

797

ca. 1956

Japan Productivity Center Conference,  
speech

N. WIENER MC 22

## Conference with Japan Productivity Center

The industrial system that has developed up to today finds a double function for the factory. The factory serves as a means of production and also a means of livelihood and means of employment of labor for a large number of people.

Now a great deal of work that is done in the factory is repetitive work, the sort of work which can be scheduled by a programming, as in the Taylor system of studying movements and the like. What we can do now is to transfer this scheduling of motion from human activity to the activity of machines. With modern automatic means of amplification, of feedback, of correcting the performance of the machine by sensing the performance, and putting corrective terms for these in as a new input to change the performance, it is quite easy to carry out a programming operation at present.

Now, the effect of this is not only to facilitate production but to separate the production function of the factory from the employment function of the factory and to lead to a very serious social reconsideration of the function of the factory.

These new developments have a rather interesting history. At the beginning of the introduction of electronics, it was not realized what a universal tool amplification was. It was not realized that it could not only be used for radio reception and radio transmission and in telephone work, but was a general way of separating in industry two problems; the problem of orders and the problem of the supply of energy for the following of those orders. Thus in modern automatization we are merely making use of facilities which we had already for thirty years,

and which come from the development of the vacuum tube, and more recently from the development of transistors and other similar devices.

Similarly, when high-speed computation was invented at the time of the war and after the war, it was not realized at first that the same sort of apparatus which would make possible high-speed computation would make possible the automatic factory.

The point is that any sequence of high-speed operation must be programmed, and programmed completely from the beginning, so the sequence of operations does not have to be determined while the operations are under way, when there isn't time.

If that can be done for the complicated computing program, it can be done for the sequence of work in a factory.

The same high-speed automatic apparatus for amplifying messages, may also be used for operating sequentially on messages, in order that a programming can be carried out.

The separation of these two aspects of factory operation, the information aspect and the power aspect, makes it possible for information going into a machine to be handled by methods which do not involve the simultaneous work of human beings. Now the work of human beings is transferred to earlier programming. We do not need to carry out this work at a high power level, but may amplify the power later.

Roughly speaking, in a great many phases of factory work the human being has formerly been used as a rather inefficient amplifier for the messages and a rather inefficient receiver for the messages. Thus on the production end of engineering, these new powers that we have are bringing us into a new age. But it must

be remembered that in doing this they are separating the two aspects of the factory of which I have spoken. Namely, they have separated the aspect of the factory as a means of production, and the aspect of the factory as a means of employment. And unless we are prepared socially to separate these functions and provide for their separate existence, we may run into catastrophic unemployment.

The high-speed automatic factory will be efficient only when there is a relatively large amount of production under fairly constant conditions.

It is possible to change the programming so as to make mass production possible for smaller batches that would otherwise be considered too small for the mass production which is essential to the good working of the automatic factory. Automatization must always be associated with some degree of mass production. In other words, automatization can be a very inexpensive method per unit of production but it cannot be an inexpensive method for a production of a small number of pieces.

Therefore, the places where automatization is to be introduced must be carefully scrutinized. In other words, the automatic factory of the future will not be a slight adaptation of the ordinary hand factory by introducing automatization at a few points, but the entire flow of the process must be designed with automatization in view if the process is to be really efficient.

Furthermore, the type of apparatus used in automatization is changing very rapidly in this respect so that it may take some years before automatization itself will be established and the apparatus will be more than temporary.

Question: Once we set up programming, is it easy to change from one form of programming to another?

Answer: Fundamentally, yes. All types of programming apparatus have very much in common for whatever purpose they are used. But the terminal apparatus, the stamping apparatus, the cutting apparatus, the milling apparatus, may be rather different. The change in programming from one apparatus to another, as far as the central control machine is concerned, is the change in the command given to the machine which is finally *driven*.

This is not an easy process but it involves very little mechanical change to the apparatus used. However, it involves a new profession: that of the programmer who is to interpret the task given to the machine in terms which the machine can understand. With that the same machine can be used for many sorts of programming provided the terminal apparatus is adequate for the purpose.

