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INFORMATION SYSTEMS AS AN AID TO MANAGEMENT

Professor Norbert Weiner

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Reviewed by Col R. W. Bergamyer, USAF on 25 September 1963

INDUSTRIAL COLLEGE OF THE ARMED FORCES
WASHINGTON, D. C.

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5 September 1963

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Reviewed by: Col R. W. Berganyer, USAF Date: 25 Sept 1963

Reporter--Grace R. O'Toole

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GENERAL STOUGHTON: Gentlemen: As you have noted from his biography, our speaker today is a most distinguished mathematician amd a recognized authority in communications and control and in the theory of cybernetics. In fact he can be rightly called the father of cybernetics.

It is indeed a pleasure to welcome back to the Industrial College and to present to the Class of 1964 Dr. Norbert Wiener.

Dr. Wiener.

DR. WIENER: Thank you. Well, I am going to talk without notes and freely about certain things that have come to my attention in connection with the use of information theory and the use of computing machines.

I am going to take some personal situations as the theme of my sermon. A few weeks ago I got a call across the country. Somebody wanted me from a certain firm which I am not going to name to give them advice and to come for three meetings about every half year in connection with a project that they had. This project was tied up with space medicine. The idea was to have a polygraph, an instrument which would record many different physiological things simultaneously.

The man spoke of smaller numbers, but he actually spoke quite explicitly of 150 different simultaneous records, and the problem was to work these up to get a correlation between these different physiological quantities and build up what would amount to an entire account of physiology, using the machine, and the biggest computing machine in the world, which they told me they had at their disposal, to organize this material.

By the way, when they called me up, I said, "Why don't you send me an account of this by mail? After all, mail is almost as fast as a telegram, and I want to know what I am getting into." The first statement was that it might get lost, which did not strike me as very impressive. I did get it a few days later, and I studied it. I wrote, "First, I am very busy with my own work. Second, I don't think that this sort of mass handling of data is likely to work. Third, if I ever got into this, my little opinion wouldn't go very far with the tremendous investment being made in that, and I don't want to have this chasing me the rest of my life."

Well, what I am going to talk about is why a thing of that sort didn't look to me like a natural, because this is something that involves pretty general considerations about organization of research in connection with information theory and with computing machines, and it involves what you may call--and this is what I am going to talk about today--not the tactics of information theory but the strategy, the strategy of using these devices for scientific investigation.

Now, people who have not been in this game--and by that I mean most life scientists, and there are exceptions--don't realize the degree of difficulty of handling say 150 different sequences of data simultaneously. There are several stages of it. They feel that the large computing machine, by its speed, can overcome all the jamming of data that you would get. 'Taint so.

In the first place, the simplest way of handling a lot of data together is simply determinants, solving a small number of linear equations together. By the way, seven is a large number for that. Supposing that you want to solve a set of ordinary simultaneous equations by the computing machine and you want perhaps only one-place or two-place accuracy, and you have seven equations together, what is the

order of the number of places you've got to keep in your computation ? More than ten. The reason is fairly obvious, if you think of it. In solving simultaneous equations by determinants, you have to add a large number of terms, some of which are positive and some of which are negative. When you've added them all, you get a quantity that is small compared with the terms you are dealing with. You are adding large quantities to get small quantities. If then you don't keep many more places than what would appear significant in the final result, you've got to work well beyond the number of places you want to end up with, because, in your manipulation, if you cut them short, you throw away not only a part of the information you get but all of it.

It's very easy to throw it all away. Now, I am talking about the very simplest problems. I'm talking, say, about seven simultaneous equations, ordinary equations. Fifteen is already formidable; fifty, even thirty, is fantastic; and 150 is terrible. I haven't figured out the precise number of places you would have to keep, but it wouldn't be enough to keep the original number or even ten. It would probably be in the hundreds of places that you would have to keep.

In other words, to get anything significant from your work, the amount of manipulation would be much greater than you would just imagine by counting the number of places you want.

But that's not all of it. I've been doing a lot of work on what we call time series, on what we call coherency matrices. I have been studying in particular the spectrum of brain waves. Now, in order to do that you have to, even if you take one sequence of brain waves, consider not merely the correlation but the correlation under any delay of that with itself. Brain waves do show a regularity at about 10 cycles per second. In order to get any significant results at all in this

relatively simple case, we have to use runs of at least, say, 5 minutes, taken second by second. That's an awful lot of data. Even for getting really significance with one single time series, you have to use a good ceal of computing machine time.

