Some Norbert Wiener "Firsts"

- **Mathematics**: "Wiener measure" (a.k.a. "Wiener space"), "Wiener process," "Wiener integral," "Wiener-Hopf Equations," "Paley-Wiener Theorems." Laid foundations of Modern Probability Theory.

- **Electrical Engineering**: In 1920s, produced first new mathematical theory for reducing noise in transmission of messages. Rewrote mathematical rules for technical analysis of electronic signals.

- **Information Theory**. Laid statistical foundations for Information Theory two decades before Shannon.

- <u>Computing</u>: In 1920s, worked with MIT's Vannevar Bush on design of first electrical analog computer. Designed and built prototype for first *optical* computer. In 1940, wrote proposal for first all-electronic, programmable, digital computer -- 5 years before von Neumann "architecture."

- <u>Automation</u>: During WWII, pioneered theory and design of first (*intelligent* 1/automated/ machine--) (2/fully/automated,) radar-guided fire controller and predictor for directing antiaircraft guns.
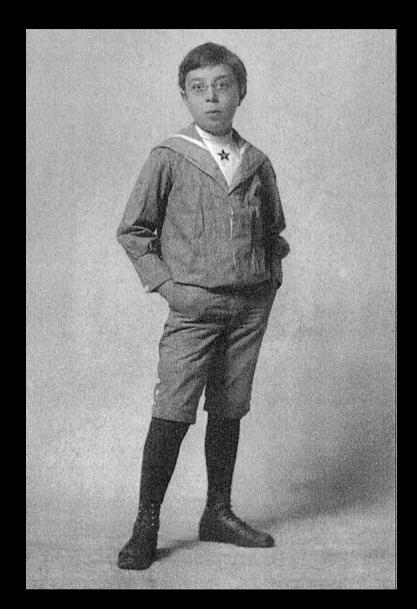
Cybernetics, 1948

- (Wiener's new) science of "communication and control in the animal and the machine" (-- "Big Bang" of the Information Age)

- Introduced terms "feedback" and "inforrmation" into popular vocabulary

- Described new "electronic brains," modeled on human brain and nervous system

- Voiced first warnings about human consequences of the new automated technologies and their "great possibilities for good and for evil"
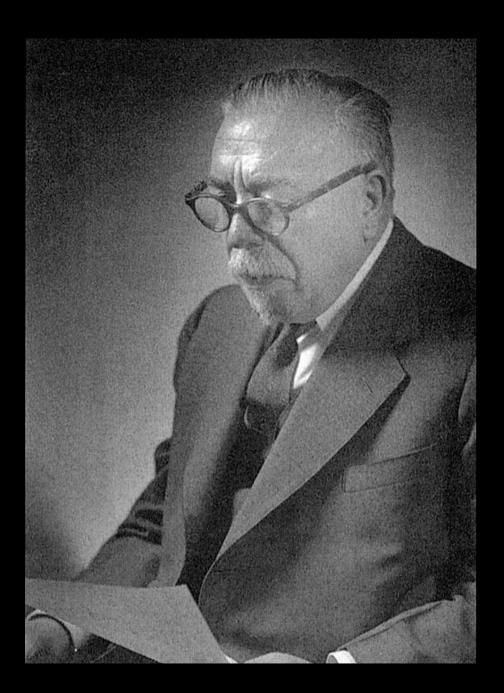
Wiener's Postwar Contributions/Firsts/Work

- Robotics: Worked with W. Grey Walter on first autonomous mobile robots. Built light-seeking "moth," light-shunning "bedbug," and "automated barfly."

- Bionics: Worked with Amar Bose on design of first bionic device – myoelectric prosthetic arm controlled by user's own thoughts.

- Man-Machine Systems: Called for "independent study of systems involving both human and mechanical elements."