Question: In Japan we are worried so much about the effects of automatization in factories and we would like to have you express your opinion on automatization with respect to employment in Japan.

Answer: Automatization will definitely cut into the ability of the factory to act as a large employer of labor. That is, in an automatized country or world, a smaller percentage of the people will be employed within the factory than normally at present.

Of course, service industries, auto repair industries, and industries involved in facing a different situation each time, will not be directly

affected. Agriculture will not be affected immediately although I will not say that agriculture will not be ultimately affected.

The problem of automatization as we face it in the States is largely a question of bringing labor through the transition stages. The purely repetitive tasks will be done by machinery in the future. The need for people will be for people who can repair the apparatus, who watch the apparatus, people who will be at the lowest level foreman and at the highest junior engineers. We are finding that since the last war, the military services, with a large number of people trained technically, are furnishing just exactly the sort of people industry needs in automatization, and for some time we may not have too much difficulty.

But we must face the problem that the care of people, the social needs of people will have to be provided for in the future largely outside of the factory.

The factories of the future will be nearly as empty as the power plants are now. In facing this a great deal can be done by grading up, but it will also be necessary to regard the machines as existing for the supply of the needs of people, and not that the people as existing to supply the needs of the machines.

Question: Do you know of any instances in which the number of people employed in certain automatized factory<sup>ies</sup> may be decreased, but the amount of employment in the allied industries increased as a whole?

Answer: That is perfectly possible, but the tendency in the factory that is automatized itself is to use fewer people.

There are cases where that is the chief motive of automatization rather than economy. Let us take oil cracking plants, which are essentially big bombs. They are too dangerous to work in, or at least in which to risk many people who work, and it is desirable to cut the number of working people as much as possible. Therefore, for humanitarian reasons it is highly desirable that they should be automatized as much as possible.

**Question:** Do you think mass production is the prerequisite to automatization?

**Answer:** Automatization is impossible without some degree of mass production. The individual apparatus is expensive and the productivity must be large in order to justify automatization. On the other hand, such things as automatic milling machines or that sort of tools make it less expensive to set up mass production methods for relatively small batches than would be needed for a complete remachining of the plants, for mass production by stamping and other devices of that sort. In other words, it is easier to place the tape on a machine than to bring in a new machine. Thus, there is an intermediate stage at which the automatic factory allows mass production methods to be done on smaller batches than would have been supposed possible before.

This is already becoming conspicuous in the airplane industry, where you can now use mass production methods for a few hundred

parts to many thousands. In other words, the separation between power and instructions makes it possible to replace the instructions of a machine by a new set of instructions, without large-scale changes that are expensive in material.

Question: In the U.S. labor may not object to automatization of factory because laborers can work in the factories where they make the machines to enable automatization. In Japan it is possible that labor may strongly resist automatization of factory for we import the machines for those purposes from abroad and fewer people can find jobs in other factories. Have you noticed similar phenomena?

Answer: In the U.S. at the beginning I had<sup>a</sup>/considerable amount of difficulty in alerting labor leaders to the fact that the automatic factory was coming, and the chief trouble I had was indifference rather than resistance. Later on I got in touch with Walter Reuther, who is the head of<sup>the</sup>/Automobile Workers Union, and he has been completely sympathetic. His chief interest was to protect labor during the period of transition when labor is still used in the old manner, and the new adjustments have not been made. But he is not against automatization coming in ultimately, provided labor as well as capital has its share in it, and in providing protection for labor against wrong or undue use of automatization during the period of transition.

Question: In what way can Mr. Reuther protect labor?

Answer: To see that the present contracts made between labor

and management, consider the changes during the intermediate period, by regulating the introduction of automatization, by a certain degree of job insurance, etc. That is already affecting the attitude of labor to the automobile industry.

Question: In Japan, in what particular field is automatization most desirable?

Answer: I have no specific knowledge of Japanese conditions, so I merely wish to say what I know about automatization in general.

