SPEAKER: Now, we are here to discuss the future of science. And to do so is nothing less than to probe the very future of mankind for it is the course of science reflecting man's ability to increase his knowledge and apply it wisely together with his spirit for creative and constructive change that will determine that future.

Since we are a conference of both scientists and theologians and of specialists and generalists, but above all of human beings vitally concerned with the human condition as a whole and the direction in which man is moving, let me briefly state my position about the spirit of man, and then I will move on to focus on the future of science.

There are unfortunately many who see the spirit of man in a state of decline. As symptoms of that decline, they usually cite such factors as an excessively materialistic outlook on the part of the advanced nations, a degrading of the environment and a wasting of non-renewable resources, a rising nationalism combined with a hardening attitude toward development, and a breaking down of social systems through all levels of government and institutions right down to the family unit itself.

And to some extent, there is some evidence for all of these claims and the media highlighting and emphasizing all the symptoms of the world's problems lend strong emotional support to this picture of decay and doom.

But without denying for a moment the seriousness of the world's problems and the challenges they pose, I contend that there is an increasing evidence to show that men and women all over the world are reacting positively and strongly in response to these challenges.

The available but usually unheralded facts confirm that never before has there been such a concern and thought and action on the part of so many individuals and institutions, national and international, over the condition of man and the world as it exists today. There is no guarantee that all these responses will be correct or productive.

As a working out of our evolutionary process about which I will have more to say later, many such responses will fail and some will even prove to be counterproductive. Those that do will most certainly take their toll, much as do all harmful mutations in the natural evolutionary process.

But I firmly believe that with mankind, the successful responses will prevail moving us to a higher plane. And contrary to what some skeptics believe, neither our technologies nor our institutions will become the tar pits of humanity.

We will survive and advance by changing them to meet our higher needs rather than decline by adapting regressively to the poorer conditions and environments that they might create as they become outmoded and harmful.

The fact that we are already in the process of doing this, which accounts for so much of the ferment and agitation visible today, is the reason I remain an optimist concerning the spirit of man.

So now let me turn to his science and outline for you some of the directions in which I see it moving. And here, again, I am an optimist, but as you will see perhaps and I hope a cautious one. Both science and technology will undergo a great many changes in the years ahead.

In general, I think we will witness a brief period of conservatism for science, one reflected in the public support of science and perhaps within the science community itself. A more cautious make haste slowly attitude is going to prevail for a while. And I would say, of course, that we are already well into that period.

I think we are going to see a continuing shift of interest toward the life sciences, particularly toward many facets of biology and biochemistry and toward the social and behavioral sciences. And this is already underway.

And perhaps most noticeable will be a Renaissance in engineering as a number of new ideas about how we should live in the future begin to take hold and must be transformed into realities. And this I believe is not so evident yet.

If we talk about the economic expansion of science in the future, I think we must come to terms with the fact that the rate of its growth will slow down. This, however, should be put in perspective and particularly in perspective with the last 25 to 30 years, which must be recognized as a period of exceptional growth.

During the peak years of this period, science support increased at an average rate of 15% annually. Of course, this was a time of unusual economic growth not only for science and not only for the United States.

As Lester Brown pointed out at the second General Assembly of the World Future Society last June, the society to which Dr. Gover referred in his introduction, the global economic output tripled between 1950 and 1975.

We cannot expect the last quarter of this century to be an extrapolation of that trend. In many respects, we would not want it to be either. Instead, a period of slower growth, one of maturation and transformation, will take place all of which ultimately will I believe prove more beneficial.

If we look directly at science, we can see many reasons why its growth will follow a similar course. In fact, science and technology are already on such a course and are now beginning to be subjected to a number of new influences and pressures. And I would like to mention a few of them.

First, there is the economic squeeze on the funding of research and development and this has several effects. In a country that historically has been rather pragmatic about its science support, there is now understandably a mounting pressure on science and technology for economic payoffs. Since the late 1960s, there has been a slight shift of support from military and space-related research to research oriented towards civilian needs.