- Technological Ethics: Launched/Began discussion (Father) of (new) (technological) ethics (of technology) for information age

Some Fields Spun-Off from and Influenced by Cybernetics

- Information Theory
- Artificial Intelligence
- Robotics
- Neural Network Theory & Cellular Automata
- Genetics & Molecular Biology
- Genetic Algorithms
- *Cybernétique Enzymatique* – Teleonomy (Fr.)
- Neuroscience & Endocrinology
- Cognitive Science & Humanistic Psychology
- Human Communication Research/Nonverbal Communication
  (group dynamics, kinesics, proxemics, paralinguisitcs, etc)
- Systems Theory
- Mathematical Modeling
- Complexity Theory & Chaos Theory
- Bionics, Bioinformatics (Biological Computation/Communications Biophysics)
- Modern Finance Theory (Wiener-Ito calculus)

"Information is information, not matter or energy. No materialism which does not admit this can survive at the present day."

—Norbert Wiener, *Cybernetics*

"The fate of information…is to become something which can be bought or sold….It is not my business to cavil whether this mercantile attitude is moral or immoral, crass or subtle. It is my business to show that it leads to the misunderstanding and the mistreatment of information and its associated concepts."

—Norbert Wiener, *The Human Use of Human Beings*

"Those of us who have contributed to the new science of cybernetics…stand in a moral position which is…not very comfortable. We have contributed to the initiation of a new science which…embraces technical developments with great possibilities for good and for evil. We can only hand it over into the world that exists about us, and this is the world of Belsen and Hiroshima . . . .

"….We do not even have the choice of suppressing these new technical developments. They belong to the age, and the most any of us can do by suppression is to put the development of the subject into the hands of the most irresponsible and most venal of our engineers. The best we can do is to see that a large public understands the trend and the bearing of the present work, and to confine our personal efforts to those fields…most remote from war and exploitation."

—Norbert Wiener, *Cybernetics*

"I…see no reason to turn over to any person, whether he be an army officer or the kept scientist of a great corporation, any results which I obtain if I think they are not going to be used for the best interests of science and of humanity."

—Norbert Wiener, 1947

"The automatic factory and the assembly line without human agents…gives the human race a new and most effective collection of mechanical slaves to perform its labor….However, *any labor that accepts the conditions of competition with slave labor accepts the conditions of slave labor, and is essentially slave labor.*"

—Norbert Wiener, *Cybernetics*

"It is perfectly clear that [automation] will produce an unemployment situation, in comparison with which…the depression of the [nineteen] thirties will seem a pleasant joke. This depression will ruin many industries--possibly even the industries which have taken advantage of the new potentialities.…"

"Thus the new industrial revolution is a two-edged sword. It may be used for the benefit of humanity, but only if humanity survives long enough to enter a period in which such a benefit is possible. It may also be used to destroy humanity, and if it is not used intelligently it can go very far in that direction."

—Norbert Wiener, *The Human Use of Human Beings*

"The magic of automation [is] literal-minded….A goal-seeking mechanism will not necessarily seek *our* goals unless we design it for that purpose, and in that designing we must foresee all steps of the process for which it is designed....The penalties for errors of foresight, great as they are now, will be enormously increased as automatization comes into its full use."

—Norbert Wiener, *God & Golem, Inc.*

"It may very well be a good thing for humanity to have the machine remove from it the need of menial and disagreeable tasks, or it may not. I do not know. [But] it cannot be good for these new potentialities to be assessed in the terms of the market, of the money they save….*The answer, of course, is to have a society based on human values other than buying or selling….*To arrive at this society, we need a good deal of planning and a good deal of struggle."

—Norbert Wiener, *Cybernetics*

"The [automatic machine] is not frightening because of any danger that it may achieve autonomous control over humanity….Its real danger…is…that such machines, though helpless by themselves, may be used by a human being or a block of human beings to increase their control over the rest of the human race…."

"…or that political leaders may attempt to control their populations by means not of machines themselves but through political techniques as narrow and indifferent to human possibility as if they had, in fact, been conceived mechanically."

—Norbert Wiener, *The Human Use of Human Beings*

"When a *djinee* is found in a bottle, it had better be left there….If you are given three wishes, you must be very careful what you wish for."