It works particularly well for continuous processing industries, say, like the oil cracking industry. It works fairly well for batch industries handling material. It can be used on automobile assembly lines and so on. It can be used for such things as automatic milling machines of which I spoke, in connection with airplane manufacture, where your batches are smaller than mass production previously has been found suitable. It probably is not much used in connection with the service industry where you have separate jobs each time. It can be used both in the factory and directly in the offices; it is used by such people as International Business Machines, and in establishing the close connection between the offices and factories so that cost accounting and similar functions may be done automatically. It can be used for quality control. It can ultimately, I believe, be used in agriculture. The place where it

can be least used, I say, is essentially the neighborhood filling station or in the garage where you may have to repair many makes of cars.

It will be of very little use in restaurants or other service industries of that sort.

But I would say that its scope is nearly as large as mass production on any plane, and that it can ultimately include agricultural mass production as well as factory mass production.

Question: Dr. Wiener, you mentioned agriculture as possibly an ultimate field for automatization.

Answer: The purpose of automatization is to take in information and change it into action. Now a great deal of agricultural work depends on recognition of the special situations; the distinguishing of agricultural crops from weeds, the recognition of the character of the soil, the distinguishing of the rows of crops and of the space between the rows. The picking of ripe cotton as distinguished from unripe cotton, different treatment for ripe bolls from unripe bolls. A great deal depends on good instrumentation and discriminating apparatus. There is no reason that it cannot be turned into action in the field as well as in the factory. The chief difficulty is that apparatus will largely have to be towed behind a tractor and must be rugged for that purpose because of the jolts of towing.

However, in the last war we were using the proximity fuse, which was essentially a vacuum tube apparatus carried by the shell, to pick up the neighborhood of an airplane.

Now if we can shoot the vacuum tube in a shell and still have it effective, I think we can tow it behind a tractor.

Furthermore, the present type of amplifiers depend on transistors and other similar devices, which are probably less sensitive to injury by shaking than old fashioned vacuum tubes.

Question: What do you think of the possibilities of automatization in Japanese agriculture?

Answer: Most of your agriculture in Japan is relatively small scale, highly intensive agriculture. I don't think automatization is coming into use in Japan as quickly as in countries where there is lesser yield of crops over larger acreage. That is, I can see it coming into the American wheat and corn field. I don't think the Japanese rice field is suitable for it.

Question: Dr. Wiener, could you possibly state your essential contribution to automatization to the present-day industry or society?

Answer: My connection with automatization was simply that I have rather organized views of what communication theory was like quite earlier, and that I saw the developments which were being made in the field of high-speed computation revolved on the same sort of

apparatus which is needed for programming in the automatic factory. In other words, I have invented no devices, but I have seen earlier than most people where the trend of the world was leading, and I have been aware of the social consequences and their nature.

Question: What would be the relation or impact of cybernetics upon industry?

Answer: I think to a large extent I have already said that the impact will be the division between the problems of information and of power in industry. With these things on a separate basis, our ability will be greatly enhanced to subdivide the problems into a knowledge problem and control problem on one side, and the problem of making this knowledge control effective by power.

Question: What briefly is information theory?

Answer: Information theory is the theory of the production, transmission, use and measurement of information, where information is to be taken as that restriction of the possibilities of the world which results we have when we already know specifically certain quantities or measurements. When we know certain quantities or measurements, the possibilities for others that we do not know are cut down. The degree of this cutting down is the information our measurements give us.

Question: In the older times human beings were used more or less as sources of power. At the present, however, information and power are separate, and machine is taking <sup>over</sup> ~~out~~ the task of giving information as in the

automatized factory replacing human beings. Then, what would be the role the human beings can take in the next stage?

**Answer:** Machine does the job of organizing and collecting information only at a low level. That is, the higher information tasks still belong to men. It is only the routine tasks of recognition and acting which are taken over by the machine. What we are finding is that the first Industrial Revolution <sup>is</sup> concerned more than anything else <sup>with</sup> the use of human beings as power. The second <sup>one</sup> concerns the replacement of human beings for low-grade information tasks. High-grade information tasks are always for man.