With economic conditions focusing greater attention than ever on such needs, significant results are now being expected and it is difficult for the public to understand why science and technology cannot produce miracles on demand, as they did for the Manhattan and Apollo projects.

It does little good for scientists and engineers to respond that the nature of the problems are different, that they don't lend themselves to the same kind of solution, that the controls are lacking and even that sometimes there is no common agreement on goals.

The public has too long been conditioned to the idea of crash programs and to the notion that the right combination of money and manpower can solve any problem within a set time period.

The concept that we live within what might be considered an ecology of problems dynamically related and subject less in any timeframe to complete solution than to amelioration and change is just beginning to dawn on many people, including many in positions of authority and important decision-making functions.

Now, one result of the emphasis on quick solutions is that as the general economic situation tightens, as attention to priorities increases, the division of those funds that are allotted to research and development may be made too heavily in favor of applied and developmental work.

And this, of course, is not a new situation. It has actually been going off and on for a long time, but we are now entering a phase where it is becoming acute.

There has always been difficulty in balancing basic and applied research. Even Louis Pasteur was torn between the need to advance the practical application of science and that of advancing the basic knowledge that underlies all progress.

This was quite evident in his speech of 1854 in which he proudly announced the establishment by imperial decree of a new university degree under the title of certificate of ability in applied science.

Then after praising this degree and stressing the government's attachment to the spread of applied knowledge, he launched into an impassioned defense of theoretical knowledge and its bases as the mother of practice that alone can give rise to and develop the spirit of invention.

And as a caution to his fellow scientists, lest they let the pragmatic influence get too strong, he added it will be especially up to us not to share the opinions of those narrow minds who disdain in the sciences all that has no immediate application.

Now, another important influence on the future of science is the other side of the cost benefit coin. For if society is interested in greater and more immediate benefits from a science and technology, it is also more concerned in these times with their growing price tag. And there is reason for this concern.

Today's methods and tools for conducting scientific research in most disciplines are more capital-intensive than ever, and the cost of equipment and manpower has risen at a rate faster than the general rate of inflation.

And for example, and I use the field of physics here, admittedly a costly discipline, the cost of instrumentation between 1945 and 1975 rose between 175 to 200% as compared with the average rise in the cost of living index of 75% for the same period.

In addition to the increasing cost of basic and applied research, the overruns in developmental work are becoming notorious and giving rise to second thoughts about many major important projects.

Now, as a result of all this, we are going to see tighter budgeting and closer oversighting of all science and technology programs with a greater demand for accountability.

Depending, of course, on the attitudes and wisdom of those who have the ultimate control over the support of these programs, the result could have any of a number of effects. They could reduce waste and sharpen the focus of our objectives in a beneficial way, of course.

But on the other hand, they could have the conservative effect of giving the major support to the most conventional research and only the established researchers, tending to narrow the scope of work detrimentally and severely limiting efforts in new and potentially significant directions.

But most certainly, these tighter times will force many scientists to become more publicly responsive and articulate about their work and its ultimate contributions to society. And we see this very much in effect today.

This brings up another kind of accountability aside from the economic aspect, which will have a great bearing on the future of science and technology. It is the kind of accountability that concerns itself with their risk benefit rather than the cost benefit ratio.

Its focus is not on the question of whether the work is worth doing, but on whether its potential harmful impact may outweigh any good it could do. Whether the research or project, in fact, should be initiated at all is often in question.

This influence on thinking related to research and development rising rapidly over the past half dozen years or so and being institutionalized by such requirements as environmental impact studies and technology assessments is already a major factor in determining the future of science.

It is affecting work on energy resources and technologies, biological research, aircraft development, advances in communications and the use of the computer, and even research in the social sciences and education.