—Norbert Wiener, *The Human Use of Human Beings*

"Any machine constructed for the purpose of making decisions, if it does not possess the power of learning, will be completely literal-minded. Woe to us if we let it decide our conduct, unless we have previously examined the laws of its action, and know fully that its conduct will be carried out on principles acceptable to us…."

"The machine like the *djinee*… will in no way be obliged to make such decisions as we should have made, or will be acceptable to us. *For the man who is not aware of this, to throw the problem of his responsibility on the machine…is to cast his responsibility to the winds, and to find it coming back seated on the whirlwind.*"

—Norbert Wiener, *The Human Use of Human Beings*

No person should "calmly transfer to the machine made in his own image the responsibility for his choice of good and evil, without continuing to accept a full responsibility for that choice."

—Norbert Wiener, *The Human Use of Human Beings*

"Of the devoted priests of power, there are many who regard with impatience the limitations of mankind, and in particular the limitation consisting in man's undependability and unpredictability….In addition to the motive which the gadget worshiper finds for his admiration of the machine in its freedom from the human limitations of speed and accuracy there is one motive...which must play a very considerable role nevertheless. It is the desire to avoid the personal responsibility for a dangerous or disastrous decision by placing the responsibility elsewhere: on chance, on human superiors and their policies which one cannot question, or on a mechanical device which one cannot fully understand but which has a presumed objectivity."

—Norbert Wiener, *"God & Golem, Inc.*

"When human atoms are knit into an organization in which they are used, not in their full right as responsible human beings, but as cogs and levers and rods, it matters little that their raw material is flesh and blood. *What is used as an element in a machine, is in fact an element in the machine*. Whether we entrust our decisions to machines of metal, or to those machines of flesh and blood which are bureaus and vast laboratories and armies and corporations, we shall never receive the right answer to our questions."

—Norbert Wiener, *The Human Use of Human Beings*

"It is relatively easy to promote good and to fight evil when evil and good are arranged against one another in two clear lines.…What, however, if we must ask, each time in every situation, where is the friend and where the enemy? What, moreover, when we have put the decision in the hands of an inexorable magic or an inexorable machine of which we must ask the right questions in advance, without fully understanding the operations of the process by which they will be answered?"

—Norbert Wiener, *God & Golem, Inc.*

"By the very slowness of our human actions, our effective control of our machines may be nullified."

—Norbert Wiener,
"Some Moral and Technical Consequences
of Automation"

"If we use, to achieve our purposes, a mechanical agency with whose operation we cannot efficiently interfere once we have started it, because the action is so fast and irrevocable that we have not the [means] to intervene before the action is complete, then we had better be quite sure that the purpose put into the machine is the purpose which we really desire and not merely a colorful imitation of it."

—Norbert Wiener,
"Some Moral and Technical Consequences of Automation"

"If we want to live with the machine…we must not worship the machine. We must make a great many changes in the way we live with other people….We must turn the great leaders of business, of industry, of politics, into a state of mind in which they will consider…people as their business and not as something to be passed off as none of their business."

—Norbert Wiener, 1954

"The lords of the present science…are nothing more than apprentice sorcerers, fascinated with the incantation which starts a devilment that they are totally unable to stop. Even the new psychology…becomes in their hands a way for obliterating the conscientious scruples of the working scientists, and for destroying such inhibitions as they may have against rowing into this maelstrom….

"Let these wise men who have summoned a demoniac sanction for their own private purposes remember that in the natural course of events, a conscience which has been bought once will be bought twice. The loyalty to humanity which can be subverted by a skillful distribution of administrative sugar plums will be followed by a loyalty to official superiors lasting just so long as we have the bigger sugar plums to distribute."

—Norbert Wiener, *The Human Use of Human Beings*

"We have a good deal of experience as to how the industrialists regard a new industrial potential…They have very few inhibitions when it comes to taking all the profit out of an industry that there is to be taken, and then letting the public pick up the pieces."

