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Definida como a "ciência do controle e da comunicação, no animal e na máquina" por Nobert Wiener, a peculiaridade desta teoria é a nova forma como encara assuntos ou temas de um novo e não usual ângulo.

Seu interesse não está em saber do que é formado, por exemplo, as máquinas, mas sim em como elas funcionam, de que maneira se comportam.

[pág. 01]

Cybernetics was defined by Wiener as "the science of control and communication, in the animal and the machine"—in a word, as the art of steermanship, and it is to this aspect that the book will be addressed. Co-ordination, regulation and control will be its themes, for these are of the greatest biological and practical interest. We must, therefore, make a study of mechanism; but some introduction is advisable, for cybernetics treats the subject from a new, and therefore unusual, angle. Without introduction, Chapter 2 might well seem to be seriously at fault. The new point of view should be clearly understood, for any unconscious vacillation between the old and the new is apt to lead to confusion.

1/2. The peculiarities of cybernetics.

Many a book has borne the title "Theory of Machines", but it usually contains information about mechanical things, about levers and cogs. Cybernetics, too, is a "theory of machines", but it treats, not things but ways of behaving. It does not ask "what is this thing?" but " what does it do?"

Thus it is very interested in such a statement as "this variable is undergoing a simple harmonic oscillation", and is much less concerned with whether the variable is the position of a point on a wheel, or a potential in an electric circuit. It is thus essentially functional and behaviouristic.

Cybernetics started by being closely associated in many ways with physics, but it depends in no essential way on the laws of physics or on the properties of matter. Cybernetics deals with all forms of behaviour in so far as they are regular, or determinate, or reproducible. The materiality is irrelevant, and so is the holding or not of the ordinary laws of physics. (The example given in S.4/15 will make this statement clear.)

The truths of cybernetics are not conditional on their being derived from some other branch of science. Cybernetics has its own foundations. It is partly the aim of this book to display them clearly.

1/3.
Cybernetics stands to the real machine—electronic, mechanical, neural, or economic—much as geometry stands to a real object in our terrestrial space. There was a time when "geometry" meant such relationships as could be demonstrated on three-dimensional objects or in two-dimensional diagrams. The forms provided by the earth—animal, vegetable, and mineral—were larger in number and richer in properties than could be provided by elementary geometry. In those days a form which was suggested by geometry but which could not be demonstrated in ordinary space was suspect or inacceptable. Ordinary space *dominated* geometry.

Today the position is quite different. Geometry exists in its own right, and by its own strength. It can now treat accurately and coherently a range of forms and spaces that far exceeds anything that terrestrial space can provide. Today it is geometry that contains the terrestrial forms, and not vice versa, for the terrestrial forms are merely special cases in an all-embracing geometry.

The gain achieved by geometry's development hardly needs to be pointed out. Geometry now acts as a framework on which all terrestrial forms can find their natural place, with the relations between the various forms readily appreciable. With this increased understanding goes a correspondingly increased power of control.

Cybernetics is similar in its relation to the actual machine. It takes as its subject-matter the domain of "all possible machines", and is only secondarily interested if informed that some of them have not yet been made, either by Man or by Nature. What cybernetics offers is the framework on which all individual machines may be ordered, related and understood.

1/4. Cybernetics, then, is indifferent to the criticism that some of the machines it considers are not represented among the machines found among us. In this it follows the path already followed with obvious success by mathematical physics. This science has long given prominence to the study of systems that are well known to be non-existent—springs without mass, particles that have mass but no volume, gases that behave perfectly, and so on. To say that these entities do not exist is true; but their non-existence does not mean that mathematical physics is mere fantasy; nor does it make the physicist throw away his treatise on the Theory of the Massless Spring, for this theory is invaluable to him in his practical work. The fact is that the massless spring, though it has no physical representation, has certain properties that make it of the highest importance to him if he is to understand a system even as simple as a watch.

[...] In keeping with this method, which works primarily with the comprehensive and general, cybernetics typically treats any given, particular**,** machine by asking not "what individual act will it produce here and now?" but "what are *all* the possible behaviours that it can produce?"

It is in this way that information theory comes to play an essential part in the subject; for information theory is characterised essentially by its dealing always with a *set*of possibilities; both its primary data and its final statements are almost always about the set as such, and not about some individual element in the set. This new point of view leads to the consideration of new types of problem.

The older point of view saw, say, an ovum grow into a rabbit and asked "why does it do this"—why does it not just stay an ovum?" The attempts to answer this question led to the study of energetics and to the Discovery of many reasons why the ovum should change—it can oxidise its fat, and fat provides free energy; it has phosphorylating enzymes, and can pass its metabolises around a Krebs' cycle; and so on. In these studies the concept of energy was fundamental.

Quite different, though equally valid, is the point of view of cybernetics. It takes for granted that the ovum has abundant free energy, and that it is so delicately poised metabolically as to be, in a sense, explosive. Growth of some form there will be; cybernetics asks "why should the changes be to the rabbit-form, and not to a dog-form, a fish-form, or even to a teratoma-form?" Cybernetics envisages a set of possibilities much wider than the actual, and then asks why the particular case should conform to its usual particular restriction. In this discussion, questions of energy play almost no part—the energy is simply taken for granted. Even whether the system is closed to energy or open is often irrelevant; what *is* important is the extent to which the system is subject to determining and controlling factors. So no information or signal or determining factor may pass from part to part without its being recorded as a significant event. Cybernetics might, in fact, be defined as the study of systems that are open to energy but closed to information and control— systems that are "information-tight" (S.9/19.).

1/6.

The uses of cybernetics.

After this bird's-eye view of cybernetics we can turn to consider some of the ways in which it promises to be of assistance. I shall confine my attention to the applications that promise most in the biological sciences. [...]

The subject is returned to in S.6/8. Here I need only mention the fact that cybernetics is likely to reveal a great number of interesting and suggestive parallelisms between machine and brain and society. And it can provide the common language by which discoveries in one branch can readily be made use of in the others.

[...] Cybernetics offers the hope of providing effective methods for the study, and control, of systems that are intrinsically extremely complex. It will do this by first marking out what is achievable (for probably many of the investigations of the past attempted the impossible), and then providing generalised strategies, of demonstrable value, that can be used uniformly in a variety of special cases. In this way it offers the hope of providing the essential methods by which to attack the ills—psychological, social, economic— which at present are defeating us by their intrinsic complexity.

Part III of this book does not pretend to offer such methods perfected, but it attempts to offer a foundation on which such methods can be constructed, and a start in the right direction.