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MR. RICHARD T. NALLE, JR.: I'll dispense with the lengthy introductions in the interest of time. I only want to make one point really, and that is that when you're talking about priorities for the second century, it seems to me it's a wonderful time to have flights of fancy and let one's mind roam over all the wonderful things that may happen in the next 100 years. But wisely, the IEEE instructed the speakers and the discussants to confine themselves to kind of the realistic look ahead, what we might expect in the next few years, the nuts and bolts kind of forward planning rather than the blue sky kind of thing.

Our first presenter this afternoon who will be talking about integrated manufacturing technology will be Dr. Koji Kobayashi. Dr. Kobayashi's accomplishments are far too great to enumerate here. The program covers them very well. Let me just say that he is Chairman of the NEC Corporation and a fellow of the IEEE. As we all know, Japan has been much more comfortable about going into automated factories than we have in this country. Interestingly enough, my background is entirely in manufacturing and I'm looking forward with a great deal of interest to hearing Dr. Kobayahi's remarks.

Also in the interest of time, I'm going to introduce his discussant also at this moment so that we can go right into the question and answer period without interrupting. He'll be followed by Professor Raj Reddy. Again, you will find his background in the program. He too is a fellow of IEEE and he's a director of the Robotics Institute of Carnegie Mellon.

It now gives me great pleasure to introduce Dr. Koji Kobayashi.

(Applause)

DR. KOJI KOBAYASHI: Thank you, Mr. Chairman. Good afternoon, ladies and gentlemen.

The advancement of science and technology should contribute to the development of society and the well being of mankind. Therefore, it is necessary that its end result should be manufactured as products, and that they should be widely circulated and effectively utilized. Research and development of manufacturing technology is vital to bring about an innovation in the production process. This will enable the products to be inexpensively manufactured at higher quality. Whatever superb possibilities a product may have, if production quality is poor, successful technological innovation cannot be achieved.

At presents, the interests of engineers tend to focus mostly on spectacular product innovations. Because of this, it is very significant that integrated manufacturing technology has been selected as one of the priorities for the second century of the IEEE. I would like to express my respect for the acute awareness of the task faced by the industry, by the planners of this Centennial Technical Convocation. Further, I feel highly honored and I'm very grateful for having been given an opportunity to talk on the subject of this important technology.

In the little more than 200 years since the industrial revolution, the industrial society has grown and matured and is now rapidly advancing into the age of the information society. And if the inventions of the Spinning Jenny and the steam engine were the motive power for the curtain raising of the industrial society, computers, modern communications technologies, and transistors can be said to be acting as motive power for the information society to come.

I have advocated for several years that the integration of computers and communications, that I call C&C, is essential to the development of the information society, and that in order to realize it, the advancement of microelectronics technology and software technology is indispensable. This is because I believe that C&C is vital for any individual to access needed information at any place and time, to process it to match the individual's purpose, and to use it. C&C technologies can be said to be closely related to the integrated manufacturing technology essential to the information society.

The desires of people in the information society are diverse. In order to respond to these desires exactly, a flexible manufacturing system should develop in which small quantities of various kinds of products are produced efficiently at dispersed manufacturing bases. Moreover, in order to make effective production and circulation possible within plants and among markets over a wide area, the flexible manufacturing system will become the C&C manufacturing system itself. With all these advances in new production techniques, manufacturing activities should always revolve around the interests of human beings, and the quality of their life and work must not be ignored. I think that advances in production technology should conform to the concept of a "man and C&C" manufacturing system centered on human beings.

In this presentation I would like, first of all, to consider the significance of manufacturing in the information society. Next, I will discuss the production system in the information society and the manufacturing technology to realize it. Lastly, I will consider the prospects for the manufacturing technology in our second century as centered on human beings.

Manufacturing is the activity of processing anc onverting intellectual and physical raw materials and elements into hardware and software products which can be easily utilized by the consumer. Since the industrial revolution, advances in energy conversion technology promoted the invention of production machines that greatly raised the productivity. As a result, mass production and distribution of hardware was made possible which greatly contributed to the material wealth of society.