Almost every federal agency involved in the support of research and development in a scientific or technological field can attest to the growing effect of this influence. The latest of these is the National Science Foundation until recently perhaps the least controversial of the federal agencies.

Today, however, NSF is finding itself under attack by a number of members of Congress and some elements of the public for supporting certain types of research grants in the social sciences and the development and implementation of science education programs that some find objectionable on the grounds of the values they teach.

And as many of you know, this controversy over the support of grants deemed unworthy or even detrimental prompted one Congressman to introduce legislation that would require every research grant approved by the National Science Foundation to be reviewed and passed on by the members of Congress.

To the alarm and consternation of many, this amendment to the NSF authorization bill went so far as to be approved by the House of Representatives. Fortunately, it was voted down in conference.

However, I think it has left a permanent mark on the science community. It has served as a warning to the science community as to the kind of attitudes and restraints it may face in the future.

This congressional activity and other public reactions indicate that a good part of this new outlook springs not only from economic interests or even from concerns with the risks of physical harm to the environment or people, but from a new combination of growing humanism and increased activism on the part of many segments of our population.

This combination forcing greater attention in the public area to ethical and human value considerations is an outgrowth of the many movements and attitudes that we saw develop in the 1960s and in the early 1970s.

It had its origins in the youth movement, the war activism, civil rights, the environmental interests, and the new consumerism. It is going to have an increasing effect on the support and conduct of science, and I think most scientists are recognizing this. And as in the other cases of new influence, it is going to have its good and bad effects.

Essentially, it is vital that science does serve the highest interest of society and contribute to the fulfillment of human values. And I believe that the science community for the most part is acting very responsibly and responsibly in this direction.

In many areas of research, such as genetic experimentation, atmospheric work, and the effects of chemicals on human health and the environment, it has taken the lead in initiating measures to place human concerns above all.

In addition, the matter of ethical and human values in science and technology is itself the subject of research programs being supported by the National Science Foundation in conjunction with the National Humanities Endowment.

But it should be realized that while there are certain values and ethical codes of a universal nature, there are also values that are more closely associated with the tastes and the likes and dislikes, the habits and culturally induced beliefs of various individuals and groups attuned to certain so-called lifestyles.

In a democratic society and particularly one of growing advocacy and activism, there are bound to be many conflicts over these. And science and technology with its increasing influence on life in general will certainly be caught up in many of these, as we see so much evidence for today.

If this is the case, it may be essential that means are worked out to establish some broad codes of conduct and values by which science and technology can operate to maximize human benefits within a framework of some type of consensus value scale. It seems to me that we must do this in order to avoid being paralyzed by a kind of case-by-case value judgment of almost everything we do.

This does not mean that technology assessments and risk benefit studies of individual concepts should not continue to be conducted, they should, nor does it mean that science should not maintain a most profound sense of responsibility toward safeguarding society from possible errors on its part or misapplications of its work. Obviously, science should.

It does mean, however, that we must find a way to avoid having a tyranny of the minorities when it comes to the possibility of advancing the general good through scientific progress.

There is no doubt that this problem, the matter of balancing the human values of individuals with the technological and social narratives of the larger community is going to be one of the major problems for democratic societies, not only the United States, but all around the world.

There are, as I will point out in a moment, tremendous pressures forcing this situation and the world with its growing and dynamically related problems can ill afford to suffer a failure of nerve or a failure of imagination, as Arthur Clark termed them, and using science to help build a better future. But this is a possibility if conservative attitudes toward new knowledge and change come to dominate the scene.

Having discussed a number of problems and influences that may affect the future of science, many of which could act as restraints on its growth, let me turn now to the reasons why I believe science must and will grow.

And by that growth, I do not mean simply a larger expenditure of money and manpower devoted to it, but the development of new directions and paradigms to advance it.

I see three major groups of pressures that will force an increasing development and use of science and technology for man's survival and change. And these three are related to the thinking of a person, a politician, and a psychologist-- Thomas Malthus, David Ricardo, and Abraham Maslow.

