INSTITUTE OF ELECTRICAL AND
ELECTRONICS ENGINEERS

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THE SECOND CENTURY BANQUET

FRANKLIN INSTITUTE
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SECREPHONE TAPING AND TRANSCRIBING SERVICE
Administrative Headquarters
2874 Limekiln Pike
North Hills, PA 19038
(215) 885-3815
New York: (212) 425-7520

VOICE: Those who are standing, please be seated so we can commence our program. Will the late comers find their tables and please be seated.

And ladies and gentlemen....ladies and gentlemen, the President of the Institute of the Franklin Institute, Mr. Richard (inaudible), Dick.

(Applause)

RICHARD (INAUDIBLE): Thank you, Nat. And good evening ladies and gentlemen and welcome to the Franklin Institute. It's truly a great pleasure for us to have been asked to host this 100th Anniversary of the IEEE. As is our customer at the Franklin Institute, we will launch this evening's affair with a toast to Benjamin Franklin. Would you all please rise.

To this great man who has left us a rich heritage of human understanding and a full appreciation of the international character of scientific endeavor, may we wisely use the talents of our inheritance for the betterment of man and in the cause of peace, to Benjamin Franklin.

Enjoy your dinner.

VOICE: Your attention, please. We know that not all of you have yet completed your dinner but shortly we will have an unusual time schedule related to satellite broadcast to our many sections in the country and elsewhere and so now, ladies and gentlemen, it is my pleasure to introduce the Chairman of the Sponsors Committee of this Convocation, Mr. Lee Everett.

(Applause)

LEE EVERETT: Thank you, Nat, and good evening Uncle Ben and ladies and gentlemen. I don't know whether you know but I think our Mayor is on route here and that's why we're starting this program a little bit early. I want to thank the members of the Sponsors Committee. If you look in the wings you will see a number of tables. We are absolutely (inaudible) here in Franklin Hall and it is their hard work to publicize this great convocation that we are here in the numbers to celebrate our 100th Birthday. It is my pleasure to read to you a letter from our Governor, Richard Thornberg, Governor of the Commonwealth of Pennsylvania. Some of you may know that before he was a lawyer, he was an engineer. It's a pity....

(Laughter)

....he changed. Nevertheless, we do recognize the Governor as one of our own and I will read you his letter.

"Greetings, As Governor of the Commonwealth of Pennsylvania, I am pleased to extend warm regards to all those attending the dinner at the Franklin Institute in Philadelphia celebrating the centennial convocation of the Institute of Electrical and Electronics Engineers. We in Pennsylvania recognize the important role technological development has played in the economic growth of our state and nation. My administration's Ben Franklin's Partnership Program, which brings together business, educational and scientific resources, is designed to encourage technological advance and the development of high technology industries. We appreciate the contributions, the members of the IEE have made over the years, and we look for your continued efforts as the Institute starts its second century.

On behalf of all citizens of the Keystone State and as a fellow engineer, I offer best wishes for an enjoyable and memorable dinner. Signed, Richard Thornberg, Governor."

(Applause)

MR. COHN: Thank you, Lee. Now ladies and gentlemen, I have the great extreme pleasure of introducing the President, the current President, of the Institute of Electrical and Electronic Engineers, Dr. Richard Gowen. Dick.

(Applause)

RICHARD GOWEN: President (inaudible), members of the Franklin INstitute, distinguished convocation participants, civic leaders, business leaders, Presidents of the IEEE, members of the IEEE Executive Committee and members of the IEEE Board of Directors, fellows, members and medalist of the IEEE, organizers of this convocation, ladies and gentlemen, it is indeed a pleasure to be together this evening in such a beautiful location. We meet under the eyes of perhaps the gentleman we recognize as foremost to be America's first electrical engineer. This evening is a very special evening. Shortly we shall be joined together with a 130 other sites in an international telecast of the activities of this evening.

I would like to ask you as you sit here this evening and shortly dessert will be served to go back in your minds to a time 100 years ago, in a city slightly north of here, known as New York City, in which a group of people much as those of you this evening, tonight, came together, the inventors, the leaders, the engineers, the scientists of that day, and they came together to form an organization, an American organization, an organization to greet the visitors from abroad who were coming in the fall of 1884 to Philadelphia to the Franklin Institute for the International Exhibition, the Electrical Exhibition, which was to be held less than a half mile from where we sit this evening.

YES, the IEEE was formed, on May 13, 1884. Tonight we are here to commemorate the First Technical Meeting of the then brand new American Organization for electrical engineers. That Technical Meeting was held on October 7 and 8, at the Franklin Institute.

Over the years we have seen tremendous changes in our technical progress. We have found the electrification of our cities, we've watched the digital communications of the telegraph be replaced by, as Bob Lucky today told us, the analog communications of Bell. We've seen many changes over the years. We found ourselves engaged in the most mysterious and exciting radio era and the IRE was formed in 1912. The IRE and the AIEE are our predecessor organizations. Over the years we've watched the electrotechnology that we are part of continue to grow. We found that through World War I there was a joining, a linkage, across the oceans of the allies and as we entered into the period of the 30's the world set about electrifying mankind in our cities. We found that as we entered World War II, electronics came of age and Philadelphia plays a very, very special role in the development of our technologies because over the years not only did we have our first Technical Meeting in Philadelphia but we also went on to see many inventions and developments from radar to (inaudible) and other great achievements come out of this fine city. It was following World War II that we found in Philadelphia, just again a few blocks from where we are, that the Morris School of Electrical Engineering, the ENAC was unveiled, the first modern digital computer. It weighed a lot, 30 tons, and used 150 kilowatts, it had 18,000 vacuum tubes and most miraculous of all, it worked. It could actually do a calculation. What a marvelous testimony to the development of electronics to be able to take all of those tubes and turn a switch on and have them complete a calculation in the miraculous time of seconds. It was a year later, in 1947, that at the Bell Telephone Laboratories we saw the invention of perhaps the device that has changed our way of living most of all. And that was the transitor. (Inaudible) Bardine brought to us a most miraculous development and we have seen that evolve into the computers of today into our technology, into the communications systems that this evening will tie us together throughout the world. It is indeed a very special time that brings us together here and I would like to ask you as you go through this evening's program to bear in mind the many giants who have proceeded us. We will be ever mindful during the evening of the statue of Benjamin Franklin but please bear in mind the many greats who have gone on and those of us who are able to be in this room this evening. It is indeed a very, very exciting and auspicious occasion.

I'd like now to just take a very brief moment and to recognize the tremendous number of (inaudible) who are in this room and I'm sure you can understand that it would not be possible to name each person but as a group I would like to take figuretively my hat off to each of you and thank you for your accomplishments and your willingness to participate in this most historic program.

Ladies and gentlemen, as with all technology, there are some constraints. We will have shortly an opportunity for you to take a break, should you want to be more comfortable during the ensuing hours of the evening. However, I must ask your cooperation. I ask that everyone be back in your seat by 8:20, very, very sharply at 8:20. We will go on the air live from this location at 8:30, with opening remarks in the evening program. We would like to keep movement in the room to a minimum and therefore it is most important that if you choose to leave your place and take a break that you do so between now and 8:20. Rest rooms are in the lobby on this floor, immediately beyond the stage. There are also rest rooms above and below on the floors. Sometimes it's important to take care of the necessary functions of life. Again, I ask your cooperation in being prompt and please return back to your seats by 8:20.

In closing, I thank you so very much for being here. We'll start our program at 8:30 sharp. Thank you ladies and gentlemen.

(Applause)

VOICE: In May, to represent its future, the IEEE brought together ten of its 40,000 student members, selected competitively from each of the ten (inaudible) regions around the world. We are pleased that the students selected by IEEE Region 2, the Region in which Philadelphia sits, is with us tonight to share our Second Century Banquet. I should like to ask her to rise and be recognized.

Ladies and gentlemen, I present Patricia Nunn, from the Divine Institute of Columbus, Ohio, symbol tonight of our student leadership and of the youth that will take us into our second century. Patricia.

(Applause)

Tonight, we are honored to have the Mayor of the City of Philadelphia as our guest. Mayor Wilson Goode, you honor us with your presence on this memorable occasion, which recognizes two events of major importance that occurred 100 years ago today in this great city when the Franklin Institute hosted America's first International Electrical Exposition and IEEE held its first technical meeting. In recognition of these historic events, having taken place in your city, and on behalf of the IEEE, I am pleased to present you with the Centennial Medal and Certificate. Sir, would you please come up.

(Applause)

MAYOR WILSON GOODE: Thank you very much. The second century for the Electrical Engineering profession begins at a time when American cities enter an era of renewed growth and high expectations. The future success of our cities will depend on purport application of new technologies. I thank you for your recognition of this city as a place where the seed of IEEE was planted and I look forward to this evening being the beginning of an equally glorious era for all of us.

On behalf of the City, thank you very much for this honor and we hope we can live up to it. Thank you all very kindly.

(Applause)

MR. GOWEN: In this very special year of the IEEE, it has been my occasion to visit with a number of members, not only in these United States but throughout the world. As you know, the IEEE holds a quarter of million numbers located in 128 countries, organized in 251 sections. During this period, we have talked about the issues of concern to the IEEE. I'd like now very briefly, as we begin to prepare for this evening's program, to share with you some of those issues. And to make it very simple and I tend to like to keep things as simple as I can, my engineering professors taught me well, I have chosen to use four letters. You'll recognize those letters relatively easily. The first letter I'd like to use is the letter I and the "I" deals with the image of our technology and this evening is an excellent time for us to share in the glow of our tremendous achievements in this century of progress. So if you will remember the "I" stands for the image of our technology. The next letter I have chosen is an "E." And that "E" stands for the exchange of technical information because the IEEE was formed as the IEE 100 years ago to enable all of us to share on technical information.

