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Lecture 5

Levels of Reality

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I have told you how Copernicus ousted man from his central position in the universe and destroyed the theological cosmos. The heavenly sphere of divine perfection towards which, from his fallen sublunar existence, man was bound to strive, was dissolved in a space without limits, without shape or centre. And monotony in space was extended into monotony in depth, by the atomic theory of matter. Galileo's mechanics, amplified by Newton, gave new life to the theory that all things are ultimately composed of masses in motion. Atomic particles alone were real and all phenomena were merely appearances of this ultimate reality. Man himself was but a chance collocation of atoms, without purpose or meaning.

I shall speak in my last lecture in February of the great historical benefits of this scientific world view. Battling for freedom of thought against established authority, it cleared the way for political freedom and humanitarian reforms. Scientific rationalism brought social and moral progress that has improved almost every human relationship in western civilization. It has been up to our own days, the chief guide towards intellectual, moral and social advances.

But troubles developed and became serious in our own century. The demand that all things must be explained by the laws of physics and chemistry became more insistent and more destructive. Its inflexible pursuit has deprived our genuine convictions from all

theoretical foundations. Our whole culture is harassed by self-doubt.

I shall propose here a principle which would restore our acceptance of higher forms of being and show how we can know and do know these less tangible levels of existence. It will be left for my later lectures to outline the way such a change in our conception of reality might benefit us culturally and perhaps in public affairs.

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The mechanical philosophy of Galileo was more fully stated by Laplace when defining a Universal Knowledge of the World. He pointed out that from to-day's topography of the ultimate particles of the world (which would include their velocities and the forces acting between them) we could calculate any future topography of the same particles, and he claimed that this would give us a knowledge of all things to come, to the very end of time. It has been objected that such predictions contradict the exercise of free will, but this had only the effect of calling in question our possession of free will. Indeed, to bring up this particular difficulty of free will is to overlook the more massive fact, that a Laplacean atomic topography would tell us virtually nothing that is of interest to us. It would give us the total energy of any particular region in the universe, but we could not even make out -as we shall see - whether things in that region had any definite temperature, and if so what that temperature was.

To fathom the depth of such ignorance parading as Universal Knowledge, imagine yourself deprived of all your previous experience and presented in its place with a Laplacean topography of the universe

Though you were endowed with an unlimited ability for mechanical computations, you would search in vain to calculate something worth knowing. For what you would want to know are things seen and felt, things heard and smelt, and the laws of mechanics cannot derive such knowledge from a topography of atomic particles. Alone the action of our sentient self, responding to the atoms impinging upon our senses, can supply such information.

But even granting, for the sake of argument, our powers of sentience and forgetting also that an atomic topography cannot define temperature, we could still get no further than to derive the laws of physics and chemistry, and this would not enable us to recognise living and sentient beings. In saying this, I contradict the claims of biologists who affirm that they are explaining life in terms of physics and chemistry. But the fact is that they do nothing of the kind. The purpose which biology actually pursues, and by which it achieves its triumphs, consists predominantly in explaining the functions of living beings in terms of a mechanism founded on the laws of physics and chemistry, yet not explicable by these laws.

We can make this clear by showing that no mechanism, not even the simplest machine, can be explained in terms of physics and chemistry. Let me choose as an example of a machine the watch I wear on my wrist. My watch tells the time. It is kept going by the main-spring, incoiling under the control of the hair spring and balance wheel, and thus it turns the hands which tell the time. Such are the operational principles of a watch, the principles which define its construction and working. It is these principles that cannot be defined by the laws of inanimate nature. For no part of a watch is

formed by the natural equilibration of matter. Each is artificially shaped and connected to perform its function. Physics and chemistry cannot reveal the practical principles embodied in a machine, any more than the physical chemical testing of a printed page can tell the content of its text.

But how can we embody any structural or operational principle in a piece of inanimate matter, without interfering with the laws of inanimate matter? To answer this question, we must realise that no inanimate object is ever fully determined by the laws of physics and chemistry. Laplace himself had to assume for his speculations on future atomic topographies an initial atomic topography which was not derived from atomic mechanics. The laws of physics and chemistry can likewise be applied only to a given set of initial conditions.