Now, there are similar problems, problems that are being actually worked on, in which we are dealing with a number of time series together. I did some work on this generalized harmonic analysis years ago, back in 1930, in an article on octoharmonatica. I was down in Los Angeles and I gave a talk to a crowd there, and one of the boys brought up the fact that my method of multiple harmonic analysis was being used, for example, in the study of these underground atomic explosions.

You see, one of the great problems there is to separate out the microseisms, the small oscillations in the earth which are noise from the explosions, which is the message. One of the tricks they use is to take a number of stations at different distances from the explosion, then change the time by delaying back, so that they are referring each record to when the explosion passes that station. They they are getting cost correlations from this.

Now, what happens is that the microseisms are different in the different places and are much smaller in their effect than the explosion itself. They get a lot of information that has been conceivable that way.

I therefore say that the working of multiple time series to determine causality by dealing with matrices not merely of observation at the same time but at different times is good and practical and is geing done. But it multiples the size of the number of terms you have to work with enormously. With a reasonably small number of terms it is useful. If you were to multiply the observations not

to 3 or 4 but to 100, you would have a terrific job of pulling out your information from those.

But that's not the worst of it. This is a method of studying linear relations between time series. It can be done with the aid of computing machines, and done well. Supposing, however, you are trying to study physiology and study a large number of data which you haven't yet organized theoretically to begin with. Then many of the relations you are looking for will be nonlinear. They won't be proportionality but much more complicated relations. One goes square with the other or is the product of two others, or something of that sort.

Now, that is also capable of a mathematical analysis. I've been working on that, on the tools of studying nonlinear transducers. It could be done. But it consumes a terrible amount of computing work if you want to make it anything like complete. In other words, if you want to take all this physiological data and take all their products and sums of their products, and so on, and get all the relations between them, the job that you would have would be astromomical, not merely with respect to hand work but with respect to the biggest computing machine you could find.

You can get swamped in work of this sort by the sheer bulk of material. Therefore--and this goes back further, to this particular invitation--I will not take work on that involves large polygraphs, giving a large number of different data simultaneously, unless the theoretical work that indicates what particular thing you are looking for has been done well. If I'm expected to work in blank with a large amount of this material, and expected to do all the mathematical work after it has been collected, no, thank you.

One of the things that an old hand like myself learns is that data that

have been collected at random, independent of an understanding of the subject, independent of theory--let's face it--are very unlikely to be of much use. There is going to be a tremendous amount of expense to store up material which we are very likely not going to be able to use later when we understand what we are really digging for. The material you have collected at large is very seldom of much value and it is very expensive to handle. Frankly, I am not going to go on a project where I suspect--and I believe such things have happened--that the chief reason for asking me for advice is to get a government contract on my name. I don't do it that way, because there is a lot of that.

Well, this leads to some more general reflections, and I think they are worth giving here. There has been an information theory, very valuable, and also a good deal of misunderstanding. Information theory has been treated as negative empathy and as negativity about the entire universe. Information as it is used in scientific investigation and information as we send it over the telephone or telegraph is information about something. Information at large you cannot give a value to. Information is important about particular things. Information in the simplest case actually reduces to the logarhythm of a ratio, the logarhythm of the ratio of the number of possibilities after you receive the information and the number of possibilities you would have had before. That's a crude way of putting it, but it's the principal action.

Now, when you deal with information, there are two ways of increasing information--to decrease the numerator and to increase the denominator--it's the negative logarhythm. In other words, when you try to make an investigation which will contain all possible, all conceivable possibilities, you find that information of that sort will be made up of information about every different thing, some of which may be extremely valuable and some of which will be of no value at all.

Here I want to go to our old friends, the monkeys and the typewriters. You know--I think it was Eddington who said--that, if we had all the monkeys in the world in all eternity pounding on typewriters, sooner or later, among other things, they would have written all the books of Shakespeare. By the way, that particular figure of speech is much older than Eddington. It goes back to Swift, even though there were no typewriters then. In The Voice and the Pewter he speaks about these frames with letters, and they twist them around and get all the combinations of letters in the alphabet and hope to get all their learning by putting these together. I say that is the monkeys and the typewriters.