So we have an "I" for the image and understanding of technology and an "E." The "E" standing for the exchange of technical information. You might guess that the next letter is also an "E." And to make that easy, I would like you to think in terms of this very distinguished building we're in this evening, this great hall, because the second of the "E's" relate to excellence. And in this, our centennial year, I would urge all of you in this room to speak out in support of excellence. And ladies and gentlemen, it should be no mystery to you now but my fourth letter is also an "E" and that deals with education because the heritage of the IEEE has been a heritage of education, not only of ourselves as engineers to serve the public but also of the future engineers and for those who are all part of mankind in our civilization. As a special effort this year, the IEEE has focused on the problems in elementary and secondary school education. We are pleased to say that in two weeks we will begin the effort for a very, very important conference which will be held in November, November 8 and 9. That conference will bring together a 100th societies, from engineering, from science and from the education professions, to join in linking together to work for the improvement of education.

So, in conclusion, I would suggest to you that perhaps you will remember "I" for image; "E" for exchange; "E" for excellence and "E" for education and you all know that that's the IEEE. And with that, it's a very proud and very fine evening. I'd like now to give us a brief break because we're about to begin our telecast.

Ladies and gentlemen, thank you so very much for being with us. We shall go on the air in just a few moments. Thank you.

(Applause)

(Pause)

MR. GOWEN: Ladies and gentlemen, the Institute of Electrical and Electronics Engineers is proud to begin this Centennial Technical Convocation with greetings from the President of the United States.

PRESIDENT RONALD REAGAN: Ladies and gentlemen of the Institute of Electrical and Electronics Engineers, I am delighted to have this chance to talk to you at your Centennial Technical Convocation at the

Franklin Institute in Philadelphia. On behalf of the American people, I congratulate you on your 100th Anniversary. The history of IEEE spans a remarkable century of technological progress. Over the years your members, now a quarter million strong, have proven there's nothing we can't do if we set our minds to it. And each breakthrough lifted us to a new, better and higher plateau, paving the way for great gains in our daily lives in the security of our nation and for the next generation.

I can remember, and believe me, it doesn't seem long ago, those first days of radio and as I think back to my early broadcasting days in Iowa, it's almost unbelieveable to think how far we've come. From radio to T.V., transistors, computers, fiber optics, macro-electronic chips and so much more. Yours is the work of a true revolution and one that rises from the deepest yearnings of the human spirit to challenge the limits of knowledge and to put the power of discovery at the service of progress. You've been and you remain the pulse of America's technological power, the cutting edge of our worldwide technological leadership. You apply the theories and principles of science and math to practical problems and your work shares as the link between scientific discovery and every day application. You're the real heroes of high tech. And you have good reasons to be proud of your accomplice achievements. And today, you and your industry continue to lead us into the future with expanding markets, new jobs and exciting progress. You've open the door to great advancements and productivity which would have been considered unthinkable only a few decades ago. No wonder electronics has been at the forefront of America's wonderful economic expansion and I don't doubt you'll remain right there.

We look to you for innovation and excellence and you never let us down. Nowhere is this more true than America's next frontier, the vast frontier of space. We've already benefit daily from a mounted revolution and worldwide communications. We can anticipate tomorrow's weather and prepare for it. Space technology has brought one life saving breakthrough after another. Our space shuttle system is opening a new era to pursue exciting sound of medical, educational, industrial and commercial opportunities of space. And none of this would have been possible without the contributions of IEEE members. Call me an optimist, but I'm convinced that we've only seen the beginning of what we can accomplish in space and right here on the ground.

When I read the theme of your Centennial Convocation, the Second Century Begins, I couldn't help think that as you sit in Philadelphia the spirit of Benjamin Franklin is still there with you. It's been said of Franklin that he was not one of those men who owed his greatness merely to the opportunities of his time. In any age, in any place, Franklin would have been great. Mine and will strenghtened grace for the benefit of our fellow man. It's this spirit that carries you forward into your second century, from the shrinking microchip to the expanding horizons of space, your work is going to continue to dazzle our imagination and continue to move us forward by leaps and bounds.

To your president, Dick Gowen, and to all of you, congratulations once again on your anniversary and best wishes for a successful and enjoyable convocation.

Thank you and God Bless you all.

(Applause)

RICHARD J. GOWEN: Good evening. I am Dick Gowen, President of the Institute of Electrical and Electronics Engineers. I extend a warm welcome to the Second Century Banquet of the IEEE, Franklin Institute's Centennial Technical Convocation. It is indeed gratifying to hear the remarks of President Reagan in recognition of the role of electrical engineers and implying the theories of science and mathematics to the solution of problems in society. In response to Mr. Reagan's call, we at the IEEE accept the challenge to continue to seek innovation and excellence in the practice of our profession.

This evening's program originates from the Rotunda of the Franklin Institute in commemoration of two events of great importance to the IEEE that occurred 100 years ago. The first of these events was the convening of the International Electrical Exhibition, held from September 2 to October 11, 1884. That Exhibition was held here at the Franklin Institute. This historic Exhibition was convened to show the world the marvels and achievements in the new and exciting area of electricity. American inventors had recently demonstrated efficient electrofication systems to light our cities, Bell's patented telephone was beginning to be recognized as an improvement over the telegraph for business communications, electricians and scientists throughout the world planned to travel to Philadelphia to learn of these miraculous achievements.

As the 1884 Electrical Exhibition was being planned, there was no American organization comparable to those in other parts of the world. A group of inventors, engineers and scientists came together in New York to create an American organization to appropriately greet their counterparts from abroad. Thus, to provide for the exchange of technical information at the forthcoming International Electrical Exhibition at the Franklin Institute, the American Institute of Electrical Engineers was formed, on May 13, 1884.

The second event we commemorate tonight is the First Technical Meeting of the AIEE, which was held at the 1884 Exhibition on October 7 and 8. At the beginning of its first century, the leaders of the

. AIEE came together to discuss the important technical questions of that day. Since that time the IEEE....the AIEE has merged with the Institute of Radio Engineers to become the Institute of Electrical Electronics Engineers. Now the world's largest technical professional organization, with over 250,000 members and in 128 countries, we come together this evening once again to call on representative leaders of our technologies to address the issues of our day.

Appropriately, as we enter our second century, this meeting is perhaps the largest technical meeting of its kind. It is being broadcast from the Franklin Institute to 44 states in the United States, to Canada, to Mexico, to Jamaica and Puerto Rico. It is a pleasure to introduce tonight's host, Edward E. David, Jr., President of Exxon Research Engineering Company, formally Executive Director, Bell Telephone Laboratories, Research Communication Principles Division, and Executive Vice President of Gould, Inc. Dr. David has also served as Science Advisor and to the President and Director of the White House Office of Science and Technology. Ed is an IEEE Fellow and member of the National Academy's of Engineering and Sciences. Dr. David.

(Applause)

EDWARD E. DAVID, JR.: Thank you very much, Dick. I want to say it's an honor and a pleasure to take part in this technical convocation in honor of the IEEE's Centennial. I want to extend my welcome to the members of this audience but also an especially warm welcome to the more than 130 sections and student branches of the IEEE joining us for this historic event via satellite communication.

And on behalf of all IEEE members, we welcome the members of the public viewing these proceedings over cable and public television stations around the country.

As you've heard by being here at the Franklin Institute for this occasion, we are returning the IEEE to its beginnings. It was here that IEEE held its first technical meeting 100 years ago. But our role tonight is not to look back but it's to look forward. The scientists and engineers who spoke here 100 years ago were preoccupied by the possibilities and the opportunities of the future, and so are we. Our theme is The Second Century Begins. Duir

During this technical conversation, which began earlier today, the leaders in industry and the universities have been examining questions critical to members of the IEEE and to the world's society. What major technical developments will occur in electrical and electronic technologies in the second century and how will they effect the economy in our institutions. In recent years, the public has often heard the message that the future isn't what it used to be. But so far our speakers have disagreed with that rather gloomy assessment. Despite what they see as some formidable difficulties, and engineers are always good at seeing what the difficulties are, they look forward to a second century of achievement that could make the first century pale by comparison.

This evening, our distinguished Keynote speaker and panelists will consider these issues in their broadest context.

Later, you and the audience will participate in the program by submitting your comments and questions. And I'd like to be a little specific about how you do that. We encourage you to begin to formulate and write down your questions as soon as they occur to you during the presentations. Those of you who are here at the

Franklin Institute will find cards at your tables for the purpose. After filling them out, just pass them to the sides of the room where we will collect them. Those of you in the remote sections and student branches can telephone questions as soon as you have them, using the 800 numbers provided to you.

Now, on with the program. Before introducing our Keynote speaker, let me name our panelists. First, there's Professor Charles Townes, Nobel Prize Winner. Alvin Toffler, Eminent Author and Idea Generator. And Dr. Joshua Lederberg, Nobel Prize Winner.

Our feature....I'll say more about these people later. You know them well, I think. through their reputations.

Our featured speaker is one of the great pioneers in our field and a former president of the IEEE, Bernie Oliver. He joined the Hewett-Packard Company in 1952, where he rose to the position of Vice President for Research and a member of the Board of Directors. Barnie Oliver has played a major role in making Hewett-Packard one of the most important and respected companies in our industry and in fact in industry generally.

Recently retired, Barnie still serves as Technical Advisor to the President of Hewett-Packard. Like many in our industry, Barnie got his start at Bell Telephone Labs where he worked on television research and radar development and delved in many things which I can tell you about personally, if you're interested sometime, on the side.

Among his many honors, he's been elected to both the National Academy of Sciences and the National Academy of Engineering. IEEE members will also be interested to know that Barnie recently accepted a position as head of NASA's program to search for extra-terrestrial intelligence.

And now for our Keynote Address. Barnie Oliver.