This is, in fact, true of any general principle that applies to experience. It must leave indeterminate a range of circumstances in which it can apply, and any particular application of such a principle requires that these circumstances be fixed by some agency not under the control of that principle. This is well known for the laws of physics. The conditions which have to be fixed by some external agency are called here the boundary conditions of the system to which the law of physics is applied. It is on these boundary conditions that the shaping of a piece of metal into a machine takes effect. In other words, machines are systems, in which the boundary conditions left open by physics and chemistry are controlled by certain structural and operational principles. And hence machines cannot be described in terms of physics and chemistry.

What is true of machines is, of course, equally true of the machine-like functions of living beings. Such functions are determined by structural and operational principles which control the boundary conditions left open by physics and chemistry. Living beings operating as machines can, therefore, not be described in terms of physics and chemistry.

The material of a machine is thus under the control of two independent principles. The role of the two is very different. If the laws of physics and chemistry were suspended for a moment, all machines would stop working; their operational principles rely for their performance on these laws. This does not hold in reverse. Pulverise a machine and its fragments will continue to obey the laws of physics and chemistry. The wrecking of the operational structure does not affect these laws, for they apply to the material of the machine in itself even when split into isolated bits of matter.

A machine or a living being functioning like a machine can be said therefore to comprise two levels. There is an upper comprehensive level, controlled by certain structural and operational principles. The lower level is formed as it were by the unorganised mass, the higher level by the principle that controls its organisation In other words, we have a lower level of isolated parts and a higher level of the functional whole formed by the parts. This higher level represents then the joint functions of the parts.

We see here the beginnings of a hierarchy in which the distinction between things essentially higher and essentially lower will be restored.[1]

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[1] The argument of this section was first developed in this form in "Tacit Knowing: Its Bearing on Some Problems of Philosophy," Reviews of Modern Physics (Vol. 34, 1962, pp. 601-615).

We can find reproduced the two-leveled structure of machines - and of living beings working like machines - in the playing of a game of chess. The conduct of such a game is an entity controlled by a stratagem and the stratagem relies on the observance of the rules of chess. This relation does not hold in reverse, for the rules of chess leave open an infinite range of stratagems. Moves of chess are therefore meaningless by themselves and their meaning lies in serving jointly the performance of a stratagem.

An intellectual skill can comprise a number of levels in the form of a hierarchy. The production of a literary composition, for example of a speech, includes five levels. The first level, lowest of all, is the production of a voice; the second, the utterance of words; the third, the joining of words to make sentences the fourth, the working of sentences into a style; the fifth, and highest, the composition of the text.

The principles of each level operate under the control of the next higher level. The voice you produce is shaped into words by a vocabulary; a given vocabulary is shaped into sentences in accordance with a grammar; and the sentences are fitted into a style, which in its turn is made to convey the ideas of the composition. Thus each level is subject to dual control; first, by the laws that apply to its elements in themselves, and second, by the laws that control the comprehensive entity formed by them.

Such multiple control is made possible here once more by the fact that the principles governing the isolated particulars of a lower level leave indeterminate their boundary conditions, to be controlled by a higher principle. Voice production leaves largely open

the combination of sounds into words, which is controlled by a vocabulary. Next, a vocabulary leaves largely open the combination of words to form sentences, which is controlled by grammar; and so the sequence goes on. Consequently, the operations of a higher level cannot be accounted for by the laws governing its particulars forming the next lower level. You cannot derive a vocabulary from phonetics; you cannot derive grammar from a vocabulary; a correct use of grammar does not account for good style; and a good style does not supply the content of a piece of prose.

This brings us to the most important application of this principle, which is the life of plants, animals and men. But I shall only give here a rough outline of the hierarchy which constitutes a human being. The lowest level is controlled by the laws of inanimate nature and the higher levels control throughout the boundary conditions left open by the laws of the inanimate. The lowest functions of life are those called vegetative; these vegetative functions sustaining life at its lowest level, leave open - both in plants and animals - the higher functions of growth and leave open in animals also the operations of muscular action; next in turn, the principles governing muscular action in animals leave open the integration of such action to innate or predisposed systems of behaviour; and again such primitive behaviour is open in its turn to be shaped by intelligence; while the working of intelligence itself can be made to serve in man the still higher principles of responsible choice.