Now, suppose the monkeys and the typewriters had written all of Shakespeare, how much information would they have given us? None--the reason being that, in writing all of Shakespeare statistically, they would have written about all the combinations of letters of the same length. Mind you, the universe wouldn't last long after that, but let's assume that it did. All right. You would have Shakespeare, and you would have all about Shakespeare, all the balderdash in the world--and there's a very narrow section of all that balderdash--all the writing in the world, whether Shakespeare or not. How are you going to find Shakespeare? The point is that Shakespeare mixed with all the balderdash in the world isn't Shakespeare.

Getting information is a separation. Shakespeare as separated from non-Shakespeare contains a lot of information. Shakespeare and non-Shakespeare put together contains none. Supposing you were having a super computer man searching through the archives of the monkey outfit for Shakespeare. It wouldn't be an easy job. As a matter of fact, it would be an impossible job. But how would he try to go about it? The first thing that he would have to do would be to have a pattern

recognition machine for recognizing whether the thing went into words, into sentences, into paragraphs, and so on, for a mere preliminary survey.

Now, pattern recognizing machines are being made. They're doing a lot of work on that in Italy now. They are just barely able now to recognize individual letters in different styles of writing. That's a tremendous achievement. But, frankly, for pattern recognition, the human brain and the human mind are far better than the machines we have at present. I won't say that pattern recognition is outside the scope of machines. I will say that as for the present and as for a long time, it is outside the scope of useful competition of machines in the human world. It's work we can do better with our eyes and our brains.

Pattern recognition is an expensive and inefficient use of machines. What then, after that? Now we've got only the significant texts, the texts that can be read. We have thrown over the rest. By the way, that is a long task of more than human ability. Now we want a machine that will recognize pithiness of style, ideas, and so on. That is a super pattern-recognizing machine. That is a thing that we are not even near.

In other words, by the time we picked Shakespeare out, the men doing the picking we would expect to have at least as much, and as a matter of fact much more, brains, time, energy, and intelligence than Shakespeare himself would have.

You know the old story they give of the tramp who comes to a house and finds only a little girl there. He says, "All I want to do is make some pebble soup." The little girl helps him. She gets him a pot and he puts the pebbles in. He says, "Now I want some water. Now I want some herbs. I want some onions to put in, to flavor it. A little milk will make it better." Then he spills the pebbles out and takes the soup.

Well, to try to pick Shakespeare out of what the monkeys have done is exactly parallel to the pebble-soup situation. That is, the work done in picking Shakespeare out is at least as great as that of writing Shakespeare. Actually, it is much more. That is, the sense in which the monkeys' work would contain Shakespeare is parallel to the sense in which a block of marble will contain a statue. After all, all the sculptor does is to remove superfluous marble. But still, we call that making a statue. That is, to get Shakespeare out of the monkeys is an utter waste of work.

Now, we don't have anywhere nearly as bad a situation as that with the computing machine, but we approach it. To work with low-grade information and add a lot of different things, and then later pick out what is significant for what you are doing, is not a very economical way of working. The situation is very analogous to that which a metallurgist has. The main problem of mining is not is there copper there, is there aluminum there, or is there iron there. The problem is, can you separate it from things that you don't want. A great deal of metallurgical work is ore treatment from concentration, flotation concentration, gravity concentration, or, in the case of the invaluable materials, handpicking. That's done. You go over a lot of packed ore, pick out the parts that look good, and throw away the parts that do not.

That's after all, what the boy used to do on a coal heap--pick out the good coal and throw the other stuff away.

Now, there is a great deal of information that (a) isn't information about what you want, and (b) the information that you want is so diluted that the other information must be treated as common, something to be thrown away. The fact that you have a lot of information is no use to you unless it is concentrated as to

information about the particular things. The problem of information recovery means not only picking out information about what you want but in the course of that, at least temporarily, throwing away what you don't want and not having to manipulate it. Every time you have to manipulate low-grade information in handling high-grade information, you are wasting effort and you are wasting money, and you are doing very inefficient work.

This bring up another point which I want to emphasize very much. With the coming in of machine computation, of information theory, and all that, there are two tendencies which are antagonistic to one another, and both wrong, and both antagonistic to good work. One is the idea that a machine can never do the sort of thing that the mind does, that a machine can never play chess or checkers. We know now it can. Mind you, there are a lot of games where it is not the best way to play them, but it can do it. We have checker-playing machines.