(Applause)

BERNARD M. OLIVER: Thank you very much, Ed. I have to remark that when you talked me into accepting this obligation, you didn't tell me I was going to be preceded by President Reagan. If you had I would have suggested that you just let him go on for 26 more minutes and it would have saved me a lot of trouble.

However, I took on the obligation and I shall try to do the best I can and so I would like to say good evening to you people of the IEEE and your wives and spouses and hello to friends everywhere who are listening in through the vehicle of satellites tonight. This is a widespread broadcast.

I'd like to begin by sketching the development of our electrical and electronics industry and our technology over the past century. And then I would like to try to make some feeble projections into the century ahead, some things that might happen if present trends continue. And finally I'd like to suggest to you all that present trends won't continue unless we take some concerted action to educate the public about technology and what technology really means to our society.

It would be wrong to give the impression that the age of electricity is only a century old. It really began with Galvante and Rolta developing the battery. the primary cells that furnished for the first time electric currents in substantial magnitude. Before that, in the....what I call the Cats' Fair and Amber Days of Electricity, it was much simply a scientific curiosity.

It wasn't much of a practical issue at all. Now, of course, in these surroundings, with particularly Ben staring at me with his benevolent gaze, it would be in error not to mention his experiments with kites, which we all know about, and while these lead to the concept of the lightning rod, I would submit that they did nothing to harness electricity for man's use. They may have promoted his understanding of electricity. But large primary batteries provided for the first time electric circuits of substantial magnitude and these currents, as this Englishman charges those things, were what enabled Ampere and Ohm and Henry and Parade to discover the laws that related electricity and magnetism. That wasn't possible before that time.

It's interesting to me that the first practical use of electricity was in the transmission of information, not in power, not in lighting or anything like that, but in getting signals across which we're still trying to do today. Joseph Henry invented the electromagnet in 1827 and almost immediately he built the first electric telegraph. It was a simple signaling device that when he was in his shop enabled his wife to call him to dinner, but it was a true telegraph. It got the message through. The true telegraphs of (inaudible) and Morris were invented three years later and the telegraph was a success because it was needed by and used by the railroads to communicate time schedules and that sort of thing. I would say that it was steam and electricity together that united these United States.

Forty-six years later, after the invention of the telegraph, a patent for the electric telephone was issued to Alexander Graham Bell and very soon the streets of our cities were disfigured by a maize of telephone poles, cross arms and wires. One has only to look at these early pictures to realize what an important invention the telephone cable was. Today, hundreds of times as many telephone lines buried....lie buried out of site in our cities and the future will bring tens or hundreds of times even more of optical fibers.

The really high part uses of electricity, lighting, heating and electric multi-power, had to await the development of the dynamo. Electric batteries simply are not adequate sources of energy for these applications. The laws of Ampere and Farade provided in 1831 the scientific basis for all motors and generators and it was true that crude motors and generators were built at that time. But while these laws definied the topology of the intertwined iron and copper involved it took nearly 50 years to refine the geometry to the point where motors or generators of significant efficiency were built. It took that long to learn how as (inaudible) says, To wrap some copper around some iron in the right way so that water falling at Boulder Dam can raise elevators in Los Angeles.

(Laughter)

Why did it take so long? Why did it take a half of century? I suspect because the few people who thought about it at all were untrained and largely impurical in their approach. There were no electrical engineering departments in those days and there is no institute of electrical and electronics engineers. They were on their own. But this chronology now brings us to 1984 and both the birth of the IEEE and its predecessor, the AIEE, and to the First Electrical Engineering (inaudible) from MIT. Other universities soon followed suit, Cornell, U.C. Berkely and Stanford, to name a few.

There could be no doubt that the academic training provided by these early institutions was largely responsible for turning the impuricism of the early inventors into true engineering. The strong theoretical training received by electrical engineers then has grown even stronger today and it probably accounts more than any other single factor for the way electricity and electronics have penetrated every aspect of our society. The trickle of the 1800's has today become a torrent.

The major applications of electrical power for the two decades before and after the turn of the century were in electric light, first arch lighting and then incandescence lighting and they were in the electrification of factories whose electric motors replaced steam and in electric streetcars and into urban railways and trains, things that have vanished from their scene today. But there was activity in communication, also. The theoretical work of Maxwell and Hertz led to the discovery of electromagnetic waves which Marconi in 1901 demontrated across the Atlantic Ocean. Wireless, long distance telephone, radio broadcasting and talking pictures were the principle developments of the early decades of this century. World War II greatly expanded the scope of electronics. The cadmium magnitron suddenly provided a source of million watt pulses a millions of a second long. At frequencies so high that modest sized antennas could produce sharp beams. This beam, electromagnetic thunder clap, was exactly what was needed to scan the skies for approaching aircraft or the seas for approaching ships. Earlier radar equipment at Pearl Harbor gave clear warning of the impending Japanese attack. But no one trusted the new gadget enough to believe the awful truth and so its mute warning went unheeded for the first and last time. Months later, radar was sinking unseen ships in the Pacific and turning the tide of war. Sonar, automatic guidance systems, proximity fuses and service systems were other World War II developments.

After the war came such a flood of new applications in developments that I can only mention a few. Commercial television, digital computers, the transistor and the laser and, of course, in more recent years, the integrated circuit, which allows hundres of thousands of transistors to be interconnected on a tiny chip of silicone. The enormous versatility of these devices has led electronics into every conceivable field, into astronomy, into medicine, into process control and factories, into business and banking, into aviation and space, to name a few. Our whole space program would not be possible without modern electronics. Nor would it have been as valuable. Today, communication satellites link the entire world with television as the telegraph once linked cities. Spacecrafts send us pictures of the surface of mars or the moons and rings of Jupiter and of Saturn. Here is a picture of Olympus (Inaudible), the largest volcano in the solar system. It is on Mars. Thirty years ago I would have never had thought in my wildest dreams that I would ever see such a sight and what I see has turned sideways.

(Laughter)

From farther out in space, radio telescopes are revealing new facts about the structure and evolution of the galaxies. Charged coupled devices are replacing photographic film in optical telescopes and they are giving thereby hundred fold increase in sensitivity and an increase in spectral response, too. The present rate of technological advances shows no rate of slowing down. In fact, it still appears to be accelerating. So we might ask ourselves, What will the next century bring. I would say that all anyone can do, except for perhaps Bob Lucky, who did a very good job this afternoon, is to extrapolate present trends a little way into the future. No one can predict the big discoveries like the vacuum tube or the transistor or the laser. These are the things that produce revolutionary changes. These are what makes life truly interesting to many of us. I have heard some people complain of what is called "future shock." "Future shock" I want you to know is what keeps me alive and going. I need it.

(Laughter)

Looking ahead we can see computers becoming much more powerful and much less expensive. We can see optical fibers linking homes and stores and offices as telephone wires do today. This will greatly change our lives by providing high quality point to point closed circuit T.V. T.V. conferencing may replace much of our business travel, or it may not, depending upon what we want to do when we travel on business. Wideband access to large computers and data bases will be possible from home. With video discs and other large scaled memory devices, together with cheap computers, I can see the day when our schools will offer not computer aided education but computer based education, with teachers playing the role of interactive tutors rather than the primary source of information. One advantage of such a system is that the teachers might be educated by it also.

Nuclear magnetic resident is developing rapidly into a safe and powerful diagnostic tool. Like X-ray CAT Scanners these NMR Scanners can reveal small tumors anywhere in the body without exposing the patient to radiation. Laser surgery of brain tumors will become a standard operational procedure. Already, gleaomas, those very rapidly growing tumors of the brain, which were once thought to be inoperable, have yielded to precise location methods and to delicate laser surgery. Great progress is being made in this field. Electronics, which has so broadened our range of communication on earth, putting us in close touch with anyone on earth, may some day put us into communication with intelligent life on planets around other stars. As you have heard, I am personally involved in the early R&D phases of such a program, the search for extraterrestrial intelligence. It's a long shot but success would have such a profound effect on our future that many scientists believe it is worth the effort. The chances of success with present receiving antennas is small but we should start out using them. Only after a failure can we argue that a larger dedicated facility is necessary. But if we persist with every larger and more sensitive receivers the day will come when we find ourselves in touch with the galatic network. Technology will then have ended our isolation among the stars. It may even happen in this century.

The microprocessor is finding uses in everything from quartz watches and pocket computers to soft diagnostics and automobiles. One rapidly developing application is in robotics. We aren't really building robots yet that stark about and glare at you at deep set red eyes and we probably never will, except for (inaudible) films. But what we are building are manipulative arms with sensors that can do an increasingly complex set of jobs, such as welding, painting, parts insertion and assembly. Distributed intelligence is needed for the automated factory. We are not there yet but many tedious jobs are being done faster and better by these so-called robots. The unions may resist these robots as they have resisted previous labor saving devices. That is true, they do so on the grounds that they will displace labor. They do that. But after a while the unemployed find other and usually more satisfying jobs and the unemployment gets distributed throughout the population. Throughout our society in the form of shorter working hours. We call it, leisure time. We work half the hours that our grandparents did and yet our lives are far richer. That is the true consequence of our technology. Yet how often we hear technology blamed for many of the world's ills. My favorite character is the guy who wakes to radio alarm, shaves with his electric razor, showers while his automatic pot brews his morning coffee, backs his car out as the garage door automatically opens and then closes, rides to work listening to music and the world news, ascends to his office in an automatic elevator, has his secretary get him reservations on the jet for a speaking engagement in Chicago that night, then picks up his tape recorded and dictates his speech, a scaving denunciation of modern technology.