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Let me now approach the structure of consecutive levels from a different view to which my last three lectures have prepared us. I shall show that the stratification of reality by successive stages

of boundary control can be known by tacit integration and I shall show also that the tacit knowing of a stratified system reproduces the fact that the operations of a higher level cannot be accounted for by the laws governing the particulars of the next lower system. The higher level vanishes the moment our attention is directed to the lower one.

I shall take as my example the two-levelled system of a machine, the characteristic relationships of which I have listed on the blackboard. To have something concrete in mind, think of things like a bicycle, a can opener, a watch, a yale lock or an aeroplane. We can know a machine at a variety of stages. We can invent it; or if it is already invented, we can use it. We may come across objects known to be parts of a machine, and guess how they are to be combined to function together; or else we may find an object presumed to be some kind of machine and guess what it is for. And finally, as a student of engineering, we may be shown a machine functioning smoothly and have to find out how it works. All these occasions of arriving at the knowledge of a machine, are guided by the imagination thrusting forward to the aim which the imagination is to perform. We invent a machine by focussing our imagination on a novel achievement surmised to be feasible, for this evokes the idea of suitable parts controlled by an apposite operational principle. We use a machine by relying on its parts for achieving their joint purpose and it is on this purpose that we focus our action. Our imagination must roam over all possible uses to which a heap of apparently related pieces can be put, if we are to guess how they function together. Only by exploring in our imagination the possible uses of a strange object presumed to be a

machine, can we discover what it is for. And finally, the student of engineering can arrive at an understanding of a machine only by testing its parts with a view to their possible contribution to the performance of the machine; he too must have the machine as a whole at the focus of his attention.

Remember then the way the thrust of the imagination is related to that which implements its purpose. It is the relation of the focal to the subsidiaries. We know a machine by focussing on its performance while relying on our awareness of the physical processes which serve to implement it.

Switch now your attention to these physical laws. Explore the physical chemical topography of a machine however meticulously. It will leave you totally ignorant of its operational principle and will fail to reveal the very fact of its existence. Any study of the lower principles controlling the subsidiaries of a comprehensive entity, is meaningless unless it is conducted with a bearing on the way the lower principles serve the higher principles; only when something goes wrong, a boiler bursts or a train derails, is this event to be accounted for by the workings of physics or chemistry which have escaped the restrictions that the higher principles of the machine should impose on its lower principles.

But I am afraid you may feel that I have rushed you into this conclusion without having properly linked it to its antecedents. In my second lecture I spoke of two levels of awareness, the subsidiar and the focal, the subsidiary bearing on the focal, by an act of tacit integration. This framework applied to a finger pointing at an object or a name designating a person, or at a probe exploring a cavity; we saw clues to perception and clues to discovery, features forming a

physiognomy and motions combined to a skilled action; we had also the case of two stereo-pictures fused to a spacial vision.

This has established the structure of tacit knowledge, and we nailed this result firmly down by the experimental evidence of subception. But the vectorial character of tacit knowing was most fully confirmed by observing that when we turn our attention on the subsidiaries their function and meaning disappears and the appearance which expressed this meaning is lost. I called this the logical disintegration of tacit knowledge.

And now, quite independently, we have hit upon the existence of consecutive levels of reality, which can build up a whole hierarchy of successive, irreducible levels. Looking then at one such pair of levels, we have realised that we know a lower level subsidiarily with a bearing on the upper level. Or more precisely, we know a dually controlled system by focussing our attention on the upper principle as it relies on the workings of the lower principle of which we are subsidiarily aware. Switch our focal attention on these lower workings, and their integrated function is lost from sight and the dual system disappears.

