EDWIN H. LAND:

SCIENCE, AND PUBLIC POLICY

by

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November 9, 1991

Presented at

Light and Life
A Symposium in Honor of Edwin Land

American Academy of Arts and Sciences
Cambridge, MA 02138

Q308LSPP 110491LSPP 11/12/91

Edwin Land worked passionately to realize his vision for the betterment of society. A significant portion of the fascinating book by James R. Killian, Jr. "Sputnik, Scientists, and Eisenhower" is involved with Land, directly or indirectly, who was a member of the President's Science Advisory Committee (PSAC) 1957-59, a Consultant-at-Large of PSAC from 1960-1973, and a member of the President's Foreign Intelligence Advisory Board (PFIAB) 1961-77.

But he was also a member of the National Commission on Technology, Automation and Economic Progress 1964-66 and of the Carnegie Commission on Educational Television 1966-67 and a Trustee of the Ford Foundation 1967-1975.

His vision of science for the public was a great one, and highly original. It is presented, for instance, in his testimony to the Senate Military Affairs Committees (at the Joint Hearings on Science Bills) October 1945. At a time of great turmoil about the structure of the United States Government for the advancement and control of nuclear energy, Land testified rather on bills related to the National Science Foundation and the role of the government in science and technology. He argued

> "...there can be no solution because we do not understand the nucleus and we do not understand the Russians. If, during the course of the next ten years, we can expand the American scientific community, expand to every locality our activity in basic and applied science, get to understand the nucleus, negotiate, argue, trade, bargain, work with, and finally get to understand the Russians and get them to understand us, then (if during this period we have had a similar policy for coming to understand the British and the French), perhaps the terrible shadow may start to lift."

Indeed, members of this Academy have taken very seriously the mission to get to understand the Russians, but the nation as a whole has not persistently supported education and scholarship in understanding foreign peoples and ourselves. Land goes on with his vision supporting the general effort for

> "...discovering the scientific talent and fostering its development; in short by the production of enough trained scientists, not only to work in basic science, but also to participate in every phase of the industrial aspect of community life."

But also,

> "the other-- and this is the field of my personal interest-- is to develop thousands of new small scientific industries..."
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> "As I visualize it, the business of the future will be a scientific, social and economic unit. It will be vigorously creative in pure science where its contributions will compare with those of the universities... the machinist will be proud of and informed about the company's scientific advances; the scientist will enjoy the reduction to practice of his basic perceptions."

And he continues with his vision of a thousand small companies, each employing 2000 people (including 50 scientists) and grossing (in 1945) $20 M each, and spending $1 M on research, which would (given inflation alone to 1991) spend $10 B on research and engineering annually, employ 2,000,000 people directly, and contribute $200 B to the national income directly "and much more indirectly."

> "And year by year our national scene would change in the way, I think, all Americans dream of. Each individual will be a member of a group small enough so that he feels a full participant in the purpose and activity of the group. His voice will be heard and his individuality recognized."

What will these people do?

> "First of all, this new company will start by contemplating all of the recent advances in pure science and in engineering. Its staff will be alive to the significance of newly available polyamide molecules... a group of fifty good scientists contemplating one of these fields and inspired by curiosity about them and a determination to make something new and useful, can invent and develop an important new field in about two years. This new field will be a monopoly for the group-- a monopoly in the best sense of the word-- because it will derive from justifiable patents and important inventions, and from know-how deliberately acquired by the group..."

> "While I feel that both the war and the pre-war periods have demonstrated that the concentration (of scientific activity and of distinguished scientists in a few large corporations) that did occur was of enormous benefit to the country and that it would be a grave hazard to prevent such concentrations from occurring, I feel equally strongly about the desirability of meeting what is objectionable in such concentration by having thousands of other small laboratories as well staffed in quality, if not quantity, of scientists. These small laboratories because of their compactness, freedom from such institutional control as exists in large corporations, the close relationship that can exist between the scientist and the people making their products, would, I believe, create far more new fields than would the large laboratories and it would be the best method of preventing significant monopolies in any essential field."

Edwin Land recommends the solution to monopoly be found in multiple monopolies which compete with one another. His position is one of opposition "to the concept that research by government should be substituted for research by the small business... (which) grows strong by having its own scientists and by building itself around their efforts."