(Laughter)

The major change inour society over the last century has been its conversion from a technologically primitive one that everyone understood to a technologically sophisticated one understood by only a few. This widespread ignorance about technology and science is at the root of many of our problems today, in my opinion. When I was in college I was first to take history in foreign languages and other liberal arts courses whether I wanted to or not, on the grounds that I would not have a broad enough education to understand the world unless I did. Today, I think most college graduates are technologically illiterate. I think the time has come to turn the tables. I think the time has come to require every college student to have a certain minimal exposure to science and technology on the grounds that they won't have a broad enough education to understand the world unless they do.

(Applause)

Unless the majority of our citizens are well enough acquainted with technology not to fear it, we cannot expect good political decisions with technological factors involved. A case in point is the needless break up of the Bell System. Believing only that big is bad, even when regulated, and not understanding the technological rationale from monopoly in public utilities, our heroes in the Justice Department have succeeded in crippling the greatest telephone system the world has ever known as well as the greatest research facility in the world, the Bell Telephone Laboratories.

(Applause)

Another case in point is the great controversy over nuclear power. The public first became aware of the power of the item after the first atomic bomb. Because of this violent introduction and because of the irresponsible way in which the military ignored the hazards of radioactive fallout during the Nevada and the Pacific tests, nuclear has come to mean danger in the public mind. A rather paralleled situation that arose a century ago when alternative current was first introduced. AC had first come to the public's attention with its use in the electric chair in Sing Sing. And a controversy arose over its safety. I am told that at noon everyday, at Central Park South, the testers would demonstrate the danger of AC by electrocuting a dog. Empathy seems to have been in shorter supply in those days. Some day the public may accept nuclear power the way it is accepted alternating current today but to reach that happy state we're going to have to bring the facts before the public. There are some other technology activists at the core at the anti-nuclear movement, modern (inaudible), who say, Even if I was convinced that nuclear power was absolutely safe, I would still be against it. But the vast majority in the movement is simply ignorant of the facts and therefore is easily scared by someone who intones to them, what if. I think it's time we took a look not at what if but at what is. Of the 1.1 Million accidental deaths in the U.S. in the decade from 1967 to 1976, about half were due to auto accidents. That perhaps is no surprise. But it is a little surprising that about 170,000 deaths came from falling. Simple falls. Next, drowning and fires called about 60,000 each. Poison took 52,000 lives in this period and guns called another 24,000. Aircraft accidents, including private planes, accounted for 17,000 deaths and 11,000 people were accidentally electrocuted. Perhaps the bad thing about nuclear power is not the nuclear, it may be the power. Have we ever considered that. Finally, at the bottom of the list of accidental deaths, we find that 5,700 came from mining accidents. 1,100 people got hit by lightning and now the cause of all the furor, radiation, killed three people. But none I might add in nuclear plants. I think it needs to be said loud and clear that nuclear power that we already have has injured no one. Rather, it has saved hundreds of coal miners' wives. It needs to be said loud and clear that the difference between weapons material and nuclear power fuel is the difference between gasoline and asphalt. The one will explode; the other won't. It needs to be said loud and clear that we live in radiation all the time and that nuclear power would not significantly increase this natural background. It needs to be said loud and clear that the radiation from nuclear plants is less than that from coal plants. There is not a single coal plant that comes within the factor of ten at meeting NRC radiation standards for nuclear plants. And this is all in addition to the carbon dioxide and the acid rain that they produce. It needs to be said loud and clear that waste disposal is a problem with coal but not with nuclear because there is so little of it. Finally, it needs to be said that there are 4.3 Billion tons of uranium in the sea. Enough for a million years of electrical power for the whole world and it appears economically feasible to extract it. These things need not only be said, we need to say them.

(Applause)

Of course another important reason for going nuclear is to save our oil and gas for mobil power. We had this fine, abundant and safe source of electric power in the atom but we can't run tractors or fly planes on nuclear power. We may be able to find a renewable or inexhaustible source of (inaudible) in the vegetable world, perhaps in latex producing plants, perhaps in genetically modified methanogentic bacteria or algie or perhaps in that fabulous copa eva tree. This remarkable tree already is known to produce ten gallons and may be able to produce 200 gallons of diesel fuel for tree per year. You know, you can tap the tree and put it in your diesel. All the genes need is something to make a hose, you know, on it. Need a crank.

If the latter figure is true, the Amazon Valley could produce three times the present world oil needs, forever. Maybe that's the way to use solar energy. Let it grow green things. It does that very well indeed.

I would think that research into the organic production of hydrocarbons would have top priority today but I'm not aware of much activity in this area. Until we have a solution at hand, we should not waste oil, gas or coal generating electricity. Now I think it's going to take some time to reorient schools and colleges so their curricula include technology education for everyone. I'm afraid we can't wait. If the public is to be reoriented in its attitudes, we scientists and engineers are going to have to tak e a more active role. In a recent issue of the publication of IEEE, The Institute, Al (inaudible) has an interesting suggestion. He proposes that OCtober be designated Science and Technology Awareness Month, and that during this month members of the Physical Society and the Chemical Society and the IEEE and others volunteer to give jargon free talks on what we do and why we believe it is important to the world. Talks to be given before the Chamber of Commerce, Lions, Kiwanis, Rotary or any appropriate civil civic or service group and I would add schools to that list also. There is a lot of educating that needs to be done in our schools. He says I find the public is fascinated by science and technology and is willing to learn about them and the things they produce and it helps if things are put in terms they understand and if the explanation comes from a friend or a neighbor. I think this is a great and timely idea. I recommend it to all of you.

It's time we began to think about survival and not just for another century, not for just a millenium, but for a billion years or more. It's time we began to develop the technology that will enable our indefinite survival rather than the technology that threatens our sudden extinction. If we can do all of this, and I think we can, I think we face an exciting and indefinitely long future. Thank you.

(Applause)

MR. DAVID: Our first panelist is a man chiefly responsible for the science and technology behind one of the seminole inventions of our times. It was in 1964 that Charles Townes was awarded the Nobel Prize for Physics for his fundamental work leading to the development of maizes and lasers. Like Barnie Oliver, Charlie is an alumnus of Bell Labs. After leaving the Labs, as it's called, in 1952, Charlie pursued an academic career which brought him eventually to the University of California at Berkeley where he is now University Professor of Physics. Charlie has also served many times as an advisor to the U.S. Government and that has included service, as Chairman of the Science and Technology Advisory Committee for the Appollo Lunar landing and as Chairman of the well known Towns Commission which was appointed by the Defense Department to evaluate various basing modes for the MXX missile. This is an all too brief introduction to a man who you all know and appreciate, Charles Townes.

(Applause)

CHARLES H. TOWNES: Thank you very much, Ed. It's a pleasure and a privilege to be here to help celebrate this wonderful century of electronics and electrical engineering. It's a pleasure to hear Barnie Oliver's fine talk. I would like to make three points. First, Dr. Oliver, otherwise Barnie, has commented that progress doesn't seem to be slowing down and maybe it's accelerating and that raises a question, How far do we have to go. How far will knowledge take us. Is it infinite. Or, sometime will our job be done. One might, for example, imagine that knowledge is like an island and you attack it from its shores and you explore all the island and then you know what's there and the physical universe might be like that. Or, one might expand from a center and as we push back the boundaries, exploring continually,the boundaries simply enlarge, always getting bigger we can see a little bit further into them, but we always see more in front of us then when we started even though we've covered a great deal of territory.

I think knowledge and technology is rather like the latter case. It's interesting that in the world of physics the most fundamental and we thought simplest part of physics, fundamental particles, which when I went to school was comprised of only a few of the electron, the protron and the neutron came along. Further examination shows that these are made up of further systems, these are made up of further systems and so far as one can see, the (inaudible) physicists simply keep going into further and further depths of knowledge and even in that very relatively simple, we would think, in fundamental area, there isn't a limit and our progress can fortunately continue. Because this has been an exciting and an exhilarating century and one would hope we can continue to contribute particularly to the knowledge and scope of the human race and to sensualities for human welfare.

My second point, however, is that our field is a very young field, a rather bumptious field. If one wants to say it was born....modern aspects of it born 100 years ago, where are we now, I suppose in late adolescent, maybe young maturity, it's still pretty bumptious, strong, growing, ready to take on very deep responsibilities in the world and in fact they must come. With the materials in the field and importance to our civilization, those responsibilities must come more and more fully. The danger is not the possible limitation of progress from the point of view of the science of technology itself, the danger may be us, and a development into good stayed members of society who have got everything qualified and maybe getting into a middle age slump. That truly hasn't happened yet. Nevertheless, there are age effects which can occur. Not necessarily in the electro field as individuals. And where might those occur? I think the United States has been blessed with very rapid development, really an explosion of developments which have made us all feel free, comfortable in the future, ready to experiment, ready to accept new ideas, exchange ideas, welcome people from all fields into our field and transmit ideas across all boundaries. And that is what has made for the greatness of the American Science and Technology scene. Partly also it's been the willingness to take chances. In the business world I think everyone recognizes the importance of the small entrepreneur who takes chances and the small entrepreneur of a company which, while it may fail completely, will on occasion succeed beyong one's wildest dreams. We also sort of recognize the importance of letting everybody try their new ideas and supporting them but that's much harder to be convincing about. The reason is that research takes a longer time to develop. The transistor, I would say, began with Mervin Kelly in the 30's, initiating real work on modern (inaudible) physics and it's real use came only 20 years later and so is common with many developments. These things which Barnie has said, are the surprises and unpredictable and which make the real breakthroughs. Those being unpredicted....unpredictable are very unsatisfactory for a politician or even a corporation officer to support. Those people and we ourselves, each of us, like to try to figure out what are the consequences of our decisions. In the field of research where one can't know, that's put us in a difficult position. We also like to see the results happen within our term of office and so long terms research, the wild chances, the freedom for individuals to try their ideas, are always difficult to support. And in the planning which we must do and surely it must be hard and thoughtful planning as to what do in that planning we must make plans for the (inaudible), for the small operator, for the new ideas that not everybody believes in, to see that the spirit of youth and growth can continue.

