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to put a halt to computer technology before it is too late?

The question was put to Dr. Robert M. Fano, Ford Professor of Engineering at MIT and director of Project MAC—Project MAC is a program to build the world's biggest and most complex computer system, one that more than a hundred people will use simultaneously. His view: "You can never stop these things. It is like trying to prevent a river from flowing to the sea. What you have to do is build dams, to build waterworks, to control the flow. But if you intend to stop it, you are just going to be swamped by the water."

In any case, Dr. Fano emphasizes, it is not the computer itself that is at fault. "A computer may be a dangerous weapon if put in the hands of an irresponsible individual, just like a knife. A knife can be a tool for eating; it can also be a weapon. Nobody would think of banning knives because you can kill people with knives."

Scientists make it plain that it is man himself who must keep "electronic brains" from getting out of hand.

MACHINES SMARTER THAN MEN?

Interview With Dr. Norbert Wiener, Noted Scientist

Is it just science fiction—the idea of building computers with brains like those of humans? As a practical matter, how could it be done? Exactly what is the danger of "thinking machines" getting out of hand, taking over from man himself?

In this exclusive interview with "U. S. News & World Report," one of the world's foremost computer experts probes an exciting future.

Q Dr. Wiener, is there any danger that machines—that is, computers—will someday get the upper hand over men?

A There is, definitely, that danger if we don't take a realistic attitude.

The danger is essentially intellectual laziness. Some people have been so bamboozled by the word "machine" that they don't realize what can be done and what cannot be done with machines—and what can be left, and what cannot be left, to the human beings.

Q Is there a tendency to overemphasize the use of computers?

A There is a worship of gadgetry. People are fascinated by gadgets. The machines are there to be used by man, and if man prefers to leave the whole matter of the mode of their employment to the machine, by overworship of the machine or unwillingness to make decisions—whether you call it laziness or cowardice—then we're in for trouble.

Q Do you agree with a prediction, sometimes heard, that machines are going to be constructed that will be smarter than man?

A May I say, if the man isn't smarter than the machine, then it's just too bad. But that isn't our being assassinated by the machine. That will be suicide.

Q Is there actually a trend for machines to become more sophisticated, smarter?

A We're making much more sophisticated machines and we're going to make much more sophisticated machines in the next few years. There are things that haven't come to the public attention at all now, things that make many of us believe that this is going to happen within a decade or so.

Q Can you give us a look into the future?

A I can. One of the big things about machines has been miniaturization—cutting down the size of the components. Where, at the beginning of the development of computers, a machine would have to be as big as the Empire State Building, it can be reduced now to something that you could fit into a rather small room. One of the chief factors in this miniaturization has been the introduction of new types of "memories," memories depending on solid-state physics—on transistors, and things of that sort.

Now, it's becoming interesting to ask: "How does the human brain do it?" And for the first time within the last year or so, we're getting a real idea of that.

You know, genetic memory—the memory of our genes—is largely dependent on substances which are nucleic-acid complexes. Within this last year it's coming to be pretty generally suspected that the memory of the nervous system is of the same sort of thing. This is indicated by the discovery of nucleic-acid complexes in the brain and by the fact that they have the properties that would give a good memory. This is a very subtle sort of solid-state physics, like the physics which is used in the memory of machines now.

My hunch is—and I'm not alone in this—that the next decade or so will see this used technically.

Q In other words, instead of a magnetic tape as a memory core of a computer, you will have genes—

A You will have substances allied to genes. Whether you call them genes or not is a matter of phraseology, but substances of the same sort.

Now, that will involve a lot of new fundamental research. How to get in and out of these genetic memories—how to put them to use—involves much research which has scarcely started yet. Several of us have hunches—these are not verified—that this can be done by light of specific molecular spectra, to get in and out of the complexes. Whether that's so or not, I won't swear. But that is a thing some of us are considering seriously.

Q Is this a prospect that should frighten people?

A Any prospect will frighten people. It should frighten people if it is applied without understanding. With understanding this can be a very valuable tool.

Q Can you describe a computer that would use genes as a memory device? What would it be capable of?

A That would sound too much like science fiction to talk about now.

Q What would the capability of this machine be, compared to the computers you have today?

A It might be enormously greater. The machine could be much smaller; it could carry a much larger set of data. But anything that I would say about this would be not only premature but hopelessly premature. But work is to be done in those fields, I'm certain.

Q People are already saying the computers "think." Is this so?

A Taking things as of the present time, computers can learn. Computers can learn to improve their performance by examining it. That is definitely true. Whether you call that thinking or not is a terminological matter. That this sort of thing will go much further in the future, as our ability to build up more complicated computers increases, I should say is certain.

IF MAN GETS IN TROUBLE—

Q Is there a chance that machines may learn more than man? Are they doing this now?

A Certainly not now and certainly not for a long time, if ever. But if they do, it's because we have ceased to learn. I mean, it's easier for us to learn than for the machine. If we worship the machine, and leave everything to the machine, we've got ourselves to thank for any trouble we get in.

