer and then on an analysis of how these offerings are perceived.

HUMAN DISPLAYS

Finally, we come to a very special class of artificial objects—-or perhaps *devices* is a better term—that display optical information. I refer to solid images of several types, pictures of many sorts, and all the surfaces of the environment that bear writing. Some twenty or thirty thousand years ago sculptures and pictures were first made, and some four or five thousand years ago writing was developed and records began to be kept. By now images and records are everywhere. A *display*, to employ a useful generic term, is a surface that has been shaped or processed so as to exhibit information for more than just the surface itself (Gibson, 196619, pp. 26—28, 224-244). For example, a surface of clay is only clay, but it may be molded in the shape of a cow or scratched or painted with the profile of a cow or incised with the cuneiform characters that stand for a cow, and then it is more than just a surface of clay.

There will be more about displays in Part IV, after we have considered the information for visual perception in Part II and the activity of visual perception in Part III. It can be suggested in a preliminary way, however, that images, pictures, and written-on surfaces afford a special kind of knowledge that I call *mediated* or *indirect*, knowledge at second hand. Moreover, images, pictures, and writing, insofar as the substances shaped and the

surfaces treated are permanent, permit the storage of information and the accumulation of information in storehouses, in short, civilization.

THE ENVIRONMENT OF ONE OBSERVER AND THE ENVIRONMENT OF ALL OBSERVERS

The essence of an environment is that it *surrounds* an individual. I argued in Chapter 1 that the way in which a physical object is surrounded by the remainder of the physical world is not at all the same as the way in which a living animal is surrounded by an environment. The latter surrounds or encloses or is ambient in special ways that I have tried to describe.

The term surroundings is nevertheless vague, and this vagueness has encouraged confusion of thought. One such is the question of how the surroundings of a single animal can also be the surroundings of all animals. If it is assumed that no two observers can be at the same place at the same time, then no two observers ever have the same surroundings. Hence, the environment of each observer is "private," that is, unique. This seems to be a philosophical puzzle, but it is a false puzzle. Let us resolve it. One may consider the layout of surrounding surfaces with reference to a stationary point of observation, a center where an individual is standing motionless, as if the environment were a set of frozen concentric spheres. Or one may consider the layout of surrounding surfaces with reference to a *moving* point of observation along a path that any individual can travel. This is much the more useful way of considering the surroundings, and it recognizes the fact that animals do in fact move about. The animal that does not moveis asleep—or dead.

The available paths of locomotion in a medium constitute the set of all possible points of observation. In the course of time, each animal moves through the same paths of its habitat as do other animals of its kind. Although it is true that no two individuals can be at the same place at the same time, any individual can stand in all places, and all individuals can stand in the same place at different times. Insofar as the habitat has a persisting substantial layout, therefore, all its inhabitants have an equal opportunity to explore it. In this sense the environment surrounds all observers in the same way that it surrounds a single observer.

The old idea that each observer stands at the center of his or her private world and that each environment is therefore unique gets its main support from a narrow conception of optics and a mistaken theory of visual perception. A broader conception of optics will be given in Part II, and a better theory of visual perception will be presented in Part III. The fact of a moving point of observation is central for the ecological approach to visual perception, and its implications, as we shall see, are far-reaching.

SUMMARY

Formal plane geometry has been contrasted with an unformalized and quite unfamiliar geometry of surfaces. But the latter is more appropriate for describing the environmentin which we perceive and behave, because a surface can be seen whereas a plane cannot.

The differences between a plane and a surface have been pointed out.

A tentative list of the main features of surface layout has been proposed. The definitions are subject to revision, but terms of this sort are needed in ecology, architecture, design, the biology of behavior, and the social sciences instead of the planes, forms, lines, and points of geometry. The term *object*, especially, has been defined so as to give it a strictly limited application unlike the general meaning it has n philosophy and psychology.

The fundamental ways in which surfaces are laid out have an intrinsic meaning for behavior unlike the abstract, formal, intellectual concepts of mathematical space.