The third point I would like to make is that the future is very much affected not only by the nature of our field but also by human aspirations. Almost anything can be done which is not contrary to some basic physical law. What gets done is primarily determined by human aspirations. And I think in that sense it's always interesting and hopeful to look at science fiction, representing man's dreams in a certain sense. The science fiction of the Greeks about Ditalus took a while to come true but here it is. 20,000 Leagues Under the Sea, which came true a little sooner. We wanted to go to the moon and we did. Those things to which we really aspire are those things which unlikely to be enabled and which are likely to happen. I sometimes think that the presses and interest in laser beams is because of Zeus's bolt of lightning and Buck Roger's ray gun. Those were some of the dreams, too.

Now in our aspirations, however, there are frequently conflicts. There are the aspirations of individuals or of nations to be completely free and independent, be able to make their own decisions, but there is also a necessary organization of society. There is even aspiration for dominance and control of other people. And those uncertain and conflicting aspirations which give us the most trouble and I am partly behind this very severe problem we have over the nuclear threat. There are aspirations also for a higher standard of living and yet, and having abundant natural resources for each individual, but there are also aspirations for children and procreation. And we have the problem of the third world in part coming about for what reason of the aspirations of both types being felt very strongly in the plight of the third world. The difficulty is enhanced by the increasing value and richness of technology. Technology, training, education, is in itself a wealth. We shall become, I'm convinced, less and less dependent on natural resources and normal products of the third world as we become more flexible, know how to use one resource instead of another and perhaps less dependent on what goods the third world has to offer.

So we have a conflict of aspirations there. Now I would say, Let's think hard about our aspirations and where they lead and with that the world is truly open to almost anything. Thank you.

(Applause)

CHAIRMAN DAVID: Thank you very much, Charlie.

Now it's time for the audience to begin to play its role. I hope you will take the blanks on your table and begin to write questions which would be intended to stimulate further discussions on items which might particularly interest you and to pass those to the side. Also, I encourage people in the audience outside of Philadelphia to begin to use the 800 numbers.

Now it's my great pleasure to introduce our second panelist. He's a man who has done as much as any person living to shape our understanding of the dramatic impact of technology on the world economy and the world's society. Alvin Toffler is the author of Future Shock and the Third Wave. These are two best selling books whose titles have become literally part of today's vocabulary. His books and articles have been published in some 30 languages and have become required reading for university students, prime ministers and Presidents. And I might say, in my own experience, my attention was called to Alvin Toffler's writings by President Nixon who was quite taken with some of his ideas.

Alvin presents a view of the future unclouded by idiological overlays and that may explain why he is probably the only person ever to address a National Republican Governors' Conference and a Democratic Party Convention on the same day.

(Laughter)

Alvin's latest book is called, Previews and Premises and is now available in translations in many countries.

Alvin, we appreciate your coming here to help us appreciate the broader significance of the activities that we're involved in.

(Applause)

ALVIN TOFFLER: I'd like to thank Ed and the IEEE to invite a non-scientist and a non-engineer who stands before you awed at the achievements of your profession over the years.

We are living in the midst of a profound revolution, however, which is not just technological and I like the emphasis of the previous speaker on aspirations, which is another way of saying values. It seems to me that there is some very profound questions posed for the society as a whole by the activities of our scientists and engineers and while we may differ heatedly over whether Bell should be broken up or whether nuclear power is good or bad, the deeper issues, I think, affect or deal with our (inaudible) attitudes toward technology. This society is rapidly moving beyond what has been called the Smokestack Era. Traditional, industrial society, based on mass production, mass consumption, mass distribution, mass communication, is undergoing a fundamental transformation in new kind of societies coming out which I believe is much more heterogeneous, much more differentiated, it is no longer an industrial mass society. And as we move into some new social economic and technological stage, it seems to me we can do better than divide ourselves into technophobes and technifiles. That technology has such complex impacts on the society as a whole, that to simply line up on one side of the other of that divide, is indeed naive. The notion that technology is neutral in its effects or that more is necessarily better, reflects an earlier age. We've been through a lot. The world has been through a lot with some of the negative effects of technology. I suppose if I have to rank myself as between technophobe and technifile, I'd probably be somewhere on the technifile side. But I do live in a world which has some pretty hideous characteristics along with the good things. And I think it's important for us not to ignore this. We have by and large selected our technologies according to rather simple criteria. An earlier speaker said that we've moved from a period of technological primitiveness to a period of technological sophistication. That's correct. I think we've got the phrase I frequently use....is we have gone from technological poverty to technological affluence. We have so many choices in our laboratories that it is impossible for us to fund them all, develop them all and apply them all. And that then raises the question of what are the criteria by which we make the selection. Until now I think the criteria had been basically, this is an exaggeration, but basically does it make a buck or does it make a big bang. In either case, if the technology could promise one or the other, chances were it would be.... it had a chance in the competition of technologies. And the market has been a phenomenally good mechanism for accelerating technological development. I think that it is an incredible invention of the human race and that it has profound and worthwhile effects, driving technology as well in good directions. But the question remains whether those two criteria are adequate. And whether in fact the rejection of certain technologies isn't the normal and natural feature of evolution. And that societies, whether socieites haven't always rejected certain technologies because they didn't fit into an evolutionary nitch in the system. Alexandria had a steam engine but it didn't know what to do with it and that died out, as we know. I guess the point I'm making is that there is a powerful feedback relationship between the values of the society and the technologies of the society, that this is particularly true as we move into a period of what might be called cultural technologies, artificial intelligence, speech recognition, automatic translation, video animation and graphics, all of these act on how we think and that in turn acts on what our values our and that in turns acts on who gets what dollars for research and what directions the technology takes.

I believe that both the technophobes and the technifiles share a rather mechanistic assumption about the way technology fits into the society and frequently they lump technologies that don't belong under the same category. For the leadight (phonetic), the nuclear power plant, a computer, a satellite or a genetic development, all are part of the same thing. It's all technology, isn't it? Well I think we need a more refined view because the impacts of technologies are differentiated, the second, third and "nth" order impacts on society, the interrelated affects, very complicated, and as the society itself grows more differentiated, those consequences become even more complex. And so, should the mere availability of some technology drive the system. I remember a conversation with an American Army General not so long ago who complained that our military lacked strategy, that basically the defense contractors presented various technologies and then the military said, Well, what can we do with these. And the General's complaint was that really it was the technology driving the strategy instead of the strategy driving the technology.

Why do we have leadights? One can feel sorry for the leadights who ultimately lost their lives in the rebellion against the spinning frames but they did not stand in the way of development. Why do we have leadights today? Why are there some people who are prepared to blow up computers or to reck havoc on technology. Well, one of the reasons may be that there aren't terribly many. One of the reasons is education, which we've heard about. But another reason is that there aren't very many institutional and legitimate ways for the public to express its fears about ecology, social change, its political concerns, its fears of war, privacy, the possible division of society into the infamation rich and the infamation poor, those are legitimate questions for all of us to ponder. Now, if there were more systemmatic and legitimate channels, perhaps, for their discussion and if that were linked to public education then perhaps the opposition might be less emotional, less (inaudible), less ignorant and less negativenistic. And if the public needs to know more about technology and science, which I heartily believe, then I think it not a bad idea that young engineers also.... let's put it this way, I don't think they would be harmed by studying some political history, anthropology, sociology, psychology and yes even some futuristics.

I'm not arguing C.P. Snow's division of the world into two cultures. As the society becomes more diverse and differentiated I think we're living in multi-cultured and that the multiplicity of cultures is in fact growing all the time. And we hear a lot today about shifting paradimes in the (inaudible) sense, in physics and biology and other fields, where there seems to be a shift from a focus on equilibrium to non-equilibrium. For example, (inaudible) and (inaudible) and Tom and people like that are all looking at a non-linear relationship and turbulent systems and chaos. And it seems to me that that's part of a transformation of our thinking, a change in the direction of science itself, not just....but not just in science, I think it's related to the development of new social models and new ways of thinking about society, too. And to understand the way the technological subsystem fits into the larger cultural system that we call the civilization, I think we need to recognize that society is increasingly affected by non-linear forces. It is far from equilibrium. It is vulnerable to outside impacts. Extremely vulnerable to outside impacts. That chance and necessity both play a role in our society. And we need to leave behind the assumption that society is anything like a physical or neutonian system or that technology is either good or bad.

The advance of technology offers fantastic promise for the human race and not just for the rich nations. I believe it holds out fantastic promise for the poor of the world as well. But, it seems to me we need not only technological advance, we need conceptual advances. We need a more complex appreciation of the feedback between the technological revolution and the social, economic, familiar, psychological and cultural revolutions that proceed with it and feed it as it feeds them. We are in a society itself caught up in revolutionary change as it transitions beyond the industrial age and I believe that the people in this room and listening out at the remote locations have an enormous opportunity to make that transition smoother rather than potentially dangerous. Thank you.

(Applause)

CHAIRMAN DAVID: Al, thank you very much.

Our final panelist is President of the Rockefeller University and is one of the world's leading scientist in the field of genetics.

In 1958, Joshua Lederberg received the Nobel Prize for research on the genetic recombination and organization of genetic material and bacteria.

Prior to becoming President of Rockefeller University in 1978, Josh served on the faculty of the Stanford School of Medicine while simultaneously holding the titles of Professor of Biology and Professor of Computer Science at Stanford. He played an active role in the Mariner and Viking Missions to Mars. As a consultant to the Arms Control and Disarmament Agency, he contributed to the successful negotiation of the Treaty of Biological Weapons Disarmament. And he has written extensively, for general as well as specialized audiences because of his strong interest in promoting public understanding of both science and technology. Josh.

