A LITTLE BEYOND TOMORROW

By Daniel J. Fink
Vice President and General Manager
General Electric Company, Space Division
Valley Forge, Pennsylvania

It is indeed appropriate that this Space Congress is being held in Huntsville, because it was here, as you all know, that we spawned the propulsive power which man used to fly in space and land on the moon, and without which we might still be earthbound. What is earthbound about Huntsville, though, is the fact this fine city is firsthand evidence that the bulk of space dollars has been spent right here on the ground. With all due respect to my vegetarian friends, it has worked out a lot better than watercress.

But I do not want to dwell on history with which you are familiar. I want to talk about the future, about a period beyond the noise and trauma of today when space will directly affect our lives in a daily manner. To bring it into sharper focus, we are at the point where there will soon be more people on earth than in heaven and hell combined. So the space program has a particular challenge to face in helping make sure that we do not unwittingly swap places with the hereafter.

In many ways the space program can be likened to a teenager — one beset with the awkwardness of public apathy and the acne of reduced funds. This teenager has some other problems, too. At one point in his life, much like other youngsters, he knew it all. The fact that he scored on his first date to the moon frightened off the girls and the public. Now they are reluctant to go steady with him, even though he is envied by some of his contemporaries. This reluctance is aggravated by his ability to consume a lot of bread. He stands in the unenviable position of having so much to give and yet he faces the stark danger of becoming impotent before reaching his twenties. Our space teenager has not been staying home. He has been on an international tour, some of it successful. However, there are a lot of people in the world who look at him only in terms of a trip to the moon, and many of those think it has been a bummer. Lest I give you the impression that all is bleak, let us consider some fundamentals. Like other teenagers, this one has to leave the warm shelter of the sixties and learn how to live in a competitive world. He must find his own way in a society that is making a quantum break with the past.

Many of us feel very strongly that the space program will affect our lives in a more direct way than it has thus far. I, for one, believe that space will become an integral part of us and we of it. Space must do this, or it may not survive as a broad-based activity. It must become a part of our everyday lives, or, perhaps, remain at best a research and development pursuit. When addressing the future, it is a well-known fact that we scientists and engineers have a strong tendency to overestimate what we can do in the short term and underestimate what can be accomplished in the longer term. For instance, we can get very optimistic about meeting a rather tight launch schedule, say for the next satellite in a given program. Yet, on the other hand, there are many prominent technologists who did not think man would land on the moon until the seventies or eighties. When we deal in the near term, we almost always have some specific project in mind that somebody is trying to sell, and there is always a tendency to push the immediate accomplishments too hard. In contrast, to delve too far into the future to justify our efforts in space may once have been an acceptable approach, but, with so much of science fiction already an accomplished fact, things like colonization of the planets have about as much impact as watching paint dry. Therefore, I would like to concentrate on the time "a little beyond tomorrow," where we can deal with possibilities that are based on research and technology already in progress. They do not seem to get the proper attention, even though I think they are the strongest rationale for our current space efforts.

First, I want to talk about one of the oldest areas which is benefiting from space technology, that is, meteorology. Weather satellites were among the first spacecraft put into orbit in the early sixties. They have been eminently successful and yet, we cannot honestly say they have revolutionized forecasting. Why not? Simply because, despite our experience, we are still in the early stages of this business. What accomplishments have we seen? Probably the major one is disaster prediction. The examples of successful hurricane detection and tracking by satellite with the attendant advanced warning for saving lives are now commonplace.

So far, these satellites have probably helped other countries more than ours in predicting the weather. Australia and Chile can come up with 1- or 2-day forecasts, which they could not do as well before, by using information about conditions in the oceans that lie in the path of their weather.

If we look ahead, we are on the verge of a significant breakthrough, because we are going from a situation where we receive pictures from space to one where we are getting data that can be fed into computers. In other words, we will be probing the vertical dimension of the atmosphere from space. This will give us the ability to make better mathematical models of the world's weather and to speak to computers on their own terms. Ultimately, as we get to understand the dynamics of the atmosphere, we should be able to solve the problem of the general circulation of the atmosphere. Then we can expect to achieve an accurate forecast about 2 to 3 weeks in advance. And that is where I believe our space meteorological efforts are taking us.

The next aspect I want to get into is to look beneath the weather at our earth, in other words, the Earth Resources Satellite. A lot has been said and written about this subject, perhaps much of it overselling in the short term. I would not want to see promises of benefits from our very first Earth Resources Technology Satellite (ERTS) be those that will only come from several years of experience in this vital and emerging field. The nub of the matter is that the world's food and other resources are in critical supply; and for the first time, we are going to have multispectral measurements from space that will give us an idea of where we stand. The interest is fantastic — for example, NASA has received some 7000 proposals for experiments involving the ERTS program. These range from studying crop diseases and ocean conditions to mapping urban areas and getting information about snow and ice cover as a means of locating water sources. Also, what better way will there be to monitor the pollutants in our environment!

As these programs progress, and the countries of the world are ready to take action, we will have new guidelines to help us decide where crops can be grown more efficiently, how to manage our precious water resources, our forests, our land, where to better find new resources and fishing grounds, and what we need to do to clean up our atmosphere.

Now, let me turn briefly to education and knowledge and how space is playing an important role here.

We all know of the impact that the space program has had on school curricula, especially in mathematics and the sciences. But, not as much is known of the new educational technologies stemming from space sciences.