**Question:** Speaking of the electronic computer, what would be the possible bottle-neck in its future development?

**Answer:** It's very hard to speak of possible bottle-neck in the future development, because the available apparatus for the electronic computer is changing so rapidly. We are developing vacuum tubes and transistors further and in Japan they are doing a great deal of work on magnetic cores, and many new devices are coming into <sup>use</sup> for the purpose of computation. That is, with the apparatus that is changing every year as it does, there may well be bottle-necks at certain stages, but how those will develop I ~~do~~ should not want to say now. I want to say this, a few years ago in the vacuum tube days a big bottle-neck was the problem of disposing of heat generated by the vacuum tubes. That is no longer a problem with the transistors.

Question: You mentioned automatization in industrial processes. What about automatization in data processing?

Answer: Yes, it's used all the time. The International Business Machine exists for exactly that business.

Question: Do they develop in parallel?

Answer: They process data. The office work done in automatization is data processing. And without any doubt it will be more closely connected with the factory work itself. Cost accounting, let us say, and the manufacture will be integrated into the same process.

Question: Today when automatization is being adopted in many fields, is there any particular approach taken to educate people or to make people adjust themselves to the way of thinking?

Answer: What you ask is a real problem and I cannot give you a complete answer. A person who is interested in a thing has enough to keep himself busy, whether what he does is labeled as work or not.

Question: Progress of industry is made possible by the exchange of information between the industries, so if an industry keeps certain information to itself it hinders the progress of the whole industry. What do you think of this?

Answer: I should say that a policy as open as possible should develop the industry, but I do not want to be quoted here as to the detail of this policy.

Question: Do you think there exists some method to enable analyzing complicated problems?

Answer: Analysis of complicated problems to put on the computing machine is always a human art. I should say probably now a tendency exists to develop a technique to divide programming problems up. But as to the comprehensive treatment of programming by routine, I doubt its possibility.

Question: Have you become aware of psychological differences between Western peoples and Asiatic peoples?

Answer: I am aware of the shades of difference within any country between different groups of people, yes. But as to any fundamental major difference I am not aware of it.

The industrial system that has developed up to today finds a double function for the factory. The factory serves as a means of production and also a means of livelihood and means of employment of labor for a large number of people.

Now a great deal of work that is done in the factory is repetitive work, the sort of work which can be scheduled by a programming, as in the Taylor system of studying movements and the like. What we can do now is to transfer this scheduling of motion from human activity to the activity of machines. With modern automatic means of amplification, of feedback, of correcting the performance of the machine by sensing the performance, and putting corrective terms for these in as a new input to change the performance, it is quite easy to carry out a programming operation at present.

Now, the effect of this is not only to facilitate production but to separate the production function of the factory from the employment function of the factory and to lead to a very serious social reconsideration of the function of the factory.

These new developments have a rather interesting history. At the beginning of the introduction of electronics, it was not realized what a universal tool amplification was. It was not realized that it could not only be used for radio reception and radio transmission and in telephone work, but was a general way of separating in industry two problems; the problem of orders and the problem of the supply of energy for the following of those orders. Thus in modern automatization we are merely making use of facilities which we had already for thirty years,

and which come from the development of the vacuum tube, and more recently from the development of transistors and other similar devices.

Similarly, when high-speed computation was invented at the time of the war and after the war, it was not realized at first that the same sort of apparatus which would make possible high-speed computation would make possible the automatic factory.

The point is that any sequence of high-speed operation must be programmed, and programmed completely from the beginning, so the sequence of operations does not have to be determined while the operations are under way, when there isn't time.

If that can be done for the complicated computing program, it can be done for the sequence of work in a factory.

The same high-speed automatic apparatus for amplifying messages, may also be used for operating sequentially on messages, in order that a programming can be carried out.

The separation of these two aspects of factory operation, the information aspect and the power aspect, makes it possible for information going into a machine to be handled by methods which do not involve the simultaneous work of human beings. Now the work of human beings is transferred to earlier programming. We do not need to carry out this work at a high power level; but may amplify the power later.