We can pick up then also the thread left loose at the end of my second lecture when I identified subsidiary awareness with the type of consciousness we have of our own body and spoke in this sense of tacit awareness as a manner of indwelling. All tacit knowledge can be regarded as an indwelling, but only the tacit knowledge of a system that firmly hangs together can be readily experienced as an indwelling. Some cases that I had listed before, like the exercise of a skill or the features forming a physiognomy, can be obviously

experienced as such. But the major examples, that I only briefly mentioned, are the comprehensive entities studied by morphology, physiology and psychology. These are the living entities that I have described today as a hierarchy of irreducible levels. And we can add now that we dwell in this hierarchy of levels in a sequence of subsidiary awarenesses, each of which bears on a next higher level of awareness, closer to the focus of our attention that is addressed to the entity as a whole.

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Polemical Section

But I must turn aside now to face the array of defenses which guard today the view that all things whatsoever are intelligible ultimately in terms of the laws ruling the ultimate particles of matter. I propose to show you that the defense of this view consists predominantly in ignoring the objections against it, however obvious they may be.

I have said that a Laplacean topography cannot tell us the temperature of any place in the world. Let me explain this. It is obvious that a well shuffled pack of cards ceases to random if you manage to peep at their faces and memorise their sequence. It is equally obvious therefore that a random collocation of atoms looses its randomness, if you follow Laplace and establish the atomic topography of the system. The probability of the system's configuration is then equal to one, its entropy is zero and the fundamental laws of thermodynamics, comprising all physical chemistry, are absent. I have published this fact, duly expressed in mathematical terms nearly eight years ago in Personal Knowledge on page 391, (I got the deduction from Wigner, who himself could not remember where he got it

from, so it appears that I shall have to figure for posterity as its author). Since then I have repeatedly referred to the fact that the Laplacean image fails to account for the basic laws of physics, but nobody has yet commented on this.

We must ask why this obvious fact has never been told by somebody else in public before. Why is it not a commonplace? Why no one responds to my statement of it? the reason is perhaps that the fact is thought to be inexplicable and hence unprofitable. I myself cannot either give an explanation for this fact, but it does show to me the absurdity of the Laplaceian Universal Knowledge, and it also presents in my view the first in a sequence of other gaps in the Laplaceian universe: gaps which comprise almost everything that is of interest to us in this world.

Let me next pass on then to this sequence of missing principles and observe the strange fact that for centuries on end it was the representation of living beings as machines, that has been regarded as equivalent to the denial of any such higher principles. Machinelike explanations of life were advanced as demonstratin the fact that life is controlled by the inanimate laws of nature and were rejected by those who upheld the presence of higher principles in living beings.

Since the seventeenth century some opponents of the Galilean world view have contested the possibility of representing living beings as machines. In his book on Science and Religion (1951) Charles E. Raven tells us how in the 1690's writers like the Neo-Platonist Cudworth and the great naturalist John Ray, attacked mechanism as a doctrine explaining life in terms of mere inanimate matter in motion.

And look at the other end of the story, three hundred years later. About the turn of the last century an important minority of biologists has arisen, who deny the possibility of representing all living functions by mechanisms of the kind known to engineering and technology. The non-machine-like processes of life which they postulate, have since been called organismic. Such organismic processes are found at work in regeneration, and are most strikingly demonstrated by the embryonic regeneration of the sea urchin discovered by Hans Driesch. Driesch found that throughout the gastrula stage any cell or combination of cells detached from the embryo regenerates the whole embryo. He called this a 'harmonious equipotential' system.

Throughout the subsequent controversy between the scientists who supported the organismic view and the predominant school who defended a mechanistic explanation of life, it was taken for granted that the issue between the two camps was whether living beings could be represented or not by the laws of inanimate nature - whereas in my opinion both sides equally excluded the representation of life in terms of these laws, whether the process was mechanical or organismic.

It is uncomfortable to oppose a fundamental conception that has been current for centuries and still continues to be accepted among philosophers and scientists everywhere today. Professor Nagel extensively discussed in his book The Structure of Science (1961), whether living beings can be explained without referring to the purpos of their organs and of the functions of these organs. He rightly thinks that if living beings would have to be necessarily described in teleological terms, this would show that they cannot be explained exclusively in physicho-chemical terms. But he does not raise explicitly the question, whether machines themselves can in general

be so explained; he takes it implicitly for granted, that they can be so explained.*