As the quality of life and level of education of the general public rise, their desires become more complex and sophisticated. It has already become difficult for products designed for general purposes to meet the demands of the general public. Intelligent products that are easy to use and tailored to suit each user's individual needs are strongly desired. In order to manucature a wide variety of products designed to meet each consumer's personal requirements in small quantity and high quality with high efficiency, a remarkable amount of information must be utilized promptly and exactly compared to the production processes in the industrial society. Further, the manufacture of information indispensable for intelligent products, namely software and data base, cannot help but carry a heavy weight in production activities. In the information society, the manufacture of information occupies an important position in industry, and at the same time information plays an important role in manufacturing activities.

Suppose we consider a series of processes ranging from input of information on the customer's product demands to a design center via communication circuits, input of tailoring information processed at the design center to the production plant closer to the customer, input of processed information to the production lines, and finally to delivery of products to the customer. The integration of computers and communications, that is C&C, becomes essential for manufacture in the information society. C&C technology guarantees a balance between the various aspects of society with regards to the problems of time, space, and the varied interests of people in the information society. Also, it is this technology that makes diversification possible, particularly in the manufacturing activity.

Manufacturing in the information society will go through many large changes in responding to changes in the structure of society and the advance of technology. The direction is towards diversification, distribution, automation, and the effective integration of each activity function, namely systematization. As the needs of the general public become more varied, the demands on people engaged in production will also become diversified. An integrated manufacturing system is an outcome of compromise between human beings, technology, and economic efficiency.

I am one of the members who first introduced quality control activity to Japan in 1946 at the recommendation of the Occupation Forces. From the quality control methods which we learned from the United States, the quality of Japanese products improved remarkably, and this promoted the development of our industry. We are very grateful to the many people who guided our QC activities.

During the course of integrating QC activity into our corporate activities, however, I raised several questions in regard to the American QC concept. The first question was the validity of statistical quality control. Statistical quality control by the QC department alone is liable to become static manufacturing activity. I felt that there must be QC activities based on the dynamic feedback concept, in which customer's claims are fed back not only to the sales and production departments but also to the research and development departments and management. In this way, the entire company dynamically cooperates in manufacturing high quality products.

The second question was the validity of QC only from the top down. The more complex production systems and processes become, the more difficult it is to secure quality only through the aims and awareness of top management. Quality is ensured by integrating the awareness and ideas of all the people who are engaged in manufacture. The ideal QC activity is one where everyone cooperates in the task of quality improvements, both from the top down and from the bottom up. This concept was developed into total quality control activity covering customers, all employees, and management.

I think that TQC (total quality control) is indispensable for building and operating an integrated manufacturing system in the information society. Educating all the people who work in production and raising their awareness is very important. Therefore, education on which Professor Linvill will lecture this afternoon will play a more and more important role.

Just as we are told to put new wine into fresh wineskins, so it is most important that in the information society, production systems appropriate to the social environment should be constructed. Products to be manufactured will include not only those hardware products where were a major force in the industrial society but also computer software in the narrow sense and software products in the wide sense which are information products. The day will come when the creation of new information, knowledge, and technology will be included in the concept of manufacturing.

It is not going too far to say that the role of IEEE in its second century is to promote the innovation of technology and its applications to support the healthy development of the information society. From the viewpoint of manufacturing technology, its role will be to promote the innovation of manufacturing technology and systems in which small quantities of various kinds of hardware and software products designed to meet individual needs are produced with high quality and low cost, rather than the mass production of a few kinds of general purpose products. For this purpose, the development of flexible manufacturing technology and systems is essential.

This slide shows an example of a system diagram of a flexible manufacturing system for hardware products.

