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MERVIN JOE KELLY

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A Biographical Memoir by

JOHN R. PIERCE

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IN PREPARING this memoir of a remarkable man, I now regret that I did not have a closer association with him. During his life, I regarded Mervin Kelly as an almost supernatural force. While I saw him many times in the course of my work at Bell Laboratories, usually with others, and a few times in his home, I did not seek him out for fear of being struck by lightning. Thus I have had to rely on other sources for some aspects of his life and personality. In quoting directly from such sources, I have in some cases eliminated passages or inserted explanatory material in brackets; I have not otherwise altered the writer's text.

In trying to organize the material in a sensible way, I have put Kelly's character and work first; then his ideas concerning research and technology; and following these, a brief biographical sketch; a list of honors, awards, and memberships; and a bibliography.

THE MAN AND HIS WORKS

Mervin Kelly had great intelligence and great force. His work with R. A. Millikan at the University of Chicago gave him a lasting appreciation of the rarity and importance of first-rate scientists and first-rate research. He himself did creditable physical research. Later at the Western Electric Company and at the Bell Laboratories (which was not formed until 1925), he did early and important work on vacuum tubes, including research, development, and manufacture. His group increased the life of telephone repeater (amplifier) tubes from 1,000 to 80,000 hours and led by 1933 to a transmitting tube for transatlantic telephony and broadcasting with an unprecedented power of 100,000 watts, later to a tube with a power of 250,000 watts.

It is clear, however, that Kelly's greatest contribution lay in creative technical management. It is no more than just to say that Kelly made Bell Laboratories the foremost industrial laboratory in the world. He recognized and inspired good men and good work. He assessed and drove to completion important technical potentialities and opportunities. He shaped and managed a complex organization. And, he inspired the confidence and won the support of the management of AT&T and of the operating telephone companies of the Bell System. As Frederick R. Kappel, former board chairman of AT&T said after Kelly's death:

"He was a great fellow for the Bell System. Mervin was always and forever pushing the operating management, and the heads of AT&T as well, to get on with new things. His aggressiveness got him in a lot of hot arguments, but I always sat back and said, 'Give it to them, Mervin, that's what we need.' Every place needs a fireball or sparkplug, and he was it."

Kelly was not only a sparkplug; he combined determination and showmanship. Twice he submitted his resignation to the president of AT&T, stating that important work at Bell Laboratories was not being adequately funded. In each case, he got the funds. Surely, he was sincere, but he was dramatic as well.

Kelly's potentials as a manager and organizer were not recognized immediately. It is said that H. D. Arnold kept him for a long time at a low administrative level because he distrusted his judgment. One contemporary said that Kelly always had a reason for his actions, but one might not agree with the reason. Oliver Buckley is quoted as having once said that when Kelly was made director of research in 1936, those who were put directly under him were men who could take his personality and so protect those at lower levels. Yet, it became clear that Kelly's very positive virtues outweighed any shortcomings. He was made executive vice president in 1944 and president in 1951.

Certainly, Kelly had a temper that frightened many. When provoked he would turn dark red, but a moment later he would be normal again. Harald Friis, who admired Kelly greatly, notes that at a large conference "He [Kelly] got excited and made what I thought were derogatory remarks about my boys. I got mad as a hornet and could not sleep for several nights. A few days later I ran into Mervin at Murray Hill. He was smiling and asked why I looked so gloomy, and took me into Bown's office. I reminded him of the meeting and said, 'I got mad about what you said about my boys and would have shot you if I had had a gun.' "

Others were less disturbed by Kelly's temper. Estill Green describes his experience as vice president in charge of systems engineering in these mellow words:

"A few years in close association with Mervin were the happiest time of my life. For years on end I had believed I needed insulation from the high voltage. Yet when I was directly exposed to it, I never experienced a serious shock, and I rejoiced to observe how the high potential overpowered inertia and loose thinking and prejudice.

"I learned never to oppose him when he had the bit in his teeth. Next morning I could remark casually, 'Mervin, there are some aspects of that matter discussed in yesterday's conference that you may not be fully aware of.' He would listen, and generally modify his position, to a minor or sometimes major extent."

This willingness to rectify an error was a quality particularly valuable in one so quick and positive as Kelly. Kelly thought he could judge a man after a few moments of conversation. Though he had a high batting average, sometimes he was mistaken. He made very confident technical judgments and they, too, could be wrong. Yet, he was fair and honest and always willing to admit a mistake.