It is difficult to argue with a tacit assumption, but Nagel does offer a general proposition to which I can address myself. His critique of biological systems is directed to proving that the functions of living things can be defined as mere events taking place without teleological significance; for it is the presence of purposive action that he rightly recognises as the sign of a nonphysical factor in a living mechanism. Let me point out therefore that the achievement of a purpose is an indispensable aspect of a machinery. I have defined a watch earlier on by the fact that it tells the time, while being kept going by the mainspring uncoiling under the control of the hair spring and balance wheel. Since I first wrote down this definition of a watch which I retained in this talk, I first came across watches in which the mainspring was replaced by a tiny electri battery; then I met another watch in which there was neither hair spring nor balance wheel, both being replaced by a piezo-electric crystal, that keeps time far more accurately; but I have not come across a watch that does not tell the time, nor do I ever expect to find one, for this purpose is the defining characteristic of a watch.

There are still inhabitants deep in the forests of Brazil, who have never seen a watch. Equip them with a complete physical chemical topography of a watch; but not until they discover for themselves that it tells the time, will they know that it is a watch

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* Commenting on self regulating physical systems, Nagel writes (p. 41 that the "fact [of their existence] offers strong support for the presumption that the teleologically organized activities of living organisms and of their parts can be analyzed without requiring the postulation of purposes or goals as dynamic agents." He takes it for gran here that self regulating physical systems can be analyzed in nonteleological terms, and this he regards throughout not without reason, as the token for the possibility of interpreting the system wholly in physical chemical terms.

will they understand what a watch is. Some months ago I brought home from America to Oxford a gadget which I had picked up without knowing what it was for. All the analytical laboratories of England could not tell my wife and me that it was an instrument for making simultaneously two holes in a can of beer; this was its purpose and this its meaning. A textbook of engineering which would teach the structure and operations of technical equipments without revealing their purpose, would be teaching the structure of meaningless objects that are producing meaningless results.

Let me say this again. The purpose of a machine is the focus of tacit integration at which its inventor aimed, and aiming at which, he evoked subsidiarily the elements which eventually placed the machine in the service of its purpose. And as he invented it so must it be understood; the learner's attention, focussed on its purpose must reveal subsidiarily the appropriate elements and operations which serve this purpose.

And I will add a new points to this. Both the invention of a machine and the understanding of it is expressed in a general principle that must be stated in terms of engineering, that is in referring to functional parts like wheel, screws, pistons, levers, etc. and of technical performances, like cutting, grinding, digging, signaling or any kind of manufacturing. If you want the protection of a patent you must limit yourself in your description of your invention to the bare minimum of physical chemical detail. Nothing must be said about the material of the machine, of its size or shape that is not strictly required for embodying the principle of your invention. Thus only will you cover the entire class of machines represented by your ideas and acquire complete protection for the whole class. Far from being

defined in terms of physics and chemistry, the invention will be defined primarily in terms of engineering and refer only secondarily to few, often trivial, physical or chemical facts as necessary requirements of its performance. The vast majority of physical chemical particulars will be left open over an indefinite range of immense variety. They will all function as subsidiaries to the boundary controlling principle which they may possibly embody.

The same can be shown to hold for the organs and functions of an organism, in opposition to Professor Nagel. His main line of thought is to show that we can denote a set of elements and events at a certain time in an organism and then denote likewise a certain set of events caused by these antecedents. He says that we can define in these terms what is usually described as a living function, without saying that it proceeds with the purpose of serving the organism. Nagel does not contest that the process in question may benefit the organism and fully agrees that we should say this to happen, but insists that we can affirm this without saying that it happens for the benefit of the organism. And he claims that once we have thus translated a teleological explanation into a non-teleological one, the living organism can be explained in exclusively physico-chemical terms.

My answer to this is in the first place that Nagel talks in physiological terms, namely organs and functions, not asking on what grounds and by what operation these entities have been integrated from data of physics and chemistry. Breathing, feeding, drinking, digesting, defecation, urination, copulating, child bearing, sleeping and waking, and even the circulation of the blood were observed without any but trivial references to physics and chemistry. Aristotle

explored large areas of biology without physics and chemistry. And above all, life itself has been known, as distinct from death and from stones and stars, as one comprehensive entity, from immemorial times, all the way back even by our animal ancestors.