This system consists of a technical information processing system, a control information processing system, a production system and a performance processing system. As can be seen in the figure, there are two major flows in the manufacturing system. One is information flow and the other is material flow. As a manufacturing system advances to a flexible manufacturing system, information flow plays an increasingly important role in this system. It is difficult to free material flow to any extent from geographical and time restrictions. However, information flow has been rapidly freed from geographical and time restrictions, thanks to the development of communications and computers. It is possible to distribute the production systems close to markets, and the technical information processing system and the management information processing system at the most appropriate places.

As shown in this slide number 7, each distributed manufacturing system function can be operated effectively by integrating it in a C&C network. Such a system can be named as a C&C manufacturing system.

The automation of production systems for mass producing fixed products will be rapidly realized by the application of current computers, robots, numerical control machines, and so on. However, for the purpose of meeting diversified needs flexibly and exactly, it is important to develop a design system which responds to individual customer's requests, that is an individual response design system. Moreover, it will be necessary to develop a design system that defines individual product specifications based on customers' conceptual demands, namely a creative design system.

The concept of a virtual plant may not be just an engineer's dream. In the virtual plant, the customers themselves can control, via C&C network, all the manufacturing processes, starting by submitting their product concepts, and ending by obtaining their exact products. Furthermore, we can expand our dream to the development of resource sharing plants in which production facilities and materials can be effectively shared among plants and enterprises dispersed throughout the entire world.

Before building a C&C manufacturing system, it will be necessary to solve many technical and system problems and to accumulate a great deal more know-how. It will be necessary to construct the system so that each intra-process, inter-process, and inter-plant system can be gradually integrated into a total system, aiming at the creation of a C&C manufacturing system. This slides shows a concept by which an individual production system is improved to become an integrated manufacturing system and further to become a C&C total manufacturing system. The horizontal axis shows organizational and geographical expansion which is governed by improvements in communications technology. The vertical axis shows the information levels increasing towards higher intelligence, with a corresponding need for the increased use of computer technology.

The system at the bottom left is to improve efficiency within the intra-process and intra-plant. In the system at the center, the function is expanded to a liaison system between individual processes and plants for maintaining continuity of manufacture, and it has an intelligent capability so that production directives can be given on-line. The system at the upper right becomes the C&C total manufacturing system where manufacturing is effectively conducted by integrating all functions from customers, material and component suppliers, production plants, design and management centers, and to distributors.

Slide number 10. In order to realize new manufacturing systems, it is vital to systemically integrate widely existing technologies, but it is also necessary to adapt newly innovated technologies and frontier knowledge. Keeping in mind the hardware manufacturing system shown in this slide, I would like to consider future trends in some important technologies.

Slide number 11. Automation of each subsystem in the production system is rapidly progressing by the use of computer aided manufacturing technology, robotics, and computer aided testing technology. However, intelligent robots must be developed for the purpose of processing, assembling, inspecting, and completing various kinds of products, particularly parts for products that have different shapes and functions. These robots must be able not only to repeat programmed motions, but also to recognize cubic objects three dimensionally, to process different products flexibly, and to assemble and inspect them based on instructions changing every moment.

Slide 12. The most manpower intensive area in present production lines is the loading, unloading, and transfer of materials and parts between processes. If it were possible to load or unload differently shaped parts without damage at the most appropriate places in the transfer handling cassette by intelligent robots, the material flow efficiency could be greatly improved.

Slide number 13. Present robots are large and heavy and can only perform simple actions compared with human workers. Much greater advances in material and control technology are still required. Also, progress in sensor technology is necessary, especially the improvement of sight, pressure, position, and angle sensors. This photo shows a linear sensor and an angle sensor using multi-layer ceramic technology. These ceramic sensors can output position and angle information directly in digital form and, therefore, should greatly contribute to cost reduction in digitally controlled machines.

Slide number 14. This photo exaggerates a simplicity of actuator utilizing multi-layer piezoelectric ceramic technology. They will enable us not only to precisely control the position and angle of machines, but also to replace pulse motors and will greatly contribute to miniaturization, low power consumption, and cost reduction of robots. Advances in microelectronics technology are, of course, essential for raising the intelligence of all machines, including robots.