The other point of view is that whatever a machine does, because of its speed and reliability, it will do better than a man. That isn't so, either. A machine is at its best in its speed and in its definiteness. Those are great advantages. A machine is at its worst in pattern recognition and in handling material which is vague to begin with. We can go through a lot of vague material and pick out something that is significant. We have to do that in sociology, in economics, and in a lot of things. That is where the brain is much better than any machine as yet developed and any machine that we have any near prospect of developing.

You must give the brain the things that are the brain's and the machine the things that are the machine's. The degree of labyrinths of the brain, the number of switching elements in it, is unthinkably greater than in any computing machine yet built or with any prospect of being built.

Probably the element of the brain which is smaller than a neuron, as compared with the smallest elements in the computing machine of the present day, which are likely to be transistors, has a loppage of probably a millionth in volume, which means that, if we could fill up a computing machine with all the smallest elements that we have at the present time to the operative size of the brain, it would have to be a million times as big--or measuring the brain to be 4 inches across, it would have to be 400 inches across.

That, however, isn't practical. We have no way of assembling an apparatus anywhere nearly as tight as the brain. In order to assemble it so that we could really get at the wires and adjust them, it would probably be more like 4,000 inches across. Our computers don't approach that size. The fact is that the brain is effectively bigger than any computer. It isn't used to the extent of the highest speed, and so on. The computer has advantages, but don't sell the brain short. It's an extremely good computer, and there are many purposes for which, if we want to replace it by a machine, we shall have to wait, and wait longer than our lives.

In other words, the idea of man versus machine is to my opinion poppycock. The thing to do is, if we have certain purposes--and notice they are in the long run human purposes--to fulfill, we have to use a man and a machine together for the things they do best. I want to go into a little more detail about that. I want to say something about the machines that we have for playing checkers. They

were made by the IBM, and they learn. They are machines in which part of the time the machine is playing the game according to a set of records of policy, of strategy and tactics already recorded in the machine. The other part of the time the machine is examining the strategy and tactics to determine which kind of strategy and tactics have in the past lead most often to winning. Then it changes its strategy and tactics to the one which lead most often to winning. In that way it can learn. In many cases it can defeat the man who programed it. That can be done and is being done.

Now let us take a few other questions about learning machines. It would be a wonderful thing if we could make a learning machine for the translation of languages. There is one little catch. In order to apply a criterion of good performance, we must have that criterion of good performance. What is the criterion of good performance in a translation? Intelligibility to people. To make such a machine as the learning machine, we must have one of two things--either a complete set of criteria of intelligibility that can be applied mechanically, which we aren't anywhere near, or an actual test with two people understanding it.

All right. We can make a learning system, a system which could conceivably greatly increase the power of a translater, but in that, the norm, the criterion of good performance must be put in by a person, because we are doing it for people. In other words, it makes much more sense to talk about a translation system with human and mechanical elements than to talk about a translating machine as against a human translator.

Well, there are other cases where we have a similar situation confronting us. You know the big push button that somebody is going to push somewhere in case

of atomic war. All right. In order to make a learning machine to know when to push a push button, we must do what you military people do all the time--train it on war games. In order to train it on war games, these games must be realistic. If you have the wrong criterion of what winning a war game gives you, and such a machine works at all, it will make you win it even if it kills you in doing it.

In other words, in order to train a machine of that sort to fulfill what are ultimately human values, the human values must be introduced into the system either at the machine or at some human place working together with the machine.

And don't let people overvalue fail safe. Fail safe is not something which you can interpret absolutely. You don't know what a fail-safe device is unless you know what safety is. Safety depends on the values that you are trying to preserve. There is nothing in a machine as such, without its human relations, which is safety or danger. Safety has to be interpreted to the machine.

So you can construct fail-safe devices in limited cases when you are preparing against specific dangers. You can't construct fail-safe devices at large against any danger unless you have a pretty good idea what you mean by danger. It isn't something that appears in the engineering textbooks. A new danger will involve a new sort of fail safe. In other words, in these uses, whether business or military or translation, of the machines for human purposes, you cannot neglect the human purposes and put the machine as a blank antagonist of human work. Either the machine or the human being is, in my opinion, a very foolish way of going anywhere.