—Norbert Wiener, *The Human Use of Human Beings*

"Such companies as IBM, RCA, Bell Labs, should not be represented at [the computing] meeting since if they fully appreciated the tremendous economic consequences involved in the development of computing machines as control devices they would undertake research immediately, inspired chiefly by the profit motive."

—Norbert Wiener, 1945

"…to show a sufficient interest in the very pressing menace of the large-scale replacement of labor by machine….to steal a march upon the existing industrial corporations….I am willing to back you loyally, and without any demand or request for personal returns….I do not wish to contribute in any way to selling labor down the river."

—Norbert Wiener,
to AUW Union President Walter Reuther, 1949

"The relations of the machine to the living being, and with systems involving elements of both kinds [present] some of the most important moral traps into which the present generation of human beings is likely to fall."

—Norbert Wiener, *God & Golem, Inc*

"There is a sin, which consists of using the magic of modern automatization to further personal profit or let loose the apocalyptic terrors of nuclear warfare....So long as we retain one trace of ethical discrimination, the use of great powers for base purposes will constitute the full moral equivalent of Sorcery.

—Norbert Wiener, *God & Golem, Inc.*

"Once such a master becomes aware that some…supposedly human functions…may be transferred to machines, he is delighted. At last he has found the new subordinate--efficient, subservient, dependable in his action, never talking back, swift, and not demanding a single thought of personal consideration....

"If your purposes involve you in a course sailing pretty close-hauled to the moral wind, your slave will never reprove you, even to the extent of a questioning glance….To this type of sorcerer, not only the doctrines of the Church give a warning but the accumulated common sense of humanity…insist that not only is sorcery a sin leading to Hell but it is a personal peril in this life. *It is a two-edged sword, and sooner or later it will cut you deep*."

—Norbert Wiener, *God & Golem, Inc.*

"No, the future offers very little hope for those who expect that our new mechanical slaves will offer us a world in which we may rest from thinking. Help us they may, but at the cost of supreme demands upon our honesty and our intelligence. The world of the future will be an ever more demanding struggle against the limitations of our intelligence, not a comfortable hammock in which we can lie down to be waited upon by our robot slaves.

—Norbert Wiener, *God & Golem, Inc*

"Render unto man the things which are man's and unto the computer the things which are the computer's. This would seem the intelligent policy to adopt when we employ men and computers together in common undertakings.

—Norbert Wiener, *God & Golem, Inc.*

"My failure to take Wiener's prophecies seriously reflected the limitations of my own worldview…and that of my intellectual friends who…felt that the fate of Western civilization depended upon the positions they took in…their dinner-party conversations....I should have seen that Wiener was describing an even more profound technological shift than either movable type or the internal combustion engine, but…because Wiener was not one of us, his prophecies seemed unreal to me and I ignored them."

—Jason Epstein, Editor, Random House

"That we shall have to change many details of our mode of life in the face of the new machines is certain; but these machines are secondary in all matters of value…to the proper evaluation of human beings for their own sake…."

—Norbert Wiener, *The Human Use of Human Beings*

"The atomic bomb marked the coming of "a new world…with which we should have to live ever after….For the first time in history, it has become possible for a limited group of a few thousand people to threaten the absolute destruction of millions…without any…immediate risk to themselves….

"Push-button warfare…possible for a limited group of…people to threaten the absolute destruction of millions…without any…immediate risk to themselves…. Behind all this I sensed the desires of the gadgeteer to see the wheels go round."

—Norbert Wiener, *I Am A Mathematician*

"We had expected that after this war--as, after all, before--we should return to the free spirit of communication, intranational and international, which is the very life of science…. Whether we wished it or not, we were to be the custodians of secrets on which the whole national life might depend. At no time in the foreseeable future could we again do our research as free men. Those who had gained rank and power over us during the war were most loath to relinquish any part of the prestige they had obtained."

—Norbert Wiener, *I Am A Mathematician*