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Commencement Address
Clemson College
June 1, 1963

THE NEXT FIFTY YEARS

I would like to try to say a little about the next fifty years--that is, your own next fifty years.

Now this may seem rather preposterous, for someone who doesn't know you to be discussing and predicting your future. Still, certain types of predictions about this graduating class are easy--for example, that a good number of you are to become important and influential as professional or intellectual leaders, businessmen, or government officials in crucial positions. Do you recognize such a person thirty or forty years from now in the new graduate next to you? Perhaps not, perhaps he's the one who will turn out to be the class bum. I cannot predict particular cases. But I would like to consider what, in general, are some of man's prospects during your lifetime.

There is a great deal that reminds us of the insignificance of man, from the similes of the psalmists to modern physical measurements of the vastness of our universe. Man's stature is indeed less than microbial by comparison with the world in which he must live, his

power trivial by comparison with natural forces around him, his lifetime an instant on any scale with which the universe would be measured, and man even among his lowly short-lived fellows is only a single individual out of a total of several billions. This is plenty to make us awed, modest, and humble, or perhaps at times frustrated and even hopeless about the significance of an individual lifetime. It is an aspect of our position we mustn't forget. But at the same time there are views of man in which he takes on a much grander aspect, a god-like quality, and where the life of an individual is full of meaning and surrounded by wondrous events. These latter aspects of man I believe even more significant than the former, and perhaps nowadays more frequently in danger of being submerged by the daily routine and the frustrations of present problems, or of an uncertain future.

Surely it is a time at least as long as fifty years which an individual must contemplate, and for which he should on occasion lay his plans. Yet this is also a period of time which is further than

any of us can see or understand very clearly. Does it lead us in due course only to total destruction by super bombs or to some macabre and inhuman existence--remember that 1984 is only about halfway along in this next fifty years--or to a real Utopia of bountiful resources through knowledge and technology, perhaps even combined with enlightenment and human understanding. Where is there a wise man who can say? Yet along the unknown and unexplored course our society is following, and with all the uncertainties and caprice to which individual lives seem subjected, there is still a strange and valuable predictability of trends amid the unpredictability of specific events. I think I can foresee some of these trends, if you'll let me make one proviso, which I will explain later.

There are occasional events--strokes of heroism, fortune, or brilliance--which are themselves recognizable as momentous. But more frequently our day-by-day existence moves painstakingly slowly, with hardly ever as much progress as we had planned and hoped for.

Yet in facing a longer period of time, I believe we are all characteristically too modest in our real expectations and too myopic in our plans and actions.

Consider, for example, the traditional three score and ten years, the period of one lifetime. This is the time of participation of an individual in history. Now all of written history has occurred in the span of only about seventy such human lives. This is a strikingly short time for us to develop from a small and primitive group to billions of individuals who are near rulers of the material world, probing the secrets of life and of the nucleus, or talking with a fellow man who is imitating the moon itself by drifting happily in orbit around the earth. This much change has occurred in the lifetimes of seventy men. Your own will span more than one seventieth of all history. And there are good reasons for saying that change and development is more rapid now than in earlier centuries, and for believing that it will be still much more rapid during the next fifty years, which are your own.

This accelerating pace of change is largely due to the development of science. Here I'm using science in short for science and technology or applied science, such as engineering, agriculture, and medicine. There are other crucially important aspects of our society, but science and technology are probably now the major revolutionary forces and certainly are producing inevitable and intriguing changes. There may be differences of opinion about the value of science, or about its future, but I believe it evident that we are right now in what might properly be called a century of science. Science has had the interesting and powerful characteristic of exponential growth, that is, growth at a rate which is proportional to its total accumulated past, and hence which is ever accelerating. The humblest scientist of today can use and profit from all that Newton accomplished, and much of Einstein's deepest thoughts, and thus push on beyond the furthest

reach of the genius of the past. The scientist of tomorrow will profit from a still larger and more powerful store of knowledge. The most striking technological developments of today only open the way for the more rapid discovery of still more powerful tools and techniques. It is frequently estimated that the amount of scientific knowledge doubles about every ten years. While this may be debatable, it is clear that the number of scientific publications and the number of working scientists are doubling at this rate. More than 90 per cent of all the scientists who ever lived are living and are at work today. Is it unreasonable then to expect over the immediate future (like fifty years) an ever-growing scientific and technological revolution?

What new things can we expect during the next fifty years? Surprises. For one can never predict the precise nature and time of a discovery; otherwise, it could hardly ~~then~~ have been novel. Discovery, as well as human behavior, is never predictable in detail. And yet we can have a broad understanding of the future without

knowledge of the details even of tomorrow. A simple review of what has happened in the past fifty years--the thirty-fold increase in the number of scientists, increased agricultural efficiency about which you here know much more than I, the rapid increase and refinements of communications, the increasing ease of transportation, new control of the almost limitless power of the atomic nucleus, and medical discoveries which have approximately doubled human life expectancy--these can give some guide to the magnitude and rate of changes we may expect next.

I will be incautious enough to make a few specific guesses about the future.