Roughly speaking, in a great many phases of factory work the human being has formerly been used as a rather inefficient amplifier for the messages and a rather inefficient receiver for the messages. Thus on the production end of engineering, these new powers that we have are bringing us into a new age. But it must

be remembered that in doing this they are separating the two aspects of the factory of which I have spoken. Namely, they have separated the aspect of the factory as a means of production, and the aspect of the factory as a means of employment. And unless we are prepared socially to separate these functions and provide for their separate existence, we may run into catastrophic unemployment.

The high-speed automatic factory will be efficient only when there is a relatively large amount of production under fairly constant conditions.

It is possible to change the programming so as to make mass production possible for smaller batches that would otherwise be considered too small for the mass production which is essential to the good working of the automatic factory. Automatization must always be associated with some degree of mass production. In other words, automatization can be a very inexpensive method per unit of production but it cannot be an inexpensive method for a production of a small number of pieces.

Therefore, the places where automatization is to be introduced must be carefully scrutinized. In other words, the automatic factory of the future will not be a slight adaptation of the ordinary hand factory by introducing automatization at a few points, but the entire flow of the process must be designed with automatization in view if the process is to be really efficient.

Furthermore, the type of apparatus used in automatization is changing very rapidly in this respect so that it may take some years before automatization itself will be established and the apparatus will be more than temporary.

Question: Once we set up programming, is it easy to change from one form of programming to another?

Answer: Fundamentally, yes. All types of programming apparatus have very much in common for whatever purpose they are used. But the terminal apparatus, the stamping apparatus, the cutting apparatus, the milling apparatus, may be rather different. The change in programming from one apparatus to another, as far as the central control machine is concerned, is the change in the command given to the machine which is finally

This is not an easy process but it involves very little mechanical change to the apparatus used. However, it involves a new profession: that of the programmer who is to interpret the task given to the machine in terms which the machine can understand. With that the same machine can be used for many sorts of programming provided the terminal apparatus is adequate for the purpose.

Question: In Japan we are worried so much about the effects of automatization in factories and we would like to have you express your opinion on automatization with respect to employment in Japan.

Answer: Automatization will definitely cut into the ability of the factory to act as a large employer of labor. That is, in an automatized country or world, a smaller percentage of the people will be employed within the factory than normally at present.

Of course, service industries, auto repair industries, and industries involved in facing a different situation each time, will not be directly

affected. Agriculture will not be affected immediately although I will not say that agriculture will not be ultimately affected.

The problem of automatization as we face it in the States is largely a question of bringing labor through the transition stages. The purely repetitive tasks will be done by machinery in the future. The need for people will be for people who can repair the apparatus, who watch the apparatus, people who will be at the lowest level foreman and at the highest junior engineers. We are finding that since the last war, the military services, with a large number of people trained technically, are furnishing just exactly the sort of people industry needs in automatization, and for some time we may not have too much difficulty.

But we must face the problem that the care of people, the social needs of people will have to be provided for in the future largely outside of the factory.

The factories of the future will be nearly as empty as the power plants are now. In facing this a great deal can be done by grading up, but it will also be necessary to regard the machines as existing for the supply of the needs of people, and not that the people as existing to supply the needs of the machines.

Question: Do you know of any instances in which the number of people employed in certain automatized factories<sup>ies</sup> may be decreased, but the amount of employment in the allied industries increased as a whole?

Answer: That is perfectly possible, but the tendency in the factory that is automatized itself is to use fewer people.

There are cases where that is the chief motive of automatization rather than economy. Let us take oil cracking plants, which are essentially big bombs. They are too dangerous to work in, or at least in which to risk many people who work, and it is desirable to cut the number of working people as much as possible. Therefore, for humanitarian reasons it is highly desirable that they should be automatized as much as possible.