The machine is an extremely useful tool but a very dangerous master. And, if we ever are, as some people say, going to be conquered by the machines, that

isn't going to be murder on the part of the machines, it's going to be suicide. If we ever put ourselves in a position where we take the machines and worship them so much that we take their interests as supposed to be superior to ours, we are on the way out. It isn't being on the way out because of the machines, it's being on the way out because we have a completely wrong attitude on how to handle them.

The machine in these things is very much like magic. Have any of you ever read a story by W. W. Jacobs, A Monkey's Paw? Some of you must have. It's a very good story written at the beginning of the last century. It's put in an equalitarian home in England. The son is working in a factory and he goes out. The guest is a sergeant major of the Indian Army. He shows the talisman that he has brought back from India, a dried money's paw. He says that a holy man in India has given it the power of answering three wishes for each of three people to show the folly of defying fate.

He says he doesn't know what the first two wishes were of the man first man who had it, but his last one was for death. He himself has had the next three wishes, and he says they are too terrible to tell about He's about to throw the thing into the fire, but the father of the family reclaims it. He wishes for 200 pounds. A few minutes later there is a knock at the door. A gentleman appears from the factory where the son was working, saying that the son has been killed in the machinery and, as a consolation, not assuming legal responsibility, they are giving the father 200 pounds. The next thing is that the mother wishes for the son back. The ghost comes knocking at the door. So the third wish, of course, is for the ghost to go away.

Well, the point of that story and of many other stories--for example,

The Sorceror's Apprentice--is that, when you ask for something by magic you are likely to get what you asked for and not what you should have asked for.

Do I need to say that, when you make a machine to achieve a purpose, you are likely to get what you have designed it to do, what you have asked for, and not what you should have asked for.

In other words, it's exactly the same problem, and a very real problem, that the use of the machine should be integrated into the achievement of human purposes together with human means, and can be.

It's half-past, and I think this is where I should get off.

Thank you.

COLONEL MULLER: Professor Wiener is ready for your questions.

QUESTION: You made a few generalized statements about fail safe. Would you elaborate on that a little?

DR. WIENER: The point is this: What do you mean about fail safe? Fail safe is judgment. That is what I mean. You can make fail-safe devices for specific purposes, but you cannot engineer against all possible sorts of failure. When it comes to such devices as the big push button, failure can take a lot of forms, unless you have engineered into it a protection of the things you want to protect. Safety is not an engineering term as such. It is a term that has to be interpreted with respect to human beings.

For example, if you are dealing with a unmanned missile, safety is a very different thing from what you mean if you are dealing with an airplane carrying passengers. Safety is not a thing that is defined absolutely.

QUESTION: Sir, I wonder if you can give us your definition of cybernetics.

DR. WIENER: The one that I gave at the beginning still holds--the science of communication and control, whether in living beings or machines, which I now amplify; all the systems involving both.

QUESTION: Would you give us your views on the limitations of game theories as applied to human situations?

DR. WIENER: Yes. If you were to take the game theory in the phenoeman way, the thing to do would be to make the best play against the best play, against the best play, against the best play, and so on indefinitely. Now, that may not be the thing that is indicated in a military situation. If Nelson had not made use in his strategy of the knowledge that he had, a Navy that had kept the sea much more than the continental navies, if the fact that they didn't have better knowledge were not taken into consideration, he would not have been able to make his blockade as complete as it was, and there would have been a delay in its effectiveness which would probably or quite possibly have destroyed this effectiveness completely.

In other words, the fact that your opponent may not be on to all the finesses of the best play may be in many cases the reason for doing something else than what is indicated in the phenoeman theory.

Does that anwer you? If I were to give this to an Army man I would simply speak of Napoleon in the same way. If Napoleon hadn't realized that he had a new way of fighting that the Austrian generals were not on to, the generals opposed to him, if he hadn't made use to the full of the fact that he was working against a system that had belonged to a generation and one-half ago and had not been thoroughly kept up to date in war, he could not have done what he did.

The knowledge that one has better knowledge is something that you don't

get in the Noeman theory of games.

QUESTION: Would you explain the theory of the feedback principle, particularly as it relates to organizations as social systems?

