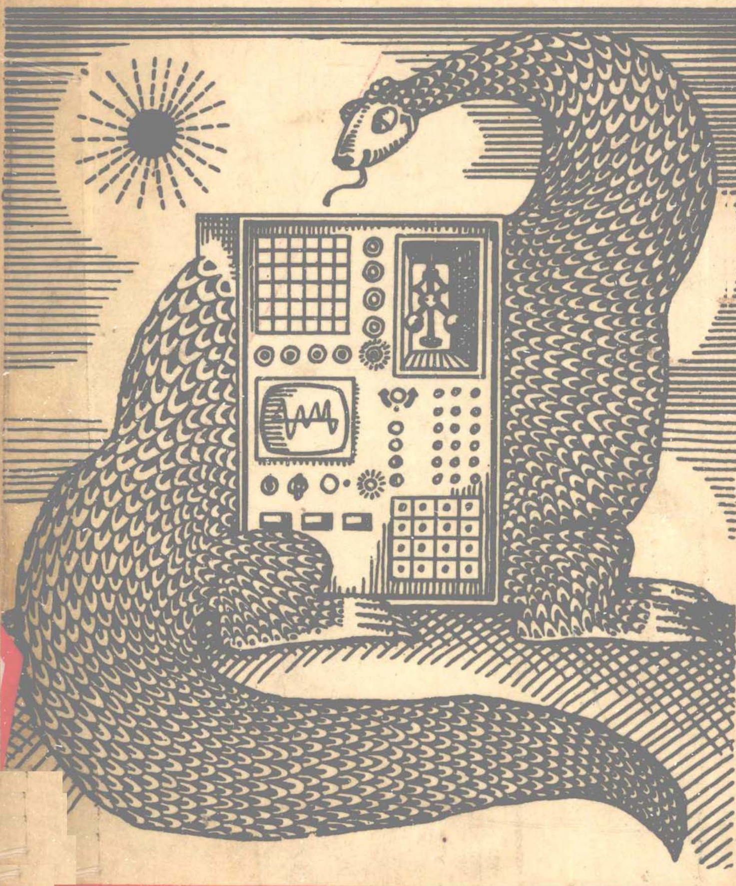
Yelena Saparina



Cybernetics Within Us

Yelena Saparina

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Translated from the Russian by VLADIMIR TALMY

PEACE PUBLISHERS MOSCOW

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КИБЕРНЕТИКА ВНУТРИ НАС

ИЗДАТЕЛЬСТВО ЦК ВЛКСМ
«МОЛОДАЯ ГВАРДИЯ»

На английском языке

Yelena Saparina

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Can a rat tell the difference between a Raphael Madonna and a Picasso Girl in Blue? Would a Martian (if there is such a thing) recognize a live cat after having seen a photograph of one? Can a "seeing" electronic machine be made to tell a cat from a dog or an A from a B? How would it go about "computing" the image? And is "machine thinking" anything like human thinking?

These and other such problems are investigated in the branch of cybernetics that studies living systems: bionics, as this ultramodern science is now called. It developed when scientists began to compare the design and operation of electronic systems with living organisms. Our body, they found, is a complex cybernetic system controlled by countless self-regulating devices. In fact, every single cell of our body is an automatic control device in its own right. Millions upon millions of tiny cybernetic units are constantly at work within us. They maintain normal blood pressure, control the composition of the gastric juices, ensure the rhythmic contraction of the heart and lungs, and do a thousand other things that come under the heading of "vital functions" of the organism.

How they work and how our body functions is described in this popular exposition, which requires no previous knowledge of cybernetics, biology, electronics, or any other subject for that matter (except reading, of course).

AUTHOR'S PREFACE

Cybernetics is said to have emerged at the confluence of at least five sciences: automatic control, mathematics, logic, biology, and communication theory. This may be the reason why to this day new definitions of cybernetics are still being suggested in an effort to reflect all aspects of this versatile science. Academician Berg once joked that he knew at least two score such definitions, and that he had probably not yet heard the last of it.

In preparing this book I interviewed many scientists, young and old, and each had his or her own ideas on the scope and content of cybernetics. There were those who would discuss their work for hours on end and those who preferred to escape to their laboratories with a perfunctory apology, enthusiasts of the new science and wary sceptics, different people with opposing views and ideas about the same problems.

It is this diversity of opinions and approaches that makes it very hard for the uninitiated to get a clear understanding of cybernetics. At last you seem to have understood a problem, then you arrive at another laboratory and find with dismay that the workers there tackle the selfsame problem from an entirely different aspect. And it's no use trying to determine who is right; the science is still young and therefore controversial. Furthermore, many people draw a line between engineering cybernetics and biological cybernetics.

The latter, the cybernetics "within" us, can be said to have been born twice. Millions of years ago nature built into living organisms a perfect automatic system with a remarkable control unit—the brain—joined by nerves to all parts of the body. Then the time came when the human brain invented self-regulating systems, without suspecting that it had actually produced a remote analogue of the wonderful control mechanisms inside the living body. Only after cybernetic machines became a fact did it occur to physiologists that living organisms might be controlled by something like these devices.