Here is the point: The computer is extremely good at working rapidly, at working in a unique way on well-presented data. The computer doesn't compare with the human being in handling data that haven't yet jelled. If you call that intuition—I won't say that intuition is impossible for the computer, but it's much, much lower and it isn't economical to try to make the computer do things that the human being does so much better.

Q What exactly is a learning machine?

A A learning machine is one which not only, say, plays a game according to fixed rules, with a fixed policy, but periodically or continuously examines the results of that policy to determine whether certain parameters, certain quantities, in that policy could be changed to advantage.

Q The example that always comes to mind is machines that play checkers—

A Well, take checkers. The machine was good enough to be able, after a while, to systematically defeat its inventor until he learned a little more about checkers.

Q Why is this not so with chess?

A Because chess is more complicated. It will be so with chess, but it's a much bigger job.

Q Are machines being taught to write?

A Yes. There are machines which will take a code and put it into handwriting, or take handwriting as well as printing and put it into a code. Oh, yes, that's being worked—you can even take speech and put it into a code.

Q Is it science fiction to talk about "thinking robots" taking over the earth?

A It is science fiction, unless people get the idea, "Leave it all to 'Tin Mike.'" I mean, if we regard the machine not as an adjunct to our powers but as something to extend our powers, we can keep it controlled. Otherwise we can't.

The gadget worshipers who expect the machine to do everything, and let people sit down and take it easy, have another think coming.

Q Are computers being used intelligently today?

A In 10 per cent of the cases, yes.

Q This is a startlingly low figure. Why do you say that?

A Because it takes intelligence to know what to give to the machine. And in many cases the machine is used to buy intelligence that isn't there.

The computer is just as valuable as the man using it. It can allow him to cover more ground in the same time. But he's got to have the ideas. And in the early stage of testing the ideas, you shouldn't be dependent on using computers.

Q Is this true also in the use of computers as the basis for automation? That is to say, is automation in some cases being unintelligently employed?

A It most definitely is. But, as for examples, that is not my field.

Q What are some of the things that computers can be used for intelligently, and do better than humans?

A Bookkeeping, selling tickets, and keeping a record of that sort. When you've got your plan of computation, machines can carry it out much better than man can. And computers of the future will do these things very much better. They'll have enough variety so they can afford to do what the brain does—waste a lot of effort and still get something.

. . . "The computer is just as valuable as the man using it"

—MIT Photo

Norbert Wiener was born in 1894, entered Tufts University at 11 and won a doctorate from Harvard at 18. He was a pioneer in high-speed computers and the related science of cybernetics, and since 1919 has taught at Massachusetts Institute of Technology. Dr. Wiener recently received—at the White House—the National Medal of Science for achievement in mathematics and biological sciences.

Q Are these machines of the future going to take away a lot more jobs from humans?

A They will.

Q That will sharpen a problem that already exists. What is the solution?

A The answer is that we can no longer value a man by the jobs he does. We've got to value him as a man.

Here is the point: A whole lot of the work that we are using men for is work which really is done better by computers. That is, for a long time human energy hasn't been worth much as far as physical energy goes. A man couldn't possibly generate enough energy today to buy the food for his own body.

The actual commercial value of his services in modern culture isn't enough. If we value people, we can't value people on that basis.

If we insist on using the machines everywhere, irrespective of people, and don't go to very fundamental considerations and give people their proper place in the world, we're sunk.

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. . . "Soviets are ahead of us" in theory of automation

Q Is it too late to halt this drive toward more and more automation?

A What has been done is irrevocable. I saw this at the very beginning. It isn't merely the fact that the computers are being used. It's the fact that they stand ready to be used, which is the real difficulty.

In other words, the reason we can't go back is that we can never destroy the possibility of computers' being used.

Q Do you consider it an irreversible trend?

A I'm not even speaking about the trend. It's an irreversible piece of knowledge. It's the sort of thing that happened to Adam and Eve when they had that encounter with the serpent. When you've eaten of the fruit of the tree of knowledge, there isn't much you can do except go ahead with that knowledge.

Q So people can look for machines to play still more of a role in automation, in running businesses, in education—

A We can. And, at any rate, whether we use machines or not—which is a decision which we have to make one way or another—the fact that they are there to be used cannot be turned off.

Q Are you saying that it might be a wiser decision not to make use of some of these machines?

A It may be wiser in particular situations. I'll give you a simple example:

It is very easy now, with automatization, to make a factory which can produce more than the whole market can consume. If you go and simply push production up, you may hit the ceiling. Competition, as it has been understood in the past, has been greatly changed by the existence of automatization. Automatization no longer fits in with *laissez faire*.

Q If there is developed in the next decade the kind of advanced machinery that you've hinted at, how can further automation be restrained?

A More than once, advance has been restrained in the past. It isn't necessary, if we make a new weapon, to use it immediately.