DR. WIENER: Socially, after all, it isn't a one-way thing. You've got to have errors corrected as they occur. In the social system there is many a social system that goes to pieces just on the feedback end, in other words, where the government has full authority but does not have adequate feedback as to what the effects of what it is doing are. It is important that there be a good realization of what is being done fed back to them.

That is, it isn't enough to have the line of command open only upward. It's got to be balanced up by a line going downward. A system in which all the communication is from above down is likely to try the impossible and not know it is impossible.

QUESTION: Doctor, as an authority on cybernitics, do you believe that the scientists will succeed in explaining the origin of organic life by mathematical means?

DR. WIENER: That is a difficult thing to say, but my inclination would be to say yes. Mind you, though, it is an extremely complicated phenomenon and it will probably be first explained in a very small part, to begin with. But there is one thing that I have been working on: Is it mathematically possible to make a machine which will make other machines in its own image? It is. I have been working on the theory of that. You will find that in one of the chapters of the new edition of my Cybernetics.

Mind you, I don't say the method is the same as that of life. It most certainly is not. But that sort of idea is by no means interminably outside of

being handled scientifically.

QUESTION: Are the machines currently developed or the ones being developed sufficient to protect our interests under the test-ban agreement?

DR. WIENER: Nothing is enough to work permanently in protecting interests. It is very hard to say that. We've got to know first what our interests are; second, what other people are doing. I think that we should say this: It is not that we have to build, build, build, but that we should realize that when one person or country can do a thing, it can be done by other persons or countries.

It's an old experience. I've had it many times personally. When one has just got something new one finds that a lot of other people get the same thing. I have been doing some work on a new basis for quantam theory recently. I find that I am being swamped by people sending me papers with very parellel ideas.

I told you the experience I had with shooting an enemy airplane and finding that other people were on the same game.

I think the safe attitude is that if anybody is doing it anybody else can. The level of science at the top is pretty much the same and can change extraordinarily rapidly. That is, we can never get a security by sticking to a particular position.

You remember in Alice Through the Looking Glass, the Red Queen. Alice says, "She runs like a bandersnatch. When will she get there?" I think it's Humpty Dumpty who says, "Oh, she has to run as fast as that to stay where she is." To get anywhere you have to run twice as fast.

QUESTION: Sir, is your research into brain frequency leading to improvement of machines or is it medical research primarily?

DR. WIENER: I'm doing some medical research now in connection with cybernetics. I might as well give you a general idea of two things that I am working on.

One thing I am working on is the problem of artificial limbs where we have a take-off from the action potential of the muscles or nerves in the stomach. That is being done in several places. Russia is one place, although I think I had the idea before they did. They give me credit for it. We are working on it in several places in this country--at UCLA, and with a group at Liberty Mutual in Boston. And it works. There's a lot more to be done about this, but it is a perfectly good mode of work.

Another thing that I am convinced of they are also working on at UCLA. As a matter of fact, that's an example of what I just said. When I went down to UCLA this summer, I told the people how I would do this job, and they told me that they were doing it, which was the same way within just about an inch.

How about diseases like diabetes, where you have to inject insulin and generally by the clock, testing several times a day, perhaps? Would it be possible to measure the blood sugar level continuously by perhaps optical means and have that regulated with a continuous injection of insulin whenever the level is above a certain amount? They are doing it, and it works. This idea of artifician homnuastatis in medicine is a cybernetic idea.

A lot of work is being done along this line.

QUESTION: Sir, do you think that that segment of our population known as middle management need to have fear for its job as a result of machinery?

DR. WIENER: It will unless the question of keeping them going, giving them something not only to work for but to live for, is taken up seriously. In

other words, it is not a problem that will solve itself automatically. But I don't say it's an unsolvable problem.

QUESTION: Doctor, in the area of machines, they undoubtedly affect manpower requirements. In the relation of the white collar workers to the blue collar workers, can you state what the ratio is today and what you expect that ratio to be in 1970?

DR. WIENER: I don't know. I said at the beginning, back in the late forties, that it would be a serious business, and it is, but I haven't kept up with the statistics. The statistics are changing year by year. I think that's a thing that you can find out from Walter Reuther.

QUESTION: Sir, at the beginning of your presentation, you discussed the redundancy or the garbage in the information and the need for eliminating it before you picked the information out of the noise. Would you comment on the best way to develop a theory when it is tied in with human values or users who are not technically trained?