Slide number 15. The rapid progress in laser technology will bring about a huge revolution in manufacturing technology. This slide shows a conceptual diagram of a super high performance flexible manufacturing system complex utilizing lasers. Optical fibers are used for communication of information between the process control center and each process machine or robot in order to avoid system trouble caused by electromagnetic induction and to secure reliability.

Slide number 16. At this stage, great advances in the technology of technical information processing systems are far more necessary than improvements in production system technology. In order to realize a design system able to interact with the individual response design system and the creative design system, considerable progress in the following technologies will be required:

Number one, knowledge processing technology for efficiently and promptly analyzing customers' requirements, and designing specific products and production procedures.

Number two, knowledge-base technology for accumulating the design know-how and engineering data base required for knowledge processing, so as to enable effective accessing.

Number three, analysis and synthesis technology for effectively and promptly executing modeling and simulation.

Number four, man/machine interface technology for designers' work stations, so as to enable designers to communicate with customers and computers effectively.

Slide number 17. In order to realize the C&C total manufacturing system, the virtual plant and the resource sharing plant have to be realized. To do so, advances in the following technologies are required in addition to those mentioned before:

Number one, C&C technology for organically connecting customers and production systems dispersed over wide areas.

Number two, information hierarchy technology for effective operation through each increasingly complex layer of design, production, acontrol, and management.

Number three, high grade software technology required for creation and alteration of systems, information control, and distribution control.

From those technologies that I have just mentioned, you can see that advancement in software technology is needed far more than in hardware. Without profound progress in software production technology in particular, it is not possible to respond to the development of manufacturing systems and their diversified needs.

Slide number 18. When I explain the importance of software production technology, I often make an analogy with Mt. Fuji, the highest mountain in Japan, the beautiful sacred moutain of Japan. The base of the mountain below the fifth station is vast and gives us a great feeling of stability. If we compare software markets to Mt. Fuji, the area below the fifth station would represent the markets for the general public, centering on application software, and the area above the fifth station would be the markets for high grade software.

Until the time a paved road was constructed to the fifth station, it took great effort to climb that far. However, at present children and aged people can reach the fifth station easily by car. If we develop software production tools which correspond to the road and the cars, anyone ought to be able to produce without trouble software for the general public. Just as more than 90 percent of the bulk of Mt. Fuji lies below the fifth station, so the majority of the software market is aimed at the general public.

The software production system may be realized by deleting technology related to material flow from the hardware manufacturing system.

Manufacturing systems in the information society must be intelligent and friendly to anyone so that everyone is able to participate in manufacturing. The integrated manufacturing technology for such a system must be composed of the most advanced technology available, not only robotics and computer aided engineering technology but also communications, computers, microelectronics, optoelectronics, software technology, as well as basic science, new materials, quality control, human engineering, and management engineering.

The advancement of integrated manufacturing technology and systems will make production more efficient and able to meet a greater variety of needs. There are loud voices citing the fear that the improvement in production and distribution efficiency might cause a reduction in employment opportunities and that the eager pursuit of greater productivity would cause the production system to ignore the human needs of the workers. If enterprises pursue short-term profits only and forget their responsibilities as members of society, these fears could become a reality. However, technology should be for the quality of life. Therefore, human beings ought to be the focus of all production activities, and technology should continue to progress towards the realization of "man and C&C" manufacturing systems centered on human needs. It is for this reason that we have expanded QC activities to TQC activities and that we, workers, researchers, and management, have aimed to develop manufacturing activities integrated with the social system, learning from the demands and complaints of customers.

The ideal that the "man and C&C" manufacturing system is aiming at is to create comfortable, natural working conditions for the workers, where they can interact easily with intelligent machines. As computers and robots are introduced into the production system, the retraining and transfer of skilled workers has become an important social task. This is because the workers need specialized training to utilize machines owing to the present immature technology of computers and robots. As technology advances and machines become intelligent, the man/machine interface will become friendly to human beings, making learning and operating an easy task for anyone.