The first and perhaps the dominating pressure is the Malthusian. And here I refer to more than just the need to balance population and food supply, although that remains the most basic requirement. The neo-Malthusian concept encompasses the production and consumption of all resources.

And no matter how we may disagree about man's ability to increase production about the extent of the world's non-renewable resources, about the Earth's carrying capacity environmentally or thermodynamically or any such thing, we must agree that the global rate of population increase today does exert an enormous pressure on civilized man.

And it is a physical, social, and moral pressure and no amount of intellectualizing about triage or a lifeboat ethic is going to reduce it, in my opinion.

I do not see our nation or any other advanced country writing off any desperate people without a major effort at emergency aid. But even more important, I think we will see a greater attempt to help all struggling nations develop means to help themselves.

And this is where science and technology will play a big role in discovering, developing, and transferring the best means for peoples in different lands and facing different sets of conditions to work out their own problems and their own destiny.

And this is the approach increasingly being emphasized today. One can see it in the new aid and advice going out to the developing nations in the new educational programs and in the policies of the United Nations and the World Bank and other international developmental organizations.

It should prove far more successful than attempts to impose westernized forms of agricultural and industrial development on areas where they may be physically or culturally unsuited.

Malthusian-related pressures will continue to fuel the need for more science and technology beyond the point where the so-called demographic transition takes place, where the economic and emotional need for a large family declines and the birth rate levels off.

This can be seen in countries where the birth rate is approaching or has already reached the zero population growth. In these cases, the labor force will continue to grow as will the formation of new families. So certain changes will force new economic growth, even though the number of new mouths to feed eventually levels off.

This is evident here in the United States where in the bases of children already born, the next decade we'll see an increase of 25% in the labor force and 34% in the number of new households.

In addition to this population age shift, we will find a 61% growth in the number of consumers in the 24 to 34 age bracket. Such a shift might not have been very meaningful in a world like that of the Middle Ages where people expected their rewards in the hereafter, but our global civilization today is increasingly temporal. It's instant communication and almost as rapid travel have sown the seeds for the kinds of pressure that will drive science and technology even further.

We might term that pressure Maslovian because it forces men to seek fulfillment of a hierarchy of needs that go far beyond those of day-to-day survival. This Maslovian pressure is related to the revolution of rising expectations that we have witnessed in the past few decades.

There are several variations on this theme related to the US and other advanced nations. Daniel Bell calls it the revolution of rising entitlements because of his feeling that many people now no longer merely expect a better life, but believe that such a life is literally their birthright in a potentially affluent world, and they demand it.

In contrast to this, recent international economic and energy problems have prompted the former UN delegate, Charles Yost, to speak of the rise of falling expectations and warns that the disappointments ahead for those who are frustrated in their drive for a better life will provoke rage and new political violence and upheaval.

I do not want to predict how this will all come out, but I can assure you that one of the topics that will be foremost on men's minds in the years ahead will relate closely to the matter of a better distribution of the world's wealth.

The effect that this is going to have on science and technology will, of course, be very significant. It will cause, as I mentioned before, a focusing on methods of agriculture and industry, but suited to the developing regions.

Among many other things, this will stimulate all the multifaceted research related to the cultivation of arid and tropical lands. It will increase the focus on health and nutrition in these areas. It will force a more intense investigation of the natural resources of these lands.

And in addition to the finding of better ways to use these as commodities, it will emphasize the innovation of labor-intensive methods of manufacturing them into products for which there will be world markets.

All this is going to pose a great challenge to science and technology to both the advance and developing nations who must learn to work together ever more cooperatively. I see no alternative to this other than an increasingly explosive and catastrophic situation.

