Norbert Wiener

The child prodigy whose study of mathematics resulted in the birth of the science of cybernetics

Norbert Wiener was born in 1894 in Missouri, USA. After taking a degree in mathematics at the age of 14 and receiving a doctorate in logic at 18, he went to study with David Hilbert at Göttingen, Germany.

Wiener's contribution to computer science came late in his life. For many years he worked at the Massachusetts Institute of Technology, studying the new probabilistic physics, and concentrating on the statistical study of the motion of particles in a liquid (a phenomenon known as Brownian movement). The particle movements were so unpredictable that it was impossible to describe them using the traditional physics of deterministic forces. So a 'probabilistic' method, by which only the *probable* location of a particular particle at a given time could be predicted, was the best that could be applied.

When the Second World War broke out he offered his services to the US government and began work on the mathematical problems implicit in aiming a gun at a moving target. The development of automatic gunsight guidance systems, his studies in probabilistic physics and his broader interest in subjects ranging from philosophy to neurology all came together in 1948 when he published a book entitled *Cybernetics.*

Cybernetics is the study of the self-governing controls that are found in stable systems, be they mechanical, electrical or biological. It was Wiener who saw that information as a quantity was as important as energy or matter: copper wire, for example, can be studied for the energy it can transmit or the information it can communicate. The revolution that the computer promises is based in part on this idea: a shift in the source of power from the ownership of land, industry or business to the control of information. His contribution to computer science was not a piece of hardware but the creation of an intellectual environment in which computers and automata could be developed.

The word 'cybernetics' is derived from a Latin word meaning 'governor'. Wiener had studied the 'governor' of James Watt's steam engine, which automatically regulated the machine's speed, and he realised that for computers to develop they must be made to imitate the ability of human beings to regulate their own activities.

The thermostat in a house is an example of a control system. It regulates the heating according to fluctuations in temperature above or below an optimum level. A human is needed only to set this level. Wiener called this faculty for self-regulation and control 'negative feedback' — 'feedback' because the output of the system (the heat) affects the future behaviour of the system and 'negative' because the changes the thermostat brings about are made to restore the temperature to the one set.

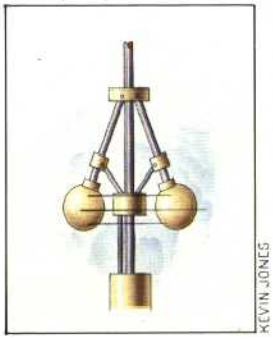
A system that can do this and also choose its own temperature (and other goals) is called a 'positive feedback' system. When an automaton can do all this and reproduce itself as well, then it approaches the human condition.

Wiener's theory of cybernetics could be regarded as a super science — a science of sciences — and it has encouraged research into many areas of control systems and systems that deal with information. Everything is information. What we know about the changes in the world comes to us through our eyes and ears and other sensory receivers, which are devices for selecting only certain data from a totality that would otherwise engulf us.

Information can also be studied in a statistical way, independent of any meaning it may have. For example, by observing the frequency with which certain symbols occur it is possible to break many types of codes. In the English language the letter 'e' occurs most often, and the letter 't' is the second most frequently used. By analysing large samples of a code and comparing the results with typical samples of English, it is possible to identify key letters and thus begin deciphering the code.

Wiener died in 1964, before the microcomputer revolution began, yet he foresaw and wrote about many of the problems that would arise in this new technology.

Speed Restriction
Wiener was fascinated by the idea of the steam governor — one of the best and simplest examples of negative feedback. Two weights are connected by pivoting arms to a spinning shaft, which is in turn connected to the flywheel of the steam engine. As the speed of the engine increases, the weights will fly outward. This movement, by means of a suitable linkage, shuts off the throttle of the engine slightly. This has the effect of stabilising the speed of the engine at any level set by the operator. Modern computers can implement far more sophisticated types of control, but the principle is still the same



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