We seem to be near great advances in understanding certain problems of high intellectual and philosophical interest. One is the question of the origin and development of our universe. The other is the nature and basic reasons for the properties of fundamental particles. Only twenty-five years ago we were at a complete loss to understand the generation of heat in stars, their history and

formation, and the production of the chemical elements. Now we seem to know most of the broad outlines of these secrets, which as it happens, are all bound together. The next steps for which we now have powerful tools in sight are an understanding of the extent and history of our whole universe, and reasons for the nature of the particular building blocks of which the chemical elements themselves are made.

But perhaps most important of all to us will be biological and medical discoveries of many kinds. Certain keys to life processes and organization are already being found, and surely we can expect the beauties and intricacies of these processes to continue to unfold before us. With this should come some real understanding of the origins of life, and of the functioning of the nervous system and of the brain itself.

New discoveries will put new power in our hands and will open new possibilities for man's physical well-being. Developments in biology will likely be the ones which will affect us most

personally and profoundly. What can we hope for?

An understanding of cancerous growth, and powerful and effective methods of controlling it.

An understanding of the aging process, and through this ways of modifying aging rates.

The possibility of controlling many key biochemical processes, perhaps by inserting some commands directly into a biological system at the genetic level.

Specific and blessed cures of a number of mental diseases.

Synthesis of simple forms of what can be called "life."

Expeditions to Mars--the fantastic trip to the moon is already so close by, though still fraught with tremendous difficulty, that it is accepted as a normal expectation and hardly worth mentioning in this list.

And with exploration of Mars we are likely to find primitive but surely very revealing forms of life.

Perhaps within our span of fifty years, we may even have some inkling of other intelligent life, probably not from our own

solar system, but on some star brother to the sun.

What about more and cheaper power to do our work, fresh water for the deserts and greater food productivity, or more flexible speedy transportation? My guess must generally be yes! -- yes! -- and always yes! What about weather control--probably that, too, in some limited forms.

All of these will take hard work, dedication, and a viable society. But we are not talking fantasies here. I am convinced that many of these things will be as real as potatoes. They are very likely things that some of you will have a hand in doing, things you will experience, and for which you will need in some sense to make plans. And even so I have surely not been sufficiently imaginative because of fear of being thought irresponsible. We know that the human brain or the tiniest biological cell can pack into its small space complexities of memory, processing of information, and control which our largest machines cannot approach. Will we perhaps make some enormous step towards duplicating their performance in pea-sized,

rather than building-sized, machinery? Will knowledge and science simply lead us on and on, ever opening new doors and spreading new wealth in front of us, or will we rather reach the boundaries of science in the next fifty years, or the limits of man's possible understanding? We cannot yet know.

We do know there will be astounding developments and challenging changes quite unforeseen, as there have been in the immediate past. In many cases discoveries of the past were even declared impossible by thoughtful persons within the same decade that they became a reality. In 1896, Lord Rayleigh, one of the last century's greatest scientists, proclaimed "I have not the smallest molecule of faith in aerial navigation other than ballooning." This was about the time that newsmen were cruelly jeering at Langley for trying to build a flying machine, and only seven years before the Wright Brothers successfully zoomed above the sands of Kitty Hawk.

Another example took place more recently in one of our largest industrial companies concerned with production of power, which decided

not to allow its laboratories to engage in nuclear physics research because such work had no promise in the power field. A very few years later came the discovery of fission, bringing in view enormous sources of power, and almost the practical equivalent of the perpetual motion machine.

Only ten years ago I remember feeling terribly bold in commenting publicly that within the lifetime of those already on earth, man would probably get to the moon. How conservative this boldness now seems, with NASA's schedule set for placing man on the moon by 1970.

It is perhaps the visionary and the science fiction writer who ~~has~~ have come closer to really describing the future than those whom we would have taken as realists and men of good judgment. We have, in fact, been living in a world where dreams come true, and at a startling pace. We have seen so many miracles that we've almost lost the ability to wonder at them. For the dreams of yesterday become the hopes of today, ~~then~~ and the realities of tomorrow, and then the commonplace of the day after.

Frankly, I envy you, for during the next fifty years there will be much that is fascinating and inspiring. You will see, enjoy, and participate in some of the wonder of human development, part of which I shall have to miss, unless somehow I can have myself put on ice and kept over a bit.

But confronted with these marvels and this optimism, I suspect that some of you have already begun to cringe, perhaps subconsciously, perhaps with deep conscious reservations. For these developments also pose troublesome problems. Knowledge and skill for cures of cancer, or of schizophrenia, also imply knowledge of how to produce them. Who will regulate and control such knowledge, and with what wisdom? Ability to affect biochemical processes or the genetic chain in beneficial ways implies also the ability to tamper with life in ways which can be monstrously inhuman. Additional power in man's hands is not necessarily enobling; it can also be disastrous. Already the avoidance of a nuclear holocaust seems precarious. Perhaps I might have labeled my talk "Will There Be Another Fifty Years?". But I am not so pessimistic. Nor am I one of those who

thinks the human race can be suddenly wiped out at this point by nuclear war. However, it is clear that a few hours' time could easily deal death to many hundreds of millions, and disaster for much of the earth's remaining human population. Why go on discovering more complications and hazards? This brings to mind the little old lady who was complaining about all the new-fangled ideas and asked "Why do people have to be rushing off into space now? Why can't they just sit home and watch television, like God intended?"