Related to the Malthusian and Maslovian pressures on science and technology will be a pressure tied to a theory of David Ricardo. This essentially is the idea that as demand on resources grows and they become scarcer and less accessible and lower in quality, the capital costs of finding and developing rises until eventually such costs are prohibitive.

Then a major decline in the standard of living sets in. This, of course, is a major factor in the Meadows model and the Club of Rome project the limits of growth, as Meadows sees the world running out of capital to develop resources long before those resources themselves are physically depleted.

He discounts the fact that science and technology have long been engaged in a running battle with Ricardian economics and have managed to keep well ahead of the game.

For example, we have managed to find and use lower grade ores at lower costs. We have developed cheaper substitute materials to replace costly resources.

We have developed our efficiency and productivity in ways that have reduced material and labor and capital costs, and we have shifted to new technologies and social systems that change our relationship to resources entirely. The question now is, at what rate can we continue to do this?

Meadows and his followers argue that because the doubling time of our population growth and resource use is now so short, we cannot avoid a catastrophic decline within the next 50 to 100 years without establishing a much slower rate of growth and a move toward stability.

Now, whether or not you agree fully or partially or not at all with the Meadows models or their conclusions, it seems to me that science and technology are now in a race against time.

It is a race that must see us develop at a relatively higher efficiency of resource use and a lower energy level both, a standard of living high enough and well distributed enough to achieve some social and political stability throughout the world for the next 25 to 50 years.

In achieving this, we will be enhancing the possibility that world population may indeed level off between 7 to 10 billion people. During this period, we and the more advanced and affluent nations will have to sacrifice enough of our standard of living to support intensive research and development into a variety of innovative and perhaps radically new ways to operate the world.

These will include entirely new energy technologies, agricultural and industrial systems, and national and global political and economic arrangements. For the truth is becoming clearer each day that while we may not have reached the limits to growth yet, we have just about reached the limits of conducting our lives in the same old way.

From this standpoint, Mesarovic and Pastel are correct in the second report to the Club of Rome. Mankind is at the turning point. We must restructure and redirect our attitudes and efforts in the light of the organically and interdependent world that exists today. To do otherwise, to try to continue along the same line of the past quarter century is, as I've indicated to court, catastrophe.

Before shifting now to some thoughts as to the directions science and technology might take at this turning point, let me state a few basic social imperatives that I believe must underline this movement. And I believe it is essential that we pursue and achieve three broad goals.

One, that we maintain peace throughout the world and intensify our efforts at arms control and limitation and eventually disarmament. The world can no longer, if it ever could, afford guns and butter. A new meaning must be given to security tied to global development.

Second, that we establish a much higher level of political and economic cooperation among the nations of the world. A global economy exists and must be treated as such.

Third, that we further increase our international cooperation in science and technology in the kind of joint research that will allow us to find mutually acceptable solutions to global environmental problems and in programs of technology transfer that will benefit all.

I must say I will not dwell on these three imperatives as I believe this audience is highly knowledgeable about them and well-tuned to their need. Instead, let me conclude with some brief remarks on the direction science and technology may take in the years ahead.

Most of these directions will be centered, I believe, on two broad goals more fully establishing the boundaries of physical, environmental, and social in which we can operate and providing the knowledge capital that will allow us to operate within these boundaries.

It is that knowledge capital upon which we have drawn so heavily in the recent past and which we must replenish with new ideas that will allow us to compensate for declining physical capital and higher cost resources.

For example, let's turn to the field of food and agriculture, so prevalent in the world's mind today. In many ways, the production of food has become more energy and capital-intensive.

Modern high-yield agriculture depends to a great extent on chemical fertilizers and pesticides, on irrigation, and on mechanized production and harvesting methods.

To bring more of the world's arable and potentially arable land into production will require considerably more of these resources. This is particularly true as we try to develop the semi-arid and tropical regions that present special problems

But, though, we will do this, our biological and biochemical sciences, I believe, hold the key to many other ways to increase our food supply. For instance, it is possible they may help us to convert a large portion of our agricultural products and other natural products not now edible to humans into a huge new source of food.