He completes a vision of the National Science Board appointed by the President and picking its own Director but provides an ingenious suggestion in support of those who oppose "the complete isolation of this scientific group from the political world." And that is a "Joint Liaison Committee consisting, for example, of three members of the board and three members of congress" for mutual education and

> "...particularly suited for considering one important problem for which a solution has not yet been proposed: the encouragement of individuals who are primarily interested in new applications of recent advances in pure science rather than in basic inquiry itself..."
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> "Those who wish to strike out for themselves should have the opportunity to complete their inventions both theoretically and practically and build them into actual enterprises."

Although Edwin Land must have realized that much about him was unique, he tried to identify those elements of his own being and experience that could be replicated to the benefit of his nation and the world.

According to David Beckler's detailed notes of the 15 October 1957 meeting of the Science Advisory Committee (of the Office of Defense Mobilization) with President Eisenhower 11 days after the Soviet Union launched the first artificial Earth satellite, Sputnik, Edwin Land urged the President to involve the American people in the satisfaction of scientific discovery; on 7 November Eisenhower in his TV and radio address remarked that one of the greatest and most glaring deficiencies of the citizenry was their failure to give high enough priority to scientific education and to the place of science in national life.

Land's emphasis on scientific education of the public was a lifelong interest, whether reflected in his later service on the Carnegie Commission on Educational Television (with James R. Killian, Jr.), in his involving Polaroid production staff in the work of the research laboratory, or in the "Introduction To Outer Space" issued by President Eisenhower 26 March 1958, more than 33 years ago. That perceptive and inspiring but practical document was written by Land, Edward M. Purcell (from whom you will hear later) and Francis Bello, known to many of us from his work with Fortune and Scientific American.

I present the paragraph headings from "Introduction To Outer Space" as an indication of its content:

1. Why satellites stay up
2. The thrust into space
3. The moon as a goal
4. A message from Mars
5. Will the results justify the costs?
6. The view from a satellite
7. A close-up of the moon
8. And on to Mars
9. The satellite radio network
10. Military applications of space technology

11. Space timetable

As Ken Olsen observed in his talk this morning about Land and Polaroid, knowing where you want to go is a big advantage.

A small portion of "Introduction To Outer Space" addresses the military uses of space, noting

> "For the most part, even the more sober proposals do not hold up well on close examination or appear to be achievable at an early date. Granted that they will become technologically possible, most of these schemes, nevertheless, appear to be clumsy and ineffective ways of doing a job. ..." After the example of "dropping" a bomb from a satellite, the report continues, "This is only one example; each idea has to be judged on its own merits. ... The history of science and technology reminds us sharply of the limitations of our vision. Our road to future strength is the achievement of scientific insight and technical skill by vigorous participation in these new explorations. In this setting, our appropriate military strength will grow naturally and surely."

In 1991, we are still involved with questions about the proper military use of space, and much that "Introduction To Outer Space" envisaged has come to pass. But not without effort and vision, and in this exploitation of space, Din Land played a pivotal role.

Most of the following can be found in James Killian's book, on which I rely in part to avoid problems with information still classified secret, and in part because I could not better Jim Killian's authoritative and eloquent descriptions. Land had been a member of the Steering Committee of the Technological Capabilities Panel (TCP), which was a sensitive and highly classified study led by Killian 1954-55, intended to provide President Eisenhower with a comprehensive assessment of the Soviet first-strike nuclear threat to the United States and the U.S. ability to prevent or withstand it. An essential element of TCP was the Intelligence Committee headed by Din Land, which conducted a no-holds-barred review of U.S. intelligence information and capabilities. That Land Panel included William O. Baker of Bell Labs, Ed Purcell of Harvard, and John Tukey of Princeton. The panelists used to joke that they could hold a panel meeting in a taxicab, and they probably would have if the information had not been so sensitive. For their frequent trips around Washington in radio-dispatched CIA automobiles, the panelists were prudently assigned code names.

I was not associated with the Technological Capabilities Panel. I had helped build the first hydrogen bomb in my early summers at Los Alamos 1950-52 and then, after joining the IBM company, I worked about half-time 1953-54 with Jerome Wiesner and Jerrold Zacharias on extensions of continental air defense, and soon after Sputnik worked with Bill Baker and others on some of the matters that had interested the TCP intelligence section. Then for more than a decade, until 1973 or so, I was a member of Din Land's Panel advisory to the President's Science Advisor, which was intimately involved with government organizations and industrial contractors in the evolution of imaging satellites.