Q On your last trip to Russia, did you find the Soviets placing much emphasis on the computer?

A I'll tell you how much emphasis they're placing on it. They have an institute in Moscow. They have an institute in Kiev. They have an institute in Leningrad. They have one in Yerevan in Armenia, in Tiflis, in Samarkand, in Tashkent and Novosibirsk. They may have others.

Q Are they making full use of this science, in a way comparable to ours?

A The general verdict—and this is from many different people—is that they're behind us in hardware—not hopelessly, but slightly. They are ahead of us in the theorization of automatization.

Q Dr. Wiener, is it necessary today to use computers for military decisions?

A Yes, and they can be used very unwisely.

I've no doubt that the problem of when to push the "big button" is being considered from the learning-machine point of view. If it isn't, I should be very surprised, because these ideas are current. You know: Let "Tin Mike" do it.

But let's look at this a little bit more in detail. How do soldiers learn their job? By war games. They have for centuries played games on the map. All right, if you have a certain formal criterion for what winning a war is, you can do this. But you'd better be sure that your criterion is what you really want and not a formalization of what you want. Otherwise, you can make a computer that will win the war technically and destroy everything.

Q How can you program a computer for a nuclear war if you've never had any actual experience in that kind of war?

A You can't completely. But, nevertheless, that is what people are trying to do.

There are no experts in atomic war. An expert is a man who is experienced. This man does not exist today. Therefore, the programing of war games by artificial criteria of success is highly dangerous and likely to come out wrong.

Q Is there a tendency to that kind of programing?

A There is a tendency in that direction, and it strikes me as top-level foolishness. The automaton has the property of what magic once was supposed to have. It may give you what you ask for, but it won't tell you what to ask for.

We have heard people say that we need to develop machine systems which will tell us when to push the button. What we need are systems that will tell us what happens if we push the button under a lot of different circumstances—and, importantly, tell us when *not* to push the button.

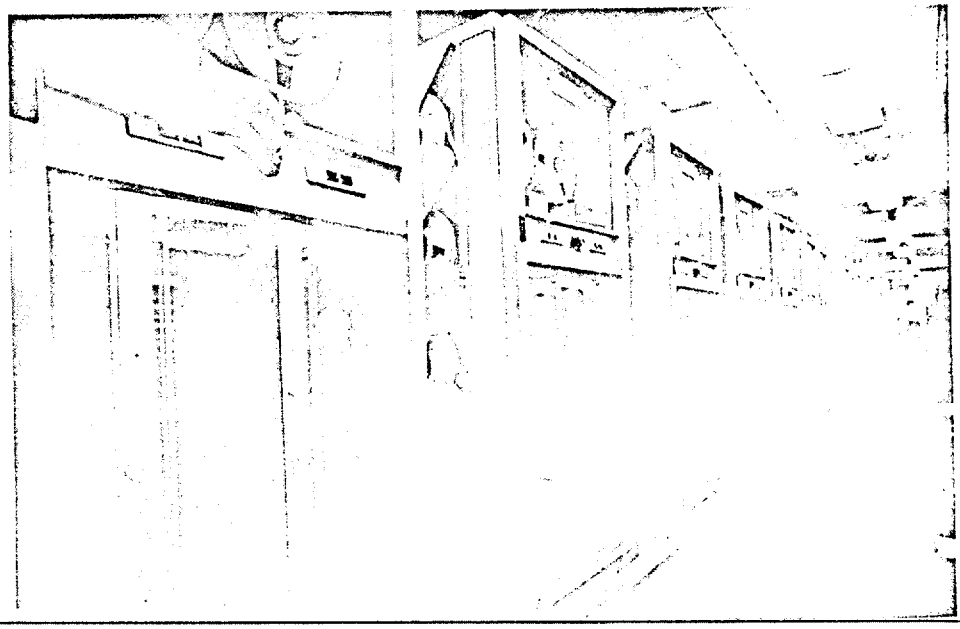
Q Do you mean it is possible for machines to declare war and doom all mankind?

A If we let them. Obviously they won't declare war unless we create a setup by which they will.

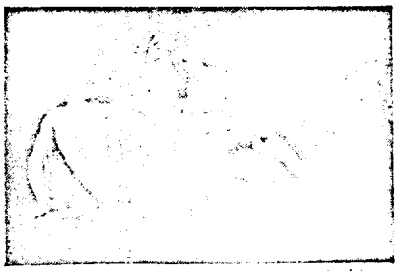
Q Dr. Wiener, is man changing his environment beyond his capacity to adjust to it?

A That's the $64 question. He's certainly changing it greatly, and if he is doing it beyond his capacity, we'll know soon enough. Or we won't know—we won't be here.

—Black Star Photo



As with Adam and Eve, says Dr. Wiener, so it is with modern man and the advent of computers . . .



—Bettmann Archive

. . . "When you've eaten fruit of the tree of knowledge, there isn't much you can do except go ahead."