We have here a series of comprehensive entities, established by tacit integration. Their particulars are largely unspecifiable, but we recognise their joint meaning. The organism itself, comprising all other organs which function in it, has the appearance of being alive and its organs appear to function in serving its life. Only by focussing our attention on the living organism can we recognise in it the functions of its organs and this is how we understand them. Since the time that physics and chemistry was developed, biology has made great progress in observing in what way the functions of living beings rely on the laws of physics and chemistry. But the physical chemical study of living organisms remains of no interest to biology unless it bears on the physiological functions which sustain life.

I shall look now once more at the argument of Professor Nagel, expressing it in my own way. It amounts to this. Instead of observing that shortage of oxygen will cause us to expand our chest <u>in order to</u> draw breath needed for life, we can say that when shortage of oxygen causes us to expand our chest, air flows into our lungs and sustains life. In this way we can transform the teleological formulation of organic functions into descriptive statements and biology can then be explained exclusively in physico chemical terms.

But the change from a teleological to a descriptive account has taken place within the physiological framework and no evidence ha

been produced that this framework can be replaced by statements made in terms of physics and chemistry. It must be held therefore to be as impossible as before. By denoting for example a state of oxygen shortage by a set of state variables and describing the consequent drawing in of breath, by an algebraic symbol, Professor Nagel has merely paraphrased physiology in terms somewhat resembling the laws of physics and chemistry. What his symbols stand for is still physiology.

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Such seeming transposition of higher principles into the laws of inanimate nature is widespread; it has indeed analogies throughout our culture. But at this point I shall remain with the scientific study of life. The most massive proof of the fact that life transcends inanimate nature consists in the consciousness of man and this fact has been therefore an embarrassment to modern psychology Consciousness, we are taught, is not a tangible fact and we must hesitate therefore to attribute consciousness to any living being, animal or man. It would seem impossible that neuro-physiologists, let alone psychologists, should deny the existence of consciousness which is a major part of their subject matter. Can one study perception without referring to what people see? Or the localisation of emotional centres in the brain, without referring to what the subject feels? Yet a distinguished neuro-physiologist like O. Hebb has urged scientists to assume that consciousness does not exist, even though such a hypothesis might eventually prove false. Nor is this an isolated instance. The psychiatrist, L. S. Kubie, speaking

on the same scientific occasion*, declared that a "working concept" of consciousness was indispensable to psychology, and went on to say:

> sometimes we are explicit and frank about this. Sometimes we fool ourselves about it. Many workers have attempted to avoid using the word because of its traditional connotations, which have had a somewhat mystical, imponderable, non-scientific, philosophic and/or theological flavour....

Kubie's words show what is happening here. Scientists who urge us to assume that consciousness does not exist do not believe this themselves. It would be absurd to suppose that Hebb wants neuro-physiologists to assume that all their subjects are unconscious. He merely wants them to describe their findings as if consciousness did not exist.

This is the programme of behaviourism. It sets out, for example, to eliminate all references to the human mind, by substituting for the mind the sound of human speech when telling about a state of mind. Such an enquiry refuses to observe that a man is in pain and it can acknowledge only that he complains of pain. The fact that this view wipes out the purpose of medicine - as the alleviator of human suffering - is disregarded. Behaviourism could describe medicine only as a process for eliminating complaints of pain, even though complaints can be more effectively silenced without medicine. The very conception of compassion is denied and torture is theoretically given free rein.

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* I am referring here to the contributions made by O. Hebb and L. S. Kubie to the Symposium on Brain Mechanism and Consciousness held in Quebec in August, 1953; see report ed. J. F. Delafrayne (Oxford: Blackwells, 1954).

None of this is intended, or even remotely approved, by behaviourists, who call in question the existence of consciousness. It is clear, therefore, that they do not mean what they say when urging us to doubt or disregard or at least avoid mentioning the existence of consciousness. This is what Kubie calls fooling ourselves.

It would seem that after three centuries of triumphs achieved in the belief that all manner of things are determined by the laws of inanimate matter, scientists would prefer to engage in any kind of ambiguity rather than admit that there are other principles at work in nature, apart from the laws of inanimate nature.