It has also been pointed out that if the technology of advanced industrial countries progresses, the gap between them and developing countries will further expand, and the north/south problem will become worse. Some people propose to restrict technological progress in order to narrow the north/south gap. I cannot agree with this proposal. Advancement in technology is a result of human wisdom, and no one can hold back technological progress. I believe that the best way to help the poorer countries is by the advance of technology. The essential thing is to raise the level of education of the people in developing countries so that they can select the appropriate road and utilize the available technology.

Number 20, slide number 20. NEC Corporation has been engaged in research on voice recognition and synthesis technology for many years in order to make conversation between man and machines possible. Moreover, NEC has been challenging the development of machine translation technology, particularly an automatic interpretation telephone so that people speaking different languages can communicate more easily and so that internationally dispersed resource sharing plants can be freely utilized. To realize the automatic interpretation telephone, advances in knowledge processing technology are indispensable. This technology is essential for the realization of the individual response design and creative design systems. The development of the fifth generation computer is a step toward the realization of these objectives.

I have been studying English for over 60 years but I still cannot communicate to my satisfaction. It is necessary to learn each language and culture for deepening international understanding. I hope that the automatic interpretation telephone will make it easy to learn foreign languages and culture and improve international communication. The technology developed during the realization of the automatic interpretation telephone will lay the technological foundations needed for the production systems of the coming information society.

As we move from the industrial society to the information society, the industrial structure will change. Whether or not there is a revolution in manufacturing technology, employment confusion in the transition period will be inevitable. In order to make this confusion as small as possible, and to get it under control in as short a period of time as possible, technology must advance and new employment opportunities must be created. For this purpose, positive innovations in manufacturing technology will be a priority in the second century of IEEE which will not be restricted by the old production technology in the industrial society.

Thank you very much.

(Applause)

PROFESSOR D. RAJ REDDY: It is an honor and a privilege to follow a man of Dr. Kobayashi's wisdom and experience. He presents a number of important concepts for manufacturing systems of the future. In this discussion, I will highlight the implications of some of the key concepts proposed by him and suggest a research agenda for the second century of our society that's a consequence of such concepts and goals.

The main theme of Dr. Kobayashi's talk is that computers integrated with communications will be the foundations of manufacturing systems of the future. This important concept is being widely acknowledged as can be seen from the recent arrangements between General Electric and Angerman Bas (Phonetic) and the recent acquisition of Raum Corporation (Phonetic) by IBM. However, what probably is not clear is the full implications of Dr. Koyayahi's proposals, far-reaching proposals, on virtual factories and resource sharing distributed factories of the future.

Imagine a customer in a remote village submitting a product concept, controlling the design and manufacturing himself, and obtaining a custom-tailored product to suit his specialized needs. Fantasy? Not necessarily. It appears tugor earth stations based on spectrum techniques might be available in large quantities for under a thousand dollars, making it possible for every remote village to have a village information center equipped with powerful personal computers connected to a low cost earth station providing many services including entertainment, education, advice on local problems of health care, agricultural production and pest control. Science fiction you say. How can an illiterate person who speaks no English in a village with no power, with people with no understanding of computers and electronics operate, maintain, and utilize the most sophisticated invention of the human race?

Interestingly, we already have technical solutions to most of these problems that you raise. Can we have a system that will converse in the native language of the user? Indeed, yes, especially in situations involving restrictive natural language that is task dependent. Dr. Kobayashi's company, NEC, recently demonstrated a translating telephone from Japanese to Portugese involving a restricted dialogue.

Can we build a rugged super computer with mean time between failure of over 20 years? Again, yes. Current nonstop computer designs have a mean time between failures of over 10,000 hours or over one year of continuous operation. Increasing the mean time between failure to 20 or even 100 years is purely a question of architecture, not technology. Super computers capable of executing a billion instructions per second and a billion bites of memory will require less than a thousand square centimeters of silicon by 1985 and will require no peripherals other than voice, vision, and a link to the satellite earth station.