(Applause)

JOSHUA LEDERBERG: Ed, thank you.

Ed, thank you very much for your introduction. I was so pleased and flattered that you invited me to join you this evening.

As you mentioned, my career is that of a (inaudible) biologist. I don't know whether you have noticed that I do display my diploma as a member of the Institute of Radio Engineers, one of the very few that I keep on my wall. It recalls to me the very exciting time that I had working with Lloyd Birkner (phonetic), when he was Chairman of the National Academy of Science Base Science Board. He recruited me into the RIE in January 1961 when I believe he was also the President of that organization, predecessor to the IEEE. In fact, the first issue that I got on my member's subscription was a special number on artifical intelligence and it included several articles by John McCarthy and Marvin Mitsky that were one of the number of sources of impotence

. to draw my own interest in that field. Why would a (inaudible) biologist care about computers and particularly about artificial intelligence. I felt that we were reaching the limit of our intellectual capability of modeling the complexity of the living systems, the (inaudible) biology that was just growing up. These are systems whose complexity is the fruit of four billion years of evolution under spontaneous mutation and natural selection, plus, and very importantly, every trick of menacular chemistry that God had invested the earth with to begin with, and many of these we are far from fully understanding. So I did join with Ed (inaudible) and (inaudible), had fun discovering rather than inventing expert systems. This meeting is a celebration of electricity but that now does also mean software and we will recall there is a computer society within the IEEE.

Now, 20 years ago, I did prognosticate, I was looking forward to what menacular biology might bring to our future, and I have to say, as I look over my writings and they are on the record, most of the things I talked about have come about. If I was in error in a few places that some of them were even more rapid in their substantiation than I care to dream about at that time. So it's not for a sense of modesty about my box score in that prophetic mode that I decided not to pursue that mode tonight. It's rather that in reflecting in my own career, However correct or incorrect, those remarks were doing that phase of my effort, I can't see that they have made any difference whatsoever. The things that were to come about have come about and if I have made any contribution to the present state of science, technology or other aspects of the state of the world, it must have been entirely through my laboratory investigations through my actual study of the nature of living organisms and my prophecies as to what that was going to bring us.

So I thought I might focus on that and focus on the ways in which there are, in our future, a very strong intersection of my field and yours which I have tried to internalize in my own interests.

Now I did not anticipate that our technology was not going to be up to my showing you a couple of flips charts. I couldn't imagine an engineering meeting that you couldn't show a flip chart. But it doesn't matter because it's not the detail of what's on them that counts. I did want to illustrate and I'm just going to wave this, a flow chart that shows something of the complexity of intermediary metabolism. As this is a crystallization of 50 years of biochemical investigation that have revealed to us the larger number of the substances that are involved in the degredation of food stuffs, into common small carbon constituents, their oxidation, the conversion of their chemical free energy, usually into the common medium of (inaudible) and triphosphate, that use of that energy in a variety of metabolic cycles to fire up other biosynthetic mechanisms. I didn't even both to count how many nodes there are. If you walk into almost any biochemist lab you'll see the same chart, it will cover a whole side of a room because at....for each node, it will have the name and the menacular formula of a given substance on the chart. There are about 400 molecules of menacular wave, averaging 150 or 200 that have been pretty thoroughly worked out and they probably account for 50% of the substances of (inaudible) of which our bodies are composed.

The flowchart shows the conversions that these compounds undergo. How glucose goes into small carbon fragments and how those small carbon fragments can be built up again into aminoacids, into purings, into other growth factors or sometimes we must get these from the synthentic activities of other organisms. The chart shows nothing of the regulatory mechanisms which must be very exquisitely controlled. It's simply will not do if you produce twice as much (inaudible) as you need for the manufacturer of your own proteins and have a deficiency of other aminoacides. And very carefully crafted regulatory mechanisms have been evolved in order to achieve that result. Now we don't make our own (inaudible), we get it from green plants, they had that problem and we had to adjust the catabolism of these nutrients accordingly. So this chart is only the beginning of the complexity of nutabolism. It only shows the principle nodes, the edges of the catalytic factors which are responsible for the interconversion of one substance into another. This may be one, this may be a whole chain of enzymes which catalize these inter-conversions. Of these we have a few hundred whose actions we can designate. We'll call them the enzyme that converts node 100 to node 101 and we will substitute the chemical name for those nodes and give some shorthand and that's how we may describe (inaudible) or some other jargon which I won't go into with you in any detail. In a limited number of cases we've actually isolated and extracted these substances so that we can demonstrate the catalytic activity of these edges connecting nodes in the test tube and there are still more limited number of cases we have enough detailed information about the structure of these protien enzymes that we can begin to rationalize how they behave, although we are far from a complete theory of the action of any enzyme.

I know a group like this is the very best one in which to exercise a few of the cardinal numbers of biological systems and these are things to contemplate, they deal very closely with what Charlie Towne has mentioned as to whether there is a practical finitude to these expansions of knowledge. If you run out of particles and physics, I suggest you start looking within the cell, Charlie, they'll be some more to do for some time to come. One of the marvels of contemporary biological science is that we have a metric of complexity of the human organism at a certain level. Each of us carries in every nucleus of every cell of our body approximately three billion nuclear tide units. These are the based pairs of the Watson (inaudible) double helix. These three billion units are, when extended into that double helix form, would range two meters in length, tightly coiled, into a little sphere approximately three or four or five microns in diameter. This would be enough to ecode for ten million genes, ten millions of a particular product, if each of them were informationally active and that information content is approximately that in a few sets of the encyclopedia Brittanica. That's the genetic code that is inscribed in the Zygot and in every cell of our body produced by that.

Happily, for investigative purposes, only about 1% of that DNA is believed to be informationally active so what we have to look forward to is (inaudible) out the hundred thousand proteins, give or take a factor of two, that's pretty precise for this sort of argument, which make up the constituence of the human body. Of those 100,000, where there is informational coding, we can guess at the names of a 1,000 of them, about 100 have actually been isolated and definitely characterized in the human organism. I actually compiled a list and all of this has to be done on the computer and it makes it very convenient to bring it to you, that we have out in front of us today. But we can say that just in terms of the elicitation of the raw material of which our bodies are formed, we can inventory 1/1,000th of the constituents. We have a glimmer of the mode of action of a few dozen of these. We can give you a good story about hemoglobin works and a good story about a few others. Others have regulatory functions in controlling the rates at which certain ages will be functional and the graphs that I've just indicated, they may have many, many other interactions, one with another, of which we only have a glimmer. Just to discover these one at a time is an enormous side of the enterprise. To comprehend the total is what I say is one of the major challenges of all of the electricity that we're going to be able to generate for the next 100 years. Thank you.

(Applause)

CHAIRMAN DAVID: Thank you, gentlemen. It's time to take questions from the audience here and from our remote sections and student branches. Those people out there should keep calling if they find the 800 number busy because we have enough people taking calls that they should be able to get through and I urge them to do so. We want to hear from them.

I hope we can keep both the questions and the answers as short as possible in the interest of covering as much ground as we can in the next 35 minutes.

So the first question that I have here is a long one. It's for Alvin Toffler. Al. It says, In one of your books, Future Shock, you said that men will have several wives during a lifetime. At each stage there would be an adjustment, for example, at age 50 one could remarry a younger woman. Do you still feel that this is in the future? And it's signed, "Hopeful."

(Laughter)

MR. TOFFLER: I have a slinking suspicion that there's a (inaudible) out there.

(Laughter)

I never quite said that.

(Laughter)

Are we serious? What I did say in Future Shock was that partially as a consequence of technological change, but in addition for other reasons, there is a generalized acceleration of life and that many of our relationships grow increasingly temporary or transient under the impact of acceleration. We talked about how fast we accelerate change. Well, when we do that, we also produce shorter product lives, we produce shorter relationships with our organizations, we produce more mobility in the society and we produce perhaps shorter family life spans and the consequence....whether that is good consequence or bad is obviously another discussion, but that is I think what the reference was to, that there is a relationship between these, I believe, between the speed of technological change and also.... and the metabolism, the social metabolism, if you want to call it that.

CHAIRMAN DAVID: So there's hope for this fellow, is there.

A question for Dr. Townes. It says, You

mentioned the inordinate interest of the press and laser beams in exoctic aspects of laser beams. Does this suggest that you consider a laser based missile defense system impractical.

(Laughter)

DR. TOWNES: Well, I'll have to explain that in a little bit length. I think lasers using light as defense systems, against ballistic missiles, the answer is yes. I believe that's quite impractical. X-ray lasers are possibly a little more workable. Nevertheless, the problem with a defense system is the following. That while, against any present offense, we can build a system which works. The offense will change as we build up a defense and the offense has an advantage. So that I do not see in the long run any reasonable prospect of any very successful complete defense. That does not mean that study of defense methods is not important but rather we cannot hope for any complete defense.

CHAIRMAN DAVID: Thank you. Barnie, there have been several questions about nuclear waste, you referred to that in your Keynote and this one, which I think spans several such questions is, Where will nuclear waste be stored so that it is a safe situation?

MR. OLIVER: The statement I made in my talk was that it is really not much of problem because its volume is so small and that implies that the selection of a site, even one on the surface of the ground, is not a serious matter. The output of a nuclear plant, if the fuel is reprocessed, the waste output is about 2 cubic yards per year, which means that if the U.S. run nuclear power it would be about 500 cubic yards per year for the whole country. That means that in 100 years we've covered about 50 feet by one mile and....no, in a year we covered 50 feet by 50 feet, six feet deep, and in a hundred years we cover 50 feet by a mile, and in 10,000 years we cover one square mile, if we simply chose to put it out in the desert. I'm not recommending that but that gives you an idea of how big a problem it is because that whole area would be covered to that same depth in two weeks with ashes if we were on coal. It's ten thousand years versus two weeks. So it isn't really a big problem. I don't want this to get into a (inaudible) about nuclear power. I'm simply saying that I'm happy to discuss these issues with anyone who cares to, but I don't think that's the tone of the evening.