New research in microbiology and enzyme chemistry is indicating that the more than 150 billion tons of cellulose waste produced annually with the world's agricultural output can be converted to food, fuel, and other valuable products.

With the help of certain fungi and enzymes, it is possible to turn this material into sugars and alcohols, amino acids and a variety of other materials, organic chemicals, solvents, drugs and antibiotics.

The biological and chemical sciences are going to help us in our food situation also in other ways. Research in nitrogen fixation could lead to the creation of crops that would reduce our heavy demand for synthetic fertilizers, thus reducing the chemical and energy resources going into them and their environmental impact, such as in nitrate runoff.

Biological integrated pest control in which there is much interest and research taking place would also relieve us of a growing problem by helping reduce the huge losses, more than 50% in some areas of the world of food supply.

Through new research in plant genetics, soil science, hydrology, ecology, and many other fields, we must learn to support new types of agricultural systems in parts of the world which have resisted previous efforts at such developments. And where this may prove too difficult or costly, perhaps chemistry can help us make use of some of the existing vegetation as food.

One example of this has been the successful extraction of leaf protein, which has been used on an experimental basis to relieve the protein deficiency of a group of children in India.

And more broadly speaking, I think we are going to witness a new outlook on the world's vegetation and plant life. Of the some 400,000 million tons of vegetation produced annually by the process of photosynthesis, man's yearly harvest of food and fiber amounts to a fraction of 1%.

Of this some 250,000 plants known to man, we use fewer than 100 on any large-scale for food. So there is a great deal more of nature's bounty that we can draw upon if we learn to understand what she has to offer and how we can use it best. This is one of a great many areas in the life sciences, where we must build more knowledge capital.

If we will be turning more to the study of biological systems in the future, I think we also will be studying and learning more that is very useful in the large systems in the atmospheric and earth sciences.

We have witnessed the beginning of this in recent years in the initial efforts of the Global Atmospheric Research Program in the tropical Atlantic last year.

Over the next decade or so, this big international program conducted with the cooperation and scientific resources of so many nations should give us a much better understanding of the interaction of ocean and atmospheric forces.

This in turn will increase our knowledge of the generation of global weather and together with other research in the atmospheric sciences could play an important role in our weather and climate forecasting. We realize now how necessary this is not only to the future of world agriculture, but to many other aspects of our lives.

In addition to the reduction in human suffering that more knowledge in these fields could effect, there are large-scale economic benefits that could be gained by a more precise understanding of weather phenomena and perhaps someday a degree of success in weather modification, which, of course, is a more long range prospect.

In a similar vein, much is to be gained in the earth sciences. Work in the relatively new field of plate tectonics and other geologic disciplines could reveal much information that would help us in the discovery of new reserves of mineral resources, as well as give us better control over our dealing with earthquakes.

And here, again, there is vital economic and human motivation to acquire and use this new knowledge capital. One area of scientific investigation to which we're going to be forced to devote more attention is that of hydrology.

In recent years, attention has focused on water pollution and some success is being achieved by government and industry to clean up and protect our rivers and lakes and estuaries.

But for some time now, the world's water supply problems have been building and they're surely getting worse. We have been drawing increasingly on our limited supply of fresh water.

Worldwide irrigation has grown tremendously. The demands of industry and cities in many areas are rapidly approaching the limits of the supply of run-off water. In some parts of the world, underground water supply is being dangerously drawn down and in many countries, there are growing saturation and salinity problems.

In view of all this, the world water situation could reach crisis proportions, even more pressing than the energy situation if not attacked by a concerted international effort. Recent water conferences have been sounding the alarm on this, and I hope it is heeded in time and with adequate cooperation and adequate resolve.

Science and technology in the years ahead should play a major role in changing and improving man's use of his resources. The era of abundance in terms of waste is over.