Can we build a computer that is battery operated which can be charged by solar cells? Again, obvious. The recent Deri general portable computer (Phonetic) designed and built in Japan weighs less than 4 kg. and has an IBM/Preci compatible system (Phonetic) with full 25 line display and runs for eight hours without recharging.

Can we build a system that can diagnose itself and assist in its own repair? I will come to this question a little later.

All I want to say is that Dr. Kobayashi's vision of virtual factories, distributed factories, resource sharing plants does not have to be a pipedream.

It should indeed be economically viable by the turn of the century. Dr. Kobayashi raises a number of interesting points, many of which are worthy of careful attention.

For example, he predicts the transition from mass production to special purpose custom production. He believes that we'll be manufacturing many information products, software products in the information age just as we manufacture hardware today. He suggests that augmenting statistical quality control with dynamic feedback from customers, sales, production, and R&D provides real time feedback to manufacturing. This will only be possible with an integrated computer and communications system. He proposes the distribution of the production system close to the markets while concentrating the knowledge and management of the manufacturing where the brains are. He predicts the need for white collar robotics, knowledge base systems for planning, scheduling, simulation, and production management -- tasks that are usually done by white collar workers in a factory.

Now I would like to discuss some other concepts that are likely to significantly alter the nature of manufacturing in the second century.

First is the concept of a self-operating factory, a factory that can convert raw materials into finished products with little or no human intervention. One can add other attributes to this basic concept. The idea of a micro-factory, a small facility, for example, that can produce a personal computer with the same economy as mass produced personal computers. The idea of a multi-purpose factory, again, for example, a factory that produces personal computers today, TV sets tomorrow, and transistor radios the day after. An inmentoriless factory (Phonetic), a factory, to use Dr. Frosch's term yesterday, that can virtually live off the land, use the raw materials available locally. A factory that possesses all these attributes must capture the knowledge about the products to be made, the raw materials to be used, the tools and fixtures; and many of these, if they're going to be multi-purpose, would have to be generic. We must have research about generic raw materials, generic tools, the generic fixtures, and so on.

A self-operating, multi-purpose, micro-factory that can live off the land comes close to the ideal Dr. Frosch wants for space manufacturing. Such a factory would be valuable here on earth if it can be produced today economically.

Second is the concept of a factory that can learn....second is the concept of a self-improving factory, a factory that can learn from observation and improve with practice. Consider an apprentice, a human apprentice, at a small motor manufacturing facility. He can look over the shoulder of an expert assembling a motor and learn to duplicate the sequence of the steps with little help. We are several years away from a computer that can look over the shoulder of a human expert and learn how to assemble a motor by itself -- that is how to write its own program for assembly from observation.

A human apprentice has another important attribute. He improves his performance with practice. We have no examples of computers that improve their performance with practice. We are far away from a computer system which can examine its programs, identify the potential sources of improvement, and compile the knowledge leading to a better performance; and yet, we must begin so that we may one day have systems that can improve themselves.

Third is the concept of a self-diagnosing factory, a factory that can monitor its own well being and discover the occurrences of abnormal conditions. The techniques of knowledge base diagnosis have been studied in artificial intelligence. Expert systems need human experts to provide the cause and effect rules. While this technique could be used in a self-diagnosing factory, we are likely to need an army of knowledge engineers to codify the knowledge. More importantly, a human expert may not even exist for a newly designed machine. What is required is a system, again, that can learn or discover its own cause and effect rules. To do this, a system has to have knowledge about itself.

Given a self-description in the form of structure and function and a number of sensors monitoring the status of the machine, it is possible to learn normal states of the sensors and flag abnormalities when they occur. The knowledge about the possible cause of a problem can be inferred from the structure/function relationship or more simply by keeping a data base of cause and effect rules acquired from observations of other systems of the same type.