Photographic reconnaissance has a long history, and by the time I had any real contact with it during September, 1952 in Korea, it had evolved to enormous aerial cameras with facilities for image-motion compensation (IMC). I suppose the intelligence section of the TCP found the same cameras, which would not be very convenient for providing photography of "denied areas" such as the Soviet union. Yet it was clear that there were vast uncertainties as to Soviet military capability, particularly in regard to ballistic missiles, and the ability to take suitable photographs would be extremely valuable. Killian tells the story of the marriage of small-format high-resolution cameras and the modified sail plane concept to create the U-2, so quickly and elegantly achieved by Kelly Johnson in the skunk works at Lockheed. Previously rejected by the Air Force, the concept was validated and given life by the Intelligence Committee of the TCP.

The system was feasible only because of the recognition that high-resolution film would allow scaling down the size and weight of the camera so that it would fit on a light aircraft that could fly at altitudes then beyond the capability of any Soviet air defense system. And this remained true until the 1960 downing of the U-2 flight of Gary Powers. Of course, within a couple of months after that politically disastrous event the United States was receiving photographic images from satellites, in the form of film cassettes returned in reentry vehicles equipped with parachutes and snagged by aircraft over the Pacific Ocean before they could fall into the sea.

In recalling Edwin Land, I note his reaction to the Soviet shoot-down of the U-2 in 1960, cited by Killian,

> "The president himself accepted full responsibility for the flight. In 1960, in commenting on this episode, Dr. Edwin Land said in a commencement address: 'It was not a question of the ineptitude that might be revealed by the truth, or the possible damage that the whole program of negotiation for peace may have suffered ... and it was not a question of whether with foresight that particular crisis could have been avoided. The issue was this: Does an American, when he represents all Americans, have to tell the truth at any cost? The answer is yes, and the consequence of the answer is that our techniques for influencing the rest of the world cannot be rich and flexible like the techniques of our competitors. We can be dramatic, even theatrical; we can be persuasive; but the message we are telling must be true.'"

As I got to know him in the work of the Land Panel over the next 13 years or so, it was clear that absolute integrity underlay this man of genius and vision. I don't believe Din Land would have been happy with the lack of respect for truth in more recent Administrations.

Bill Baker recounts that in the late 1950s, he and Din Land and Jerry Wiesner would meet over dinner in Washington and "tell one another stories" of the latest discoveries, inventions, and clever solutions to problems. Din Land evidently felt no need to keep his good ideas to himself. Din and Jerrold Zacharias would engage in "competitive inventing," sometimes on real problems and sometimes on toys. These same qualities of insight and fun were evident in Din Land's leadership of the Land Panel on which I was privileged to serve until about 1973.

About the activities of the Land Panel, I can give only impressions of the atmosphere of that activity, and even there must ignore some important aspects. We would meet several times a year for two or three days in Washington or in the field at contractor establishments to understand the capabilities of existing systems and the options for improvement. At times, there were serious problems to be addressed; at times great opportunities. The Land Panel did not so much invent new concepts as evaluate and choose. Sometimes, there were obvious technical mergers to be made, and occasionally a key missing element was supplied during Panel discussion. Land's addiction to thought and work was obvious at these Panel meetings.

When we met at Polaroid, we could look forward to small sandwiches brought in from Elsie's; my favorite was cream cheese and caviar. Somewhat later, we would meet in a magnificent boardroom at Polaroid, and would be provided dinner by Din's cook. Occasionally our Panel meetings would run until midnight, and even then we would look forward to spending 30 minutes after the meeting with Din in his lab, looking at his "Mondrian" or other striking aspect of his current research. I recall that one session ended at daybreak, but that was unusual, even for Din Land.

The thought and dedication of the Panel members and of Land himself is hardly reflected in dry phrases such as the following that I excerpt from a draft report I provided in 1965 at Din's request, evidently attempting to reflect his leadership and the Panel consensus:

> "The Panel... was requested ... review the current status of three programs and to recommend what direction the national effort should take in order to realize the economic, operational, and above all, the end-product advantages of a successful system of this type. ..."