**Question:** Do you think mass production is the prerequisite to automatization?

**Answer:** Automatization is impossible without some degree of mass production. The individual apparatus is expensive and the productivity must be large in order to justify automatization. On the other hand, such things as automatic milling machines or that sort of tools make it less expensive to set up mass production methods for relatively small batches than would be needed for a complete remachining of the plants, for mass production by stamping and other devices of that sort. In other words, it is easier to place the tape on a machine than to bring in a new machine. Thus, there is an intermediate stage at which the automatic factory allows mass production methods to be done on smaller batches than would have been supposed possible before.

This is already becoming conspicuous in the airplane industry, where you can now use mass production methods for a few hundred

parts to many thousands. In other words, the separation between power and instructions makes it possible to replace the instructions of a machine by a new set of instructions, without large-scale changes that are expensive in material.

Question: In the U.S. labor may not object to automatization of factory because laborers can work in the factories where they make the machines to enable automatization. In Japan it is possible that labor may strongly resist automatization of factory for we import the machines for those purposes from abroad and fewer people can find jobs in other factories. Have you noticed similar phenomena?

Answer: In the U.S. at the beginning I had<sup>a</sup>/considerable amount of difficulty in alerting labor leaders to the fact that the automatic factory was coming, and the chief trouble I had was indifference rather than resistance. Later on I got in touch with Walter Reuther, who is the head of<sup>the</sup>/Automobile Workers Union, and he has been completely sympathetic. His chief interest was to protect labor during the period of transition when labor is still used in the old manner, and the new adjustments have not been made. But he is not against automatization coming in ultimately, provided labor as well as capital has its share in it, and in providing protection for labor against wrong or undue use of automatization during the period of transition.

Question: In what way can Mr. Reuther protect labor?

Answer: To see that the present contracts made between labor

and management, consider the changes during the intermediate period, by regulating the introduction of automatization, by a certain degree of job insurance, etc. That is already affecting the attitude of labor to the automobile industry.

Question: In Japan, in what particular field is automatization most desirable?

Answer: I have no specific knowledge of Japanese conditions, so I merely wish to say what I know about automatization in general.

It works particularly well for continuous processing industries, say, like the oil cracking industry. It works fairly well for batch industries handling material. It can be used on automobile assembly lines and so on. It can be used for such things as automatic milling machines of which I spoke, in connection with airplane manufacture, where your batches are smaller than mass production previously has ~~been~~ found suitable. It probably is not much used in connection with the service industry where you have separate jobs each time. It can be used both in the factory and directly in the offices; it is used by such people as International Business Machines, and in establishing the close connection between the offices and factories so that cost accounting and similar functions may be done automatically. It can be used for quality control. It can ultimately, I believe, be used in agriculture. The place where it

can be least used, I say, is essentially the neighborhood filling station or in the garage where you may have to repair many makes of cars.

It will be of very little use in restaurants or other service industries of that sort.

But I would say that its scope is nearly as large as mass production on any plane, and that it can ultimately include agricultural mass production as well as factory mass production.

**Question:** Dr. Wiener, you mentioned agriculture as possibly an ultimate field for automatization.

**Answer:** The purpose of automatization is to take in information and change it into action. Now a great deal of agricultural work depends on recognition of the special situations; the distinguishing of agricultural crops from weeds, the recognition of the character of the soil, the distinguishing of the rows of crops and of the space between the rows. The picking of ripe cotton as distinguished from unripe cotton, different treatment for ripe bolls from unripe bolls. A great deal depends on good instrumentation and discriminating apparatus. There is no reason that it cannot be turned into action in the field as well as in the factory. The chief difficulty is that apparatus will largely have to be towed behind a tractor and must be rugged for that purpose because of the jolts of towing.

However, in the last war we were using the proximity fuses which was essentially a vacuum tube apparatus carried by the shell, to pick up the neighborhood of an airplane.

Now if we can shoot the vacuum tube in a shell and still have it effective, I think we can tow it behind a tractor.

Furthermore, the present type of amplifiers depend on transistors and other similar devices, which are probably less sensitive to injury by shaking than old fashioned vacuum tubes.

Question: What do you think of the possibilities of automatization in Japanese agriculture?