Fourth is the concept of a self-repairing factory, a factory that can repair a malfunctioning unit. Such a repair could be accomplished in a number of ways:

By replacing the malfunctioning part. Where does this part come from? It could be from inventory. It could be manufactured in situ from generic raw materials. Or it could be produced through the use of automated reverse engineering techniques in which a new design would be automatically formulated to make a newly manufactured part through the worn out assembly of the rest of the system.

Repair by technology insertion in which functionally coolant and compatible part, which is not structurally the same, can in fact be inserted for a repair of the system.

The knowledge of our structure and function of a system must now be augmented by assembly and disassembly instructions, part/whole relationships, and manufacturing instructions for the parts to be made in situ requiring raw materials, tools, fixtures, and so on. If we are successful in developing a self-operating, multi-purpose micro-factory that can live off the land, which can also diagnose and repair itself, then we are not far from the self-replicating factory of Dr. Frosch, or going further from a self-replicating factory, even a small factory that can produce larger new factories. This could lead to an evolutionary growth of manufacturing facilities so that space colonies can be self-sufficient to a large degree.

What is needed is the same knowledge that has been developed for self-operating, diagnosing, and repairing functions. Given one such facility, the desired parts could be made, assembled, tested, diagnosed and repaired if necessary, and integrated into the rest of the factory. No new techniques will be necessary beyond the ones we've talked about.

What I have just proposed is an ideal. Many of these things might appear to be too far-fetched. But even if we can accomplish 90 percent of each of these goals -- that is 10 percent of the time there are human beings in a self-operating factory -- 10 percent of the time we need human beings to diagnose the factory, 10 percent of the time we need human beings to repair. Even if we could do these tasks 90 percent of the time, we would already have accomplished a major breakthrough in manufacturing. This is the agenda for the second century, as I see it.

Finally, Mr. Kobayashi raises two very important social concerns. One is about jobs, and the other is about poor and the disadvantaged nations of the world. It has been observed by a number of futurologists that jobs in manufacturing will follow the pattern of agriculture and that all of manufacturing in the United States will require less than 5 percent of the work force, or a potential loss of over 20 million jobs in the United States alone. What will these people do?

The hope is that the emerging technologies will create many more new jobs than the jobs that have been lost. And Mr. Kobayashi suggests that retraining and transfer of workers from the outmoded job skills to new technologies is an important responsibility for society at large and IEEE in particular in the second century.

The second concern he raises is that the technological progress will widen the gap between the haves and the have-nots, increasing the north/south disparity between the industrial and developing nations of the world. The answer seems to be not the transfer of wealth from north to south as suggested by the Brandt Commission (Phonetic) at the Kamkoon Conference (Phonetic), not shipping of tons of wheat and corn to the hungry, but rather transfer of knowledge, know-how, and literacy.

The great Chinese philosopher, Wan Sui (Phonetic), once said, "If you give a fish to a man, you will feed him for a day. If you give him a fishing rod, you will feed him for life." We must go one step further. If we teach him how to make that fishing rod, we will feed the whole nation.

Sharing of knowledge and know-how in the form of information products is surely the only way to reduce this ever-widening gap between north and south. The current technological revolution provides a new hope and new understanding. The computer and communication technologies will make it possible for a rapid and inexpensive sharing of knowledge. This technological progress will make it possible to have a global electronic society in which high quality custom products are produced economically and efficiently by the users themselves using distributed micro-factories, virtual factors, and multi-purpose resource sharing factories as envisioned by Mr. Kobayashi. I applaud his vision for the future.

Thank you.

(Applause)

MR. NALLE: Thank you very much, Drs. Kobayashi and Reddy. I'm going to exercise a privilege of the chair and waive the question and answer period until we get closer to schedule. And if we have time at the end of the program, we will bring up any of the speakers that you want to talk to.

But in deference to the other speakers, I think we ought to get back on schedule. So, Dr. Kobayashi, I'm not going to have a question and answer period right now. You should take your seat over here, doctor.