Scarcities, the threat of scarcities and even the contemplation of scarcities is going to change our ways of operating. This is particularly true concerning energy, a subject with which I would like to conclude. The energy situation is unique. It is the first time in history that the entire civilized world is affected by the threat of a diminishing resource.

Regardless of the fact that some people presently see an oil glut in parts of the world or that large reserves of coal are still in the ground, we should expect the decline of the fossil fuel age within the next 50 to 100 years. In view of this, we must act now and for a number of reasons.

The first lies in the recognition of how essential energy is to every aspect of our life. Previously, the availability of energy resources and its relatively low cost lulled us and made us forget this.

For example, in the United States, the consumption of primary energy resources accounts for only 2.3% of the gross national product, while in the rest of the world it averages only 1.6%.

This means that on the average, a doubling of energy costs over five years would only consume an extra 4/10 of 1% of economic produce each year, an amount that could be made up easily without reducing real income.

But energy availability is another matter, as its reduction by 50% over a five-year period would virtually paralyze most sections of a modern economy and probably radically change the lifestyle of the modern world.

In addition to this threat of reduced availability of energy and its rising cost, there are other reasons that will drive us to use our science and technology to develop alternative energy sources.

One is the environmental impact associated with the further exploitation of fossil fuels. Another is the fact that these hydrocarbons are invaluable source of chemicals for industry. As I once pointed out, no less an authority on oil than the Shah of Iran has reminded us that there are some 70,000 derivatives from petroleum today.

And a third reason is that it takes a long time, not years, but decades or longer to properly research, develop, and bring into full commercial use new energy technologies. They cannot be introduced full-blown overnight no matter how good they look on paper or how well they might work in the laboratory.

Also, it takes a long time to make all the social and economic adjustments in a large-scale energy transition. These and many other facts would indicate that over the coming decades, we must begin to change our relationship to our energy resources and technologies.

To make the required transitions, we must carry out, particularly in the United States, a concerted effort in energy conservation. This can be done. And if carried out intelligently, it can be done without any great reduction in our living standard.

A reduction of energy waste in industry and in transportation, in our homes, and office buildings could help to cut our annual energy growth rate from its more than 4% to between 2 and 3% with little economic hardship.

But some initial economic sacrifices will have to be made to develop our energy alternatives. And this is true for the entire range of them whether they are nuclear, solar, or fusion, nuclear fusion, or any combination of these.

The current impasse in developing legislation to set long range energy policy for this country lies principally in the fact that the political courage is lacking to tell the public it will have to pay in a number of ways to assure its energy future. Until we get by this impasse, our progress will be slow. Once past it, we may see remarkable advances.

Associated with this is a final thought with which I would like to conclude. And that is the energy problem epitomizes the great dilemmas we face in using science and technology to advance the quality of life for the human race.

Our success in science over the past few decades has, in a sense, fostered many new problems for the world. But it also has given many of us a false sense of security, an idea that science moves us toward a utopian problemless, riskless society.

Nothing could be further from the truth first because man and not science and technology as such always is accountable for the choices that either enrich or diminish the quality of life.

Secondly, we live and always will live in a dynamic situation amid problems whose solutions will breed other kinds of problems, and in a society where the leaps of progress will be proportional to the risks taken.

Even within the bounds of a steady state society, a no growth society or any other scheme of population, resource, energy, equilibrium we might achieve, there always will be change and creative growth that will challenge the human intellect.

There always will be dangers and risks and increasing responsibilities that will drive us toward a new level of excellence in all we do or try to achieve.

This is the process of human evolution at work, a process that started with man's ascendancy and will continue for some time. How far and to what end I will leave it for you and others to speculate upon.

But we must believe that it will all turn out well and we must work constantly toward that end. As a scientist, I believe as Edwin H. Land once put it for scientists and engineers, optimism is a moral duty. Thank you very much.

[APPLAUSE]