CHAIRMAN DAVID: Thank you very much.

Al, several people have asked this question, this particular one is from here, Philadelphia. What country or group do you see as the world leader in technology in the year 2000?

MR. TOFFLER: It seems unlikely to me that there will be a really radical change in that by the year 2000. I mean, if we use the conventional measures of technological sophistication, the United States and Japan seem to be at the cutting edge. I think, however, that other countries are beginning to recognize the significance of high technology....quote, "high technology" for their economic development and I speak not just of Europe and the so-called industrialized nations but also the so-called third world countries who are, in one way or the other, eagerly examining possibilities that the new technologies might open pathways of development that were closed to them when the dominant technologies were....or dominant industries based on the technologies were steel mills and textile and so on. I just came from Brazil where I found myself plunged into the debate over whether or not Brazil should ban or should protect its domestic microcomputer industry and I argued against that. I lost. Today's paper carried the news that they did that. But the interest, the recognition that cutting edge technology may have a role to play in economic development even in the poorest nations is spreading around the world.

MR. TOWNES: Ed,....

CHAIRMAN DAVID: Yes, Charlie.

MR. TOWNES: I'd like to point out that 16 sixs is really not a very long time for technological development. Most substantial technological projects take the order of the decade and 16 years then is not time for there to be any very large shift in the general centers of technological expertise. That might take place later but 16 years is simply too short of a time.

CHAIRMAN DAVID: I think that's a very interesting point. Suppose we extended the time scale to 50 years, what would you expect to happen then.

MR. TOWNES: I would not be willing to make any firm prediction.

(Laughter)

CHAIRMAN DAVID: Barnie, would you like to say anything about that, or Al.

MR. OLIVER: No.

MR. TOFFLER: I think society, human society, is not the deterministic system and therefore you cannot make those kinds of straight line projections with anything resembling reality. I think that what the best you can do is try to model the present situation, look back in history, draw some tentative conclusions and be prepared to be all wet.

MR. OLIVER: I'd like to add one thing to that, if I may, Ed. It seems to me that technology can do a variety of things and it has been said already tonight it will go in the direction that society drives it. We will do with technology what society wants us to do and by and large and so that the statement that it has been driven by the fact that you can make a buck out of it simply was another way of saying that it was driven by the fact that a lot of people liked it, you know, because you can't make a buck unless a lot of people like it. So, that has been the case right from the beginning and I expect it will continue to be the case.

MR. TOFFLER: That's the linkage that is a linkage between the value system of any society and the output of the technological effort.

I would say one thing about the distribution of technologies around the world and that is I believe that the industrial revolution disseminated a kind of package of technologies so that all industrialized countries, most of them developed auto industries and textile and apparel and certain backbone industries that we now call the Smoke Stack or basic industries. I'm not sure that the next stage of economic and technological development is going to disseminate the same package all over the world. I believe we're going to see a much more heterogeneous world with countries specializing in different technologies rather than there being a uniformed package from end of the planet to another.

CHAIRMAN DAVID: There is this close linkage as you have pointed out between, I guess in the short way to say, its markets and technology. That linkage is pretty tight in successful technology developments. Would you say then that if you look 50 years ahead that those countries that have adopted primarily a market approach to technology are going to be in the lead. And those that don't are going to find themselves somewhat isolated. Or more backward.

MR. TOFFLER: Are you directing that to me?

CHAIRMAN DAVID: Yes.

MR. TOFFLER: Well, that 50 years is a long time and at rapid rates of changes.

CHAIRMAN DAVID: Well let's go back to 16 years.

(Laughter)

MR. TOFFLER: I think the market system is a desirable system that it offers the opportunities for innovation. It welcomes risk. It makes entrepreneaurism possible and my travels in Europe and in Asia recently I hear all sorts of scientists, engineers and business people lament the impossibility at present of a truly entrepreneurial system that they....the story that one hears again and again and again is you go from France to Japan to Singapore or wherever, you keep hearing that you couldn't have an Apple. You couldn't have that kind of a dramatic sudden development growing out of somebody's back yard without great difficulty because the system, the taxation systems, the venture capital systems, all of the economic and also the cultural supports for this are not necessarily there.

MR. TOWNES: Ed, May I enter a word.

It's true that finances have a good yield of technology but I think it would be very shortsighted to say that that is sort of the primary and only force even in a society which is interested in....very much interested in money. There are other factors which I regard as terribly important, such as a general interest in learning, a curiosity, a kind of sensive inventiveness, an openess, openess both to ideas and to people and I think these things are terribly important as a basis for long-lived successful technology. On that basis I would say, too, that I think successful technology in United States has a fairly long life because we have such a very strong basis in science. Science is terribly important to the development of technology and vice versa. Good technology enhances science enormously and those fit together in such a strong way and we already have such a strong base in science that I have no doubt that the United States will be very strong technically for a long time. And I think those elements of curiosity, education, interesting learning, interest in ideas must not be neglected.

CHAIRMAN DAVID: I think it's an important point your making. A good friend of mine, John Pierce, used to say, Technology doesn't always take you where you want to go. And I think that's probably right.

Josh, do you think that natural intelligence will suffice to unravel the nature of the genetic elements that you mentioned in your talk or will we need the assistance of articial intelligence or computer-based intelligence in order to carry out the exploration that you described.

MR. LEEDERBERG: Well, I was hinting, I wasn't sure even that some of the two might not be sufficient for dealing with systems of the really enormous complexity of trying to get you to use your own imagination about. I think our own natural intelligence has elements of creativity, of fantasy, of imagination, which our computers simply don't have the world experience and are not likely to for a very long time to match. But obvious-y they can marshall an enormous amount of data, they can be somewhat more tireless, they can deal very rapidly with certain route functions and so we use them now in a highly symbiotic way and see nothing more than a progression, not any necessarily interrevolutionary breakthroughs as the mode of utilization of that kind of support for the conduct of our experiments and for the development of our understanding of these very complex systems.

CHAIRMAN DAVID: That question came from Tampa, Florida, we now have one from San Francisco for Barnie Oliver. Which says, Could you give us your comments on the future impact of foreign electronic technologies on the American electronics industry.

MR. OLIVER: Well I think that the impact of foreign technologies are beginning to be felt in a very definite way in our country and I think it poses a real challenge to the American system and to American engineers to compete with it. There's no question about

Japan and other countries have moved ahead enormously over the last decade or two and are continuing to do so. In some cases they do so under umbrella government that encourages things that we would be put in jail for doing but I think that could be too much of an excuse. I think we have to step out and strive out and meet this challenge face to face, I think we can. I have great faith in the ability of our native scientists and engineers to do this.

CHAIRMAN DAVID: This one is from Dayton, Ohio and it's for Charlie Townes. Assuming that President Reagan's SDI, Strategic Defense Initiative, is approved by the Congress, what kind of spinoffs or benefits to the general public do you envision due to the emphasis on (inaudible) directive energy research over the next few decades.

MR. TOWNES: Well, that's hard to predict, of course, in any detail. Already, however, there are manufacturing processes which use such things, X-ray lasers, I certainly expect to be very important in research and in medicine in the long term. Almost any technology or new knowledge which is developed turns out to have a very wide variety of applications and in many cases quite unexpected. So, while emphasis are on the SDI Program, it may or may not be an optimum way of spending our money and I would hope that we won't spend an enormous amount on it. Nevertheless, one can expect a good evil spinoff, I think, from any good solid technical program.

CHAIRMAN DAVID: Thank you. Al, another question for you. Do you believe there will be a few very well paying jobs and a great number of lower paying jobs in our society and if so how will the U.S. adapt to this socially and politically.

MR. TOFFLER: I think that the structure of jobs that become available and the number of jobs that become available are not a function of technology as much as the function of social policy and economic policy. That it is theoretically possible to keep everybody working if you define work as shuffling papers or if you define work in a broad way you can make jobs and keep people working but if social policy depends purely on the marketplace I think we're going to have a difficult transition for the following reason. And I have had the opportunity to debate this at the....in the White House with people who, of course, are totally committed to that point of view. In what I would call the second wave period or traditional industrial society you could have ten million people unemployed and if you created 10 million jobs you sopped up the unemployment but today, it seems to me, as the work system becomes more differentiated, more demastified and more specialized in many ways, you could have twenty million jobs and ten million people unemployed who can't take those any of those twenty million jobs. So there has to be some linkage between the available pool of labor and the skills required and that means something more than just letting nature take its course. I don't believe that it is inevitable that we wind up with what I call a helox society with the majority of people in low paid "service" and "repetitive" menial jobs and an elite handling the mid job. I don't believe that's at all inevitable.

CHAIRMAN DAVID: That's hopeful. This is a question from New York and it's for Barnie Oliver.

Barnie, if you make contact with extraterrestrial intelligence, what question would you ask.

(Laughter)

MR. OLIVER: Well, it has to be speculated a great deal among circles, of course. I happen to believe that the major benefits that would come from such contact are not so much scientific as they are social because the mails are slow, in other words. By the time you ask any question and got an answer, a century might have elapsed you see if the civilization were 50 light years away or even more time if it was farther away from you. So, I don't think the benefit comes about from question and answer sessions such as this one. I think the benefit comes about from learning the patterns of society in civilizations that have achieved longevity, for example. In another words, we'll probably be in contact, if at all, with those who have achieved a long existence because they've been there a long time and they've radiated signals long enough for us to pick them up. So, we might learn how they do it and maybe we could learn something very valuable from that. Over and above all that, I think it would be marvelous to be cut in on the galactic club, so to speak, to be cut in on the natural history of the galaxy, to learn the life forms that have existed on

. numerous other situation, to have a history that was not just 4,000 years old but maybe 4 Billion years old because that might be the time over which this society, intercommunicating society, have grown. So, you'll have to expand your horizons a bit out of the human frame and think about what could happen on this long time scale. These are the things I think are exciting.

qa CHAIRMAN DAVID: Josh,....