Answer: Most of your agriculture in Japan is relatively small scale, highly intensive agriculture. I don't think automatization is coming into use in Japan as quickly as in countries where there is lesser yield of crops over larger acreage. That is, I can see it coming into the American wheat and corn field. I don't think the Japanese rice field is suitable for it.

Question: Dr. Wiener, could you possibly state your essential contribution to automatization to the present-day industry or society?

Answer: My connection with automatization was simply that I have rather organized views of what communication theory was like quite early~~er~~, and that I saw the developments which were being made in the field of high-speed computation revolved on the same sort of

apparatus which is needed for programming in the automatic factory. In other words, I have invented no devices, but I have seen earlier than most people where the trend of the world was leading, and I have been aware of the social consequences and their nature.

**Question:** What would be the relation or impact of cybernetics upon industry?

**Answer:** I think to a large extent I have already said that the impact will be the division between the problems of information and of power in industry. With these things on a separate basis, our ability will be greatly enhanced to subdivide the problems into a knowledge problem and control problem on one side, and the problem of making this knowledge control effective by power.

**Question:** What briefly is information theory?

**Answer:** Information theory is the theory of the production, transmission, use and measurement of information, where information is to be taken as that restriction of the possibilities of the world which results we have when we already know specifically certain quantities or measurements. When we know certain quantities or measurements, the possibilities for others that we do not know are cut down. The degree of this cutting down is the information our measurements give us.

**Question:** In the older times human beings were used more or less as sources of power. At the present, however, information and power are separate, and machine is taking <sup>over</sup> ~~out~~ the task of giving information as in the

automatized factory replacing human beings. Then, what would be the role the human beings can take in the next stage?

**Answer:** Machine does the job of organizing and collecting information only at a low level. That is, the higher information tasks still belong to men. It is only the routine tasks of recognition and acting which are taken over by the machine. What we are finding is that the first Industrial Revolution <sup>is</sup> concerned more than anything else <sup>with</sup> the use of human beings as power. The second <sup>one</sup> concerns the replacement of human beings for low-grade information tasks. High-grade information tasks are always for man.

**Question:** Speaking of the electronic computer, what would be the possible bottle-neck in its future development?

**Answer:** It's very hard to speak of possible bottle-neck in the future development, because the available apparatus for the electronic computer is changing so rapidly. We are developing vacuum tubes and transistors further and in Japan they are doing a great deal of work on magnetic cores, and many new devices are coming into for the purpose of computation. That is, with the apparatus that is changing every year as it does, there may well be bottle-necks at certain stages, but how those will develop I ~~sh~~ould not want to say now. I want to say this, a few years ago in the vacuum tube days a big bottle-neck was the problem of disposing of heat generated by the vacuum tubes. That is no longer a problem with the transistors.

Question: You mentioned automatization in industrial processes. What about automatization in data processing?

Answer: Yes, it's used all the time. The International Business Machine exists for exactly that business.

Question: Do they develop in parallel?

Answer: They process data. The office work done in automatization is data processing. And without any doubt it will be more closely connected with the factory work itself. Cost accounting, let us say, and the manufacture will be integrated into the same process.

Question: Today when automatization is being adopted in many fields, is there any particular approach taken to educate people or to make people adjust themselves to the way of thinking?

Answer: What you ask is a real problem and I cannot give you a complete answer. A person who is interested in a thing has enough to keep himself busy, whether what he does is labeled as work or not.

Question: Progress of industry is made possible by the exchange of information between the industries, so if an industry keeps certain information to itself it hinders the progress of the whole industry. What do you think of this?

Answer: I should say that a policy as open as possible should develop the industry, but I do not want to be quoted here as to the detail of this policy.

Question: Do you think there exists some method to enable analyzing complicated problems?

Answer: Analysis of complicated problems to put on the computing machine is always a human art. I should say probably now a tendency exists to develop a technique to divide programming problems up. But as to the comprehensive treatment of programming by routine, I doubt its possibility.

Question: Have you become aware of psychological differences between Western peoples and Asiatic peoples?

Answer: I am aware of the shades of difference within any country between different groups of people, yes. But as to any fundamental major difference I am not aware of it.