GOOD FORTUNE IN WONDERFUL PLACES

It has been a great honor to receive the Japan Prize. I have been very fortunate in this. I have also been fortunate in my work and in colleagues and friends, in my country and in Japan, whom I cannot name in this brief summary.

In the West, we think of fortune as a woman or goddess who can be courted but not compelled. How can we court good fortune in technology?

Science seeks to discover truths of nature that are eternal. Science inspires technology. Technology produces the means for extending science, and technology continually creates things which serve man. In technology, the new quickly becomes old, and individuals, universities and industries that do not change with changing technologies will become obsolete.

There have been many changes in my technological career, but I have always had the good fortune to learn and work in wonderful places, where I had the freedom and support to pursue new ideas.

The first wonderful place was the California Institute of Technology, usually called Caltech, where I did my undergraduate and graduate work. Caltech has very high standards, but the students have a continuing choice as they study. At first I intended to become a chemical engineer, but freshman chemistry cured me of that. Then I thought of becoming an aeronautical engineer. Finally I settled on electrical engineering. This was a good choice, because I liked the field and was good at it, and it was a forward looking field.

It is courting ill fortune to work in a field you don't like or aren't good at, or that is a decreasing rather than increasing importance. I was fortunate that at Caltech I could change my mind without jeopardizing my future.

From Caltech I went to another wonderful place, Bell Laboratories. There I worked in the research area for 35 years. The research area has about a tenth of the employees; the rest then developed components and systems for manufacture by Western Electric and use in the Bell System.

The very broad responsibility of research in shaping the future of nationwide telecommunications gave good general guidance. Research was led rather than managed by highly competent technical people. Such leadership assured that only productive researchers stayed in research, and that researchers with a good record of accomplishment received great freedom and much support, especially when they tried hard. This was demonstrated by the support of research on satellite communication, which led to Echo in 1960 and Telstar in 1962.

The management of Bell Laboratories knew that not all research proves successful. And, sometimes research succeeds indirectly, or elsewhere. The Pierce gun was invented during work on a worthless vacuum tube. The Pierce ring found no use in the Bell System. In a light-hearted way I supported and collaborated in work on the use of computers in producing musical sounds. This laid the basis for the production and sale of digital music synthesizers ——but not by the Bell System.

In 1971 I left Bell Laboratories and returned to Caltech as professor of engineering. There I learned to appreciate good teachers and to understand some of the problems of universities.

Research in American universities is supported chiefly by a host of diverse government grants, usually to a professor and his students; sometimes to a small group of professors. Thus, leadership tends to be widely scattered among small groups. It may be hard to get support for a really new idea that government agencies

haven't heard of yet. Universities need and seek broader support. They need leadership to get from the old to the new. Such broad leadership is difficult, but there have been great leaders. Millikan at Caltech and Terman at Stanford are examples.

In 1980 I became emeritus at Caltech and for two years served as chief technologist of the Jet Propulsion Laboratory, usually called JPL, which is managed for NASA by Caltech. JPL is a very good laboratory that has responsibilities for such projects as Viking, which landed on Mars, and Voyager, which sent back wonderful pictures as it passed Jupiter and Saturn. JPL does other diverse work as well.

As at Bell Laboratories, most JPL employees aren't researchers. Support comes from a diversity of contracts, large and small, with various government agencies. It is a tribute to the management and the researchers that good research is done at JPL.

In 1983 I came to another wonderful place, CCRMA (the Center for Computer Research in Music and Acoustics), pronounced karma, and CCRMA became my fate. CCRMA is a part of the music department at Stanford, and the founder and director, John Chowning, is a musician. He learned of the musical uses of computers from work at Bell Laboratories. He became so good with computers and electronics that he invented FM (frequency modulation) synthesis, which is used in Yamaha digital synthesizers, such as the DX7. Yamaha pays Stanford royalties for the use of Chowning's invention.

CCRMA is small, but, like the Bell Laboratories I knew, it has a broad purpose—music and acoustical studies relevant to music and its performance in recordings or concert halls. The students and staff include electrical engineers, computer scientists and workers in hearing as well as musicians. All of the musicians become expert programmers. John Chowning is a good leader in the same way that those who led research at Bell Laboratories were good leaders.

From my good fortune at these diverse, wonderful places, I have come to believe that several things are important in courting good fortune in technological research.

We cannot successfully plan the future in detail. Individuals and institutions must change what they do as technology changes. It is essential to use good judgment from day to day. Sometimes bureaucracy and the dead hand of the past stand in the way.

Even the very best researchers and leaders are sometimes right and sometimes wrong. Freedom and support for talented and productive researchers is essential.

Good fortune cannot be compelled. We cannot guarantee success. Through talent and leadership, we can court good fortune. If we are lucky, fortune will smile on us, as she has smiled on me.