MR. LEDERBERG: It's been only a few years since Barnie and I have debated these same matters but there was one ready answer that I often encountered in these discussions. There are really two questions. One is, given the circumstances that there may be a fairly high bandwidth but a long turn around time.

(Laughter)

The first question we shouldn't have to ask but that's there. What do you know that we don't. And the second is, Give us some reason to believe that you're benevolent and to be trusted.

(Laughter)

MR. OLIVER: May I respond to that a little bit.

There's a whole anti-study movement that has come into being that says where they are, they call it the Family Paradox because he has supposed to have asked that question at (inaudible) and I....however, I want to answer to that because natural law is such that you don't get there and back in a human life time or even a much more than a human life time without enormous expenditure of energy. Enough to keep all the wheels turning and the lights burning in the U.S.A. for thousands and thousands of years, you know, that's for a single mission and I can't see, if you travel at lower speed, of course, it takes an enormous time and I can't see their appropriations committee voting for a mission that would pay off 20,000-30,000 years in the future nor take all the energy that their country needed for 30,000 years. So, it isn't all that easy. I think they're going to be home minding their own business. And so are we. Besides, our biochemistries might not agree. We couldn't eat each other very well, anyway.

CHAIRMAN DAVID: Does anybody have any other comments on that.

MR. TOFFLER: I have a question.

CHAIRMAN DAVID: Yes.

MR. TOFFLER: On this strategic defense business, is there any likelihood and do you think it would be feasible, plausible or worthwhile to pursue an initiative like that on a multi national basis which eventually in fact invites the "adversary" into the system.

MR. TOWNES: Yes, in the sense I think that's the only way it would be logical. At least almost the only way. If there is a cooperative world then a reasonable shield against a modest number of weapons might be achieved without an enormous expense and this would prevent any danger from let's say a parted number of missiles or something like that. So that careful agreement in a cooperative world would make such a system valuable. ON the other hand, a primary problem is to find a cooperative world. If we have than then maybe we don't have to worry too much. I'm not trying to imply that a knowledge of defense against missiles is not important. That's something I have to feel that we must think about however and do research on. I'm simply telling you about the deployment of any sizable system and there I think cooperation is almost essential.

CHAIRMAN DAVID: Yes, Josh.

MR. LEDERBERG: I think I'd dwell a little longer on what Dr. Townes mentioned about the uncertaintity of the last word with respect to strategic defense as against offensive innovations and if I look ahead I guess I'm a little worried about the potentiality for technical success of an SDI. If that existed at the present time and the more so if there had been some cooperation in developing a uniformed base for a strategic missile defense system, I fear that we would then end up in a world of enormous anxiety with respect to technological breakthroughs. Uncertainty as to what is going to be the next step, the next offensive capability that could be developed and it really doesn't take a great deal of imagination to see methods of weapons delivery which will beat any existing plane of defense that we have at the present time. So I have a little trouble being sure that we're going to feel more secure in the face of that degree of technological uncertainty than we do at the present time.

CHAIRMAN DAVID: Before you stop, Josh, why don't you answer this one from Columbia, Maryland. Do you think that genetic manipulation will enable us to cure cancer?

MR. LEDERBERG: Well, the genetic manipulation of microbes has been the means by which we've made enormous strives just in the last two years in understanding the onca gene. These manipulations have entailed extraction of bits of D & A, a few tens of thousands of units, take them from cancer cells, put them into a setting where they can be experimentally studied very carefully, plant them into bacteria and so forth. That kind of manipulation is very rapidly giving us a much more accurate picture of the nature of cancer. I suspect that it is very likely to also generate the products that will be helpful in the diagnostic that already is and in the therapy of cancer. Genetic manipulation is also used for another technology altogether and that is the thought of altering the genetic constitution of the human individual. I see very little profit in that. The likelihood that that could ever be done sufficiently reliable that you would depend on its doing just the right thing and never altering the nuclear(inaudible) of of other parts of the gene that you would wish to preserve in tact is very, very low indeed and that would be a sufficient reason I think to not look to that direction of exploitation.

CHAIRMAN DAVID: This question comes from Milwaukee and it's addressed to Al Toffler and Charlie Townes and Josh Lederberg and anybody else who wants to answer it. It says, What role do you suggest that religion might play in the acceptance of technological development. And how can educational institutions bring about this acceptance.

MR. TOFFLER: Depends on what religion.

(Laughter)

If I think about Iran and technology, I have one set of images in my head. If I think about other countries and technology, other religions and other countries, I obviously have....they generate different scenarios. I think that we're moving into a world which, as I have repeatedly said, is going to be more socially, politically and culturally diverse than the mass society created by a smoke stack industry and a smoke stack technological base. And that suggests to me that the first moral stricture of the new society is going to have to be tolerance to diversity or else we're going to have a very unhappy time, which suggests that I can live with anybody so long as they're not so phanatic that they won't let me live.

CHAIRMAN DAVID: Anybody else want to chime in. Charlie.

MR. TOWNES: I'll try that one. Of course, we've just been talking about the leadites, which was a religious position against technology. Religion clearly can have an affect. I would say rather more broadly that after all what we're talking about is one's view of what the universe and what man is all about, what we're here for, what we're doing, that the religious view. It obviously must have a very profound effect on what we do and what we think and what we are willing to accept, to plan for. So, that while there may be a question of what anyone technology, how it is treated by religion, the fact that there is an effect of one's views of the meaning of life on the technology that we use is, of course, very clear.

CHAIRMAN DAVID: Let's talk just briefly, because we only have a brief time left, about education.

It was something that was mentioned by each of you in one way or the other. There are several questions about it. The one that I will use is from the Philadelphia section. In the light of the increasing isolation of the science and engineering community, what are the ways that you counteract this isolation in the education of the public in schools, education of the public in publications and education of the government. And, again, we can chime in on this, anybody who wants to try it.

MR. OLIVER: I'll tackle it since I brought the issue up tonight. I think it's a very serious matter. I think that education has been in a sort of a slump over the last few decades. I don't know whether it's really get out of it or not but I've been at a times disparing of the success of public education in this country because of the low standards that we're.... in place in our public schools. I think we have to expect higher standards of teachers, higher standards of teaching, better training and skills and their primary grades and a real sincere desire on the part of teachers to communicate information, factual information, orientative information to the students so they know what they are in the world and where they're going. I have seen many young people drifting because of the absence of this guidance. I have seen people, you know, they get bored, they're not being told anything, they're not being stimulated. It's just a bad situation or has been and I hope we're getting out of that. But I think it's up to all of us to try to do something about that in addition to introducing a little more technology and technical understanding in the schools. I might say that we've been concentrating on technology tonight and things engineers do but I would like to add that over the last decade there has been a complete scientific revolution which has taken place in the world. The degree of scientific knowledge that exists today in such areas as Josh's area and the area of cosmology, in the area of Charlie Townes' article, physics and so on, is just enormous, the strives that have been made in all of these things. And I think that our schools are mostly unaware of much of that and it's something that needs to be communicated to the next generation if they're to understand the society that they're going to be in. So there's a vast updating that is necessary in our school system. I think it's an extremely crucial and critical problem.

CHAIRMAN DAVID: Anybody else want to chime in on that. Charlie.

MR. TOWNES: Yes, I might comment on that. Not only is the understanding of science and technology important for the economy of the country and progress in the country. I think it's very important for the unity of the country that everyone have some sense of what technology is about, what science is about. I would say the same thing about the humanities. It is also important that everyone have some sense of the humanitarian values and the humanitary culture. Both are important. But we are in special danger of losing part of our population behind in the growth of our civilization and our technology and I think we must work very hard to see that people generally are aboard this very terribly important development.

CHAIRMAN DAVID: I think we've reached the end of question and answer period. I want to thank the audiences and thank the panelists. This has been a fine occasion and, Barnie, thank you for a great Keynote speech.

Now I want to turn the proceedings back to Dick Gowen for his closing remarks. Dick.

(Applause)

MR. GOWEN: On behalf of the Board of Directors of the IEEE, I, too, would like to extend our deep appreciation and thanks to Drs. David, Oliver, Townes, Toffler and Lederberg. Your remarks this evening in combination with the Technical Papers, the discussion of today and tomorrow, provide a most appropriate compilation of our technology as IEEE enters its second century of service to mankind.

I extend a special thanks to those who have worked so hard to make this evening, the Centennial Technical Convocation, and indeed our year, of centennial celebrations possible. This has been a unique evening. Through the use of today's information technologies, we have linked ourselves together with our common interest in the future. Tonight, there are many students who have participated in this exciting program, in sections and branches and universities, across north and central America. These students, along with their counterparts around the world, hold the keys to the future growth of technology and the future of mankind.

The final event of the IEEE Centennial celebrations will be held in San Jose,California in what we know as silicone valley. At that event, we will focus

. on the education and the future development of our young engineers. We invite you to join us in Silicone Valley on November 30 for IEEE's Centennial Keys to the Future Convocation. As this evening draws to a close, let us once again recall a man who dared to reach to the sky in search for greater understanding of electricity. Dr. Benjamin Franklin is recognized as America's first electrical engineer. In his opening remarks, President Reagan characterized Dr. Franklin with these words, "Mine and will, strength and grace, for the benefit of our fellow man."

Tonight, we pledge ourselves to practice our profession in the spirit of Benjamin Franklin. Mind and will, strength and grace, for the benefit of our fellow man.

Ladies and gentlemen, good night.

(Applause)