DR. WIENER: Let's take up the problem right in the beginning, when we are trying to find out scientifically what is important--for example, the use of this thing for space research, how to do physiology. One of the things that you've got to do whether you are using computing machines or are computing by hand is to have an idea. The computing machine is a speed-up; it's an enlargement of your possibilities, just about as much as an automobile is. But the idea that the computing machine will supply its own methods and all you scientists will have to do is sit down in an office and get somebody to deliver papers to it ain't so. It is harder. You can do much more with a computing machine than you can without it, but it is also harder and demands more on

thinking and classical scientific methods.

That is, you have to have hypotheses or the bulk of data will get out of hand. You cannot work blindly with a computing machine. The computing machine is so big that you keep your eyes open to witness a job, and yet, the danger of working blindly is that you can waste time, people, and money much better with a big computing machine than without it.

Mind you, it has tremendous uses as a tool, but the man who won't be a good scientist without a computing machine won't be a good scientist with it. As a matter of fact, at the preliminary stage of my work, even when I intend to use a computing machine later, the problem of getting the time for it, the problem of adjusting my thinking to short intervals of time that must follow, is too great, and I do a lot of work with the old hand crasher or with pencil and paper before I go to the computing machine. I block out my work without the computing machine before I pull the computing machine in. It is much easier in that way to use lots of time and not to have to spend a lot of time in waiting.

In computing machine research, a good deal but by no means all of the saving of time is made up for by the wasting of waiting time.

QUESTION: Doctor, can you give us your views on what the various elements within our country--government, organized labor, and industry--can or should be doing with regard to the reduced requirement for labor force with the increases in automation?

DR. WIENER: That's quite a question. That practically amounts to laying out the course of the Government for the next 20 years. I do say this, namely, that you can't have people hanging around purposeless or just looking at television. One of the most important things is getting people interested in what

they are doing.

Now, I am going to say things that sound ridiculous because I am talking about a very small-scale undertaking. I came down here yesterday from Sandwich, New Hampshire. In New Hampshire the farming has gone to pieces. It never was much good, but at the same time it can't stand the competition of the West. The forests have become national forests and there isn't the demand for people in the woods that there used to be, although there is some demand. The people are working largely to keep up the places of the summer people there . In the winter there is a great shortage of work.

One thing that has helped the community best is the introduction of the home industries not merely to give them something to sell but to give them some interest in making things, in doing things well. The people there fully appreciate it. What has happened is, for example, the local grocer is a silver maker and designer, and a whole lot of the people there are doing craftsmanship of a high level.

Now, if you think that I think that this is a solution of the whole problem, it isn't. But things of this sort have had more influence in history than you might think.

You know, in Switzerland the watchmaking industry is a home industry. The family assembles in a home and does a lot of the work. Do you know how that happened? In the 18th century, with the long winters up in the mountains with nothing to do, both economically and socially it was necessary to do something to help the people, and watchmaking was deliberately introduced to give them something to do in the winter. After all, there is a great industry whose basis is on something of that sort.

Now, that is a very, very small part of the thing. Obviously, we will need better education. We'll need, if we are going to have scientific work done, to prepare for that not merely in the colleges but long before that, in the people who are going to go to high schools, even. There is a tremendous amount that needs to be done.

I don't want the job of remaking the country now on this platform. It's a tremendous job. The only thing I want to say is that it is a job and it involves much more than the direct unemployment question. Unemployment is bad not only because the people aren't earning money but because the people aren't spiritually earning their lives. There are big problems there.

I think you gather that I feel that the problem goes far beyond the economic problem, and certainly it does. We are facing a complete remaking of our lives nowadays. It is a revolution which isn't the Communist revolution. It's a thing that the Communists are feeling as much as we are--the need of adapting life to our modern capacities and techniques.

That's a problem all over the world, a problem of the same order as the population problem. I think that this problem of the change in the way of life nowadays and how to make it a going concern with our new possibilities is a deeper problem than the political problem and is one that exists in every country in the world.

COLONEL MULLER: Dr. Wiener, I am afraid our time has run out on us. I would like, however, to express the opinion of all of us here. It has been an honor and a privilege to have you address us.

DR. WIENER: It has been an honor and a privilege to be here, sir.

COLONEL MULLER: Thank you very much.