Brazil, for example, is planning a direct-broadcast educational television system that would reach more than 100 000 schools. In some cases, as many as six classrooms with television monitors would be used in each school. Another possible use of the system would be adult education during the evening hours. In the U.S., there are plans to beam educational television via satellite to rural schoolrooms in Appalachia. The intent in all such programs is to get the best educational talent a country can find to reach the maximum number of people. In the future, computer-aided education would enable a child at his desk to tap into knowledge sources anywhere, instead of relying just on the school library. These "electronic encyclopedias" will give us the means so that by the year 2000 every person in the world, wherever he may be, could have access to at least a high school education.

Transportation is another vital area that needs to benefit from space work, because our mobility as individuals is threatened in a world that is becoming more densely populated every day. There are some obvious problems where space technology is the only valid solution, such as air traffic control. Today, airplanes fly over the oceans with lateral separation standards of 120 miles and 20 min flying time in-track.

Sometime in the next decade or two, they may be able to reduce these standards to, say, 30 miles laterally and 5 min in-track so that they can fly more safely with the denser patterns that will result as air traffic gets as packed as some of our highways. Over land, air controllers will be locating planes within 50 ft and 1.5-mile airspeed. Down on the ground, we may see police cars, taxicabs, and other fleet vehicles controlled through pinpoint location provided by satellite.

Up until now, I have been talking about areas in which a lot of basic work has been done, and there are programs underway that give us some good ideas of how the future might turn out. However, there is a concept that is still in its infancy, called space manufacturing, that may ultimately show the most promise, although it will require new programs to get us where we want to go. It is possible that the weightlessness and near-perfect vacuum of space

could serve as the basis for manufacturing facilities that will give us materials and products of a quality unattainable on earth, except at prohibitive cost. Things like purer vaccines and superior crystals are examples of prime possibilities. It has been estimated that by the end of this century the total value of electronic materials and biologicals manufactured in space could run upward of $50 billion.

In the last 20 years of so, we have achieved an order of magnitude of purification in some of our biological materials. This is, perhaps, a practical limit achievable on earth. Yet, you and I still get undesirable side effects from some vaccines and medicines. Therefore, space may afford us the opportunity to reach another order of magnitude of purity without too much difficulty and thereby do away with these side results.

Another very interesting possibility has to do with the manufacture of high-quality magnetic oxide crystals in space. They would have little bubbles of gas moving around inside them, and would be used as memory storage units for computers. The increase in capacity and reduction in volume, in comparison with memory devices used today, would enable us to approach the capacity of the human brain. We might also achieve random access, like the brain has, in dredging up forgotten facts and figures. This development is being experimented with on earth, and the hope is that the better crystal structure we might attain by manufacturing in space would give us vastly improved results. Economically, today's memory devices cost between 5 cents and 1 cent per bit of information. The memory units of the future that I am describing would perhaps cost less than one-tenth of a cent.

Turning to more personal factors, not too much has been said about the community aspects of using space. In other words, man living with man, his attitudes, the haves and have nots, jobs, equal opportunities, and everything that goes to make up the whole sociological picture. Just a scant 10 years ago, live television could not be sent across the Atlantic. We were able to watch man's first steps on the moon 2 years ago. Now, communications satellites ride shotgun on the world and we can receive television anywhere. At the same time, about half of the international phone calls made today are going by satellite, and such usage is growing at a rate of about 40 percent per year. Voice transmissions on the earth sometimes have trouble reaching beyond the horizon, but, with relay satellites, we can cover nearly half the surface of the world at once. In the future, every person could have a portable telephone and could dial anywhere. Secretaries could type letters at their desks and, in a fraction of a second, they could be sent to their destinations by "Telemail." As the world continues to shrink, and each of us can watch and talk with his neighbor in real time, and vice versa, our expectations and attitudes will rise above national boundaries and what we have been taught in the past. So the sociological impacts will be staggering — I will not even venture a guess on the outcome.

In the field of health, space has already made many contributions. Electronic heart pacers, diagnostic sensors, and sight switches for manipulating wheelchairs are but a few among numerous examples of practical applications. In fact, the medical field has been one of the prime benefactors of the space program, because of the obvious necessity for providing life-support systems for our astronauts. In the future, we may have diagnostic and treatment centers in our own homes, tied into the medical facilities of the world by satellite. If we are ill, we can use our own time-sharing computer terminal to ask the outstanding minds of the medical profession what ails us and get a prescribed treatment in return. Whether this will lead to a generation of electronic hypochondriacs remains to be seen. Since diagnoses and treatments will not be restricted to physical ailments either, we may also have group therapy by satellite.

To sum it up, space surrounds all the earth so it is, indeed, a province of all peoples. Thus far, more than 70 countries are working with the U.S. on some program or other applying space to their problems. The United Nations is very active, too, particularly with respect to earth resources programs for developing countries. I submit that without the overview and the information that space can afford us, we cannot hope, literally, to survive on earth except at deteriorating levels. We are into the first payoff years of space, and we cannot stop now.

I want to close with several predictions. First, we are going to see a resurgence in favor of space and technology. Second, many of the benefits I have been discussing with you today will surely come to pass. And third, all of us, by virtue of our attendance at this Space Congress, qualify as salesmen for space. I can make these predictions with confidence because I have been assured by the chairman that most people will shortly forget what I said. Second, if I am wrong, a lot of other people are wrong, too. And, third, I may just damn well be right. If I am, then there is a great period ahead for all mankind.