Knowledge, science, skill, and their increase can't be exorcised or eliminated as something foreign and unwanted; they are part and parcel of society and their benefits are demanded on every hand. They are part of man's birthright and his nature. Those who would blame society's problems on too much science and civilization are about in the position of the inexperienced man who went to an alcoholic party, drank freely and enjoyed himself enormously until he suddenly looked at his wife in alarm and said, "Mary, you've drunk too much, your face has already become all blurred and fuzzy."

Knowledge does not create moral problems itself, but frequently makes them more evident, and pressing, and sometimes more grandiose. The continuing scientific and technological revolution also shakes up our thinking, places us in new contexts, and allows or forces new solutions to the age-old problems of society and morality. Will the atomic bomb be a means of forcing the elimination of war, and of binding world order during these next decades? If we are sufficiently wise, perhaps so. If not, heaven help us.

With or without science, we are still faced with deep human problems, some of which science will help us solve. What, for example, will happen to the world's starving overdense population during the next fifty years? How can we justify ~~ourselves~~ or be allowed to continue as an oasis of high living standards and excess food simply because of our good fortune of birth while much of the world's population is crowded and starving? New agricultural productivity and techniques, new techniques in nutrition, and of birth control are giving us now a practical chance to act on this

problem. If we are callous about these less fortunate peoples in the next decades, we will very likely leave a legacy to the next generation much more explosive and troublesome than that left on our doorstep by the slave trade of the eighteenth and nineteenth centuries, or the angry and virulent communism left by the abuses and callousness of nineteenth-century capitalism.

Much has already been said in the past about the marvellous benefits of science. It seems clear that during the next fifty years we really will have arrived at the point of being able to achieve almost any human need. It has been pointed out that while the Egyptians--at the cost of tremendous labor and dedication--were able to build up the remarkable pyramids, we are now able to put them in orbit! Not that this represents a human need. More seriously, there are few physical goals not ruled out by some specific law of nature which we cannot hope to reach if we really devote our minds and energies to them. This is the nature of my prediction, which I more or less promised at the beginning, but I indicated there would be

one proviso, and here it is -- that there continue to be a coherent and viable society.

Perhaps almost every century has seemed the crucial one to those planted in it, and certainly the course of civilization has faced crossroads many times in the past. But I cannot keep down the thought that ~~the~~ this particular coming half century will be one of the most crucial. Powerful forces are at play, the stakes in human lives and in possible welfare or disaster are always growing, and the pace is getting faster. We're in for an exciting, perhaps an exhilarating, and perhaps a very rough ride.

What is there that will prevent our complete enjoyment of the almost arbitrarily large physical wealth one can envisage? People. I mean that nasty fellow next door. And I also mean his problem with me. All other limitations seem likely to be really cleared away, and we will be given our choice still more clearly and starkly than ever before -- how does one live -- how does one live with his fellow man and his God?

Is the ineluctable march of science I have described, or the wealth of knowledge and power we have in our grasp benign or frightening? Neither. They represent great opportunities through which in the next fifty years we can find triumph or disaster.

What should we as individuals do? Preparation, knowledge, and education are of course important for effective work in this ever-changing world. But for a period like fifty years, I can't give any advice better than that given by a man from Tarsus some time ago: "Whatever is true, whatever is honorable, whatever is just, whatever is pure, whatever is lovely, whatever is gracious, if there is any excellence, if there is anything worthy of praise, think about these things." There are no slick tricks which can make a lifetime successful, nor gimmicks nor ploys which really solve international problems. There are also no clever moves for temporary advantage which will clear up the problems associated with the word "segregation." Only the continuing power of good character, the ability to use good sense and apply throughout our continual trials and uncertainty principles of behavior which have been tested through

history and shown to be admirable. These are the things which will produce the right trends regardless of what specific events the next fifty years bring.

But there is an additional hope. Note that the great strength of science has come from its accumulative effect, the fact that one scientific contribution makes easier another one, and that brings forth still another. With this, confidence and enthusiasm are generated which now result in the magnificent structure and power of modern science. The spiritual and moral realm, or the realm of human relations, also can show this cumulative property. The wise and good actions of one person or nation are likely, although not sure, to bring similar responses in others, which in turn produces an atmosphere where spiritual and moral values flourish further. Virtue is catching, as well as knowledge. There is, of course, a difference, in that mankind usually doesn't backslide in knowledge, which always increases. In morality and human relations, there can be either upward or downward trends, and I shall attempt no prediction for the

next fifty years. But I am sure that we will be severly tested, and I know the direction the trend must go if man is to survive in the form we would like to see him. If this generation can usher in a trend towards integrity, towards humanity, towards high moral and spiritual standards, one which will grow from individual to individual, and catch up our civilization in a wave of enthusiasm, dedication, and the confidence that man can take himself in hand and live nobly with his fellow man, then the next fifty years will be truly magnificent ones.