Of course, the resulting report was very specific about the "three programs..."

Because of its importance and controversial nature, a crucial report of July 1971 required a formal position on the part of each of the seven members of the Land Panel. Having been asked by Din Land to provide the draft report, I was also saddled with successive modifications and with getting final approval from each of the members. This was no small feat for a report that had to be distributed by courier and viewed without retaining a copy. Nevertheless, approvals came quickly (with the help of Land's secretary, Natalie Fultz, in tracking down the panelists)-- all except the final endorsement of the last Panel member, who was vacationing in Hawaii. I plotted carefully when I might reach him by telephone without interfering with his pleasures, and decided that 5:30 pm would be optimum. Aware of the six-hour time difference between Hawaii and New York, I planned the call to reach him at 5:30 and, to my pleasure, found him in his room. It took only a moment to realize my mistake; the time in Hawaii was 5:30 am. We got it sorted out, and the report was unanimously endorsed and eventually implemented, although not without bureaucratic problems.

The legacy of Edwin Land is thus to be found not only in this building and in the Polaroid Corporation that he built, but in one of the

greatest success stories of our age—the systems that provide our leaders with an awareness of what is going on in the world, if only we are wise enough to know where to look and to interpret what we see.

I believe it would be foolish-- no, it would be tragic—to follow the siren song urging that we put actual weapons into space, or that we must be ready to destroy photographic satellites launched by some nation not friendly to our cause. We depend heavily on our own satellites to gather vital information, and it is far easier to destroy a satellite than to build another highly capable one. Sadly, "a (satellite) eye for a (satellite) eye" would be no consolation for us and little deterrent for an opponent; we can hardly organize the wrath of nations against a power using an antisatellite weapon (ASAT) against one of our satellites while maintaining that our own use of ASAT against other satellites would be legitimate. Our course should be that of conviction and leadership toward the early conclusion of a universal Treaty banning satellite destruction or tests of such antisatellite systems, and a Presidential declaration would go far toward realizing that goal.

To summarize, I quote Killian now at length, in a description to which I fully subscribe:

> "The figure of Edwin Land exemplifies the kind of scientist who appealed to Eisenhower and who helped to make science advice welcome at the White House.
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> "Land is an authentic genius. His powers of exposition, his facility in expressing complex ideas in novel, witty, and clarifying ways, can lift a meeting or a report to a higher level of discourse. In addition to heading the intelligence division of the Technological Capabilities Panel, he was a member of PSAC, chairing one of its most sensitive panels, and of the President's Board of Consultants on Foreign Intelligence Activities. In these assignments he pointed the way to the development of new intelligence-gathering technology, such as reconnaissance planes and satellites, that have given unique powers, benign in their operation, to American intelligence agencies, undergirding policy decisions of immense consequence and saving the nation billions of dollars.
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> "In meetings with presidents his eloquence and lucid exposition incited their latent imagination and prompted them to make decisions and to undertake leadership roles that had been, until then, beyond their reach.
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> "During these activities when he was a colleague of mine at the White House, he was also building a great company. As chairman of the board he is Polaroid's chief executive officer, but he likes to think of himself as primarily director of research, emphasizing, as he does, that the chief executive officer of a company such as Polaroid should be the director of research.
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> "While accomplishing all of these things, he has been doing basic research in vision and contributing ideas in education to MIT and Harvard-- ideas that have grown out of his conviction that each human being has a potential for creative accomplishment that can

be realized by the right environment and the skilled influence of creative teachers who believe in this potential.

"Recently, in reminiscing about the Eisenhower days, Din Land (as his friends and associates call him) expressed the feeling that his major contribution as an adviser had been to convey to the president and other leaders something of the humanistic and aesthetic values of science. He took greater pride in this act of 'teaching' the qualities and values of science than in his immense technical contributions to the strengthening of our military, intelligence, and space technology.

"At the latest count he holds five hundred patents and has been elected to the Inventors Hall of Fame, but his inventions are by-products of his deep commitment to science.

"Let me be more personal. It has been a rare and enriching privilege for me to be associated with him in a variety of missions and enterprises for a quarter of a century. To all these joint undertakings he has contributed fresh insights, a sense of adventure, and a 'vision of greatness.'"

We continue to benefit from the talents and efforts of this great man.