Thus cybernetics, which developed from a comparative study of machines and living organisms, returned to biology, remaining at the same time in the engineering domain. In short, as someone once remarked, cybernetics is a science in which the physiologists tell engineers how to build machines, and engineers tell physiologists how life works. Whenever people discuss cybernetics they inevitably arrive at the crucial question: Will machines ever get so "clever" as to learn to "think"?

I, too, could not evade that question, although, as you will see, I put off answering it to the very end. In fact, I didn't answer it at all: I have given the facts and leave the answer to you.

I have undertaken to be your guide in a rather unusual journey through books, research institutes, laboratories and lectures. You may find some things amusing and some doubtful. My only hope is that you will not find them boring. And finally, I am a juornalist not a scientist. This, however, might not be so bad: at least you will be seeing things through the eyes of a layman.

BY WAY OF AN INTRODUCTION

The past decade or so has seen the rapid advance of cybernetics, a new science concerned with the study of control and communication.

The science of control covers three main spheres: control of machine systems and manufacturing processes; control of organized human activity, such as finance, insurance, commerce or transport; and control of processes in living organisms. To the latter belong the physiological, biochemical and biophysical processes associated with the vital functions of the organism whose purpose is to ensure its survival in an overchanging environment.

Modern instruments and means of gathering, storing and processing information about the intricate structure and functioning of living organisms have opened up remarkable vistas to biology. The close co-operation of electronics experts, mathematicians and biologists is yielding important theoretical and practical results of increasing value.

Scientists are penetrating deeper and deeper into the most complex laws of living nature. Electronic diagnosing machines are coming into use in the medical profession. Devices have been built that can substitute for the heart, lungs or kidneys during an operation, thus greatly facilitating the work of surgeons. Broad prospects are opening up in the study of higher nervous activity.

The approach to the study of physiological phenomena in which the various systems of the organism and the factors affecting it are artificially separated and examined individually cannot be used to investigate the laws governing the functioning of the organism as a whole. The properties of individual nerve cells could be, and have been, studied in great detail. It is impossible, however, to derive directly from the properties of individual cells such complex aspects of cerebral activity as thinking and speech.

For the physiologist the attraction of cybernetics consists in that it deals with complex systems, physiological systems included, and the laws governing their operation.

When designing electronic machines, man learns from nature, just as he learned from her in developing his first simple tools, which were "extensions" of his limbs. The brain, of course, is immeasurably more complex than arms or legs, and in many respects it is the as yet unattainable ideal of the engineer. In spite of its compactness, light weight and negligible power consumption, it is an extremely reliable system with a substantial safety margin.

On the other hand, the brain is rather slow, its memory is not too good, it often forgets important things, and it succumbs to fatigue and malnutrition. The brain is an extremely delicate piece of machinery that must be carefully protected from jars and jolts. It also undergoes pathological changes due to disease and ageing.

In endowing electronic machines with some of the brain's simpler functions the engineer seeks to make good some of its shortcomings. The greatest gain in this respect has been in speed. Machines, however, are far inferior to the brain in reliability, and maintenance is a serious problem in itself.

The question naturally arises whether it is possible to simulate the brain electronically, at least in part. One of the newest branches of cybernetics is called bionics, which deals with the development of electronic neuron analogues and their utilization in computing machines. The prospects of this new scientific discipline are exciting indeed.

The development of "learning" machines, which not only carry out the programmes built into them by their designers but also accumulate and utilize the results of subsequent experiences, has opened up a vista of remarkable possibilities. Work is at present being carried out on machines capable of interpreting speech, writing and visual images directly, and even of formulating concepts.

An increasingly important place among the cybernetic disciplines is occupied by "mathematical linguistics", a new branch in the science of language which is closely linked with the development of "machine" languages and the automation of translation from one language into another and the abstracting of scientific literature.

With cybernetics steadily invading all spheres of life, a popular exposition of its applications to medicine, physiology, psychology and linguistics is certainly welcome. Yelena Saparina has successfully coped with the difficult task of presenting complex problems in a simple and entertaining manner, and the reader will undoubtedly find much of interest in her book.

Alexander Berg,
Academy of Sciences of the U. S. S. R.

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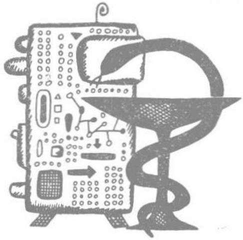

I. DISEASES OF MEN AND "DISEASES" OF MACHINES

Cybernetics and the Heart

Professor Nikolai Amosov, head of the Kiev Institute of Thoracic Surgery, was one of the first medical doctors to realize the need for surgeons to be good engineers as well.

"Cybernetic machines are essential in our work," he told me when I came to interview him at his institute in Kiev. "We have built several machines which we use in operations on the heart, lungs, and other organs."

Professor Amosov seemed quite at home with engineering terms, and I thought that he could hardly have discussed mechanical hardware with such ease if he were only a doctor.

"As a matter of fact," he told me, "at first I wanted to be an engineer and I joined the power engineering department of a polytechnical institute. But medicine also appealed to me, so I entered a medical college as well."

He was an inquisitive student and spent many days and nights over his books. As an engineering