Kelly was courageous in breaking with tradition, but very determined in having his own way. It did not bother him to break Bell Laboratories regulations. But when he laid down the law, he expected to be heard and obeyed, whether it was a matter of lax working hours of management or staff, the neatness of premises, or the nature and direction of technical programs. While he would listen to advice, his judgments were his own, not a consensus. When he addressed groups of Bell Laboratories people, he often spoke with his eyes closed. Clearly, he was looking inward for inspiration and not outword for acceptance. On one occasion, an executive spoke somewhat contrary to a pronouncement Kelly made. I said to the man sitting next to me, "The moving finger writes, and having writ. . . ." I was correct; the executive was not demolished, he was merely disregarded.

Yet, Kelly was universally respected and admired by the most competent and touchy men who worked under him. They received an interested and fair hearing, and he remembered what they told him. His memory was indeed phenomenal. After someone had shown and explained his work, Kelly would remember everything a year later.

Kelly worked harder than he felt others should. As Kappel said, "When Mervin was an advocate for something, there was no shortchanging of his energy to get the job done." More than once, Kelly drove himself to the point of exhaustion.

In the end, Kelly judged people and programs by real accomplishment. His integrity was absolute. I believe that he never thought in any terms other than what was right and what was just.

Kelly's greatest accomplishments lay in the Bell Laboratories. He valued talent sincerely, as his warm biographical sketch of C. J. Davisson shows. He wanted, found, appreciated, and encouraged the sort of men who invented the transistor. William Shockley has said, "Kelly's stimulus to look for new devices useful in the telephone business, plus exposure to new theories about rectification mechanisms in copper oxide, led me to invent a structure that would have worked as a transistor."

When the transistor had been invented, Kelly recognized its worth. As a foreign member of the Swedish Academy of Sciences, he pressed for the award of the Nobel Prize to Bardeen, Brattain, and Shockley. And, for years at Bell Laboratories nothing was any good unless it was "new art" (solid state).

Kelly fostered or launched ambitious programs in nationwide dialing, in automation of maintenance and testing, in microwave communication, in coaxial cable transmission, in transoceanic cables, and in electronic switching. All were timely, and, in the end, all were successful.

In 1943 Kelly outlined a branch-laboratory concept. This eventually led to the establishment of laboratories for final development at manufacturing locations of Western Electric. This proved important in several ways. It linked final development and its procedures and personnel closely to those responsible for the manufacture of new devices and systems. It prevented too large a concentration of personnel in a few central locations. It gave a desirable measure of responsibility and independence to work in various well-defined fields of development.

Kelly valued training as well as talent. When he found, after World War II, that university instruction in engineering was not fresh and deep enough for the graduates to cope with current communications problems, he inaugurated in 1948, within Bell Laboratories, a Communications Development Training Program (known as C.D.T., and as "Kelly College"). C.D.T. emphasized, as he said, "increasing depth in the physics, chemistry, and mathematics essential to modern technology, with advanced courses in communications and electronic technology." The courses were taught partly by university faculty members.

Yet, Kelly looked toward universities as the normal channels of education. He wrote:

"While it is probably always worthwhile for a laboratory to give some orientation courses to new members of technical staff, I believe that much of the training of our graduate course would have greater value if done at the university in academic surroundings. The problem of deeper and more basic training for the young engineers who wish a career in creative technology is a problem of importance to national strength. It needs a more positive attack."

and also:

"We must all keep in mind though that the first and most important responsibility of the universities is the training of scientists and engineers in adequate volume to meet our country's needs."

In furtherance of these beliefs, Kelly arranged for Bell Laboratories-supported fellowships in physics, electronics, and communication to be established at a number of universities.

In 1957 C.D.T. was changed in this direction when New York University opened a graduate center at Bell Laboratories. As engineering education caught up with the postwar world, emphasis changed to oncampus training, including doctoral programs, and to specialized communication courses given within Bell Laboratories.

While the Bell Laboratories' work in common carrier communication was closest to Kelly's heart, he recognized the country's need for advanced military systems. It was his influence and driving force that made Bell Laboratories so active and productive in radar during the war and later in antisubmarine warfare and antiaircraft and antimissile missiles. Yet, Kelly was no militarist. In 1954 he wrote, "It is a tragedy of our times that our nation's primary concern is with security." He tried as best he could to help the nation meet what he saw as a most urgent need, both in individual articles and speeches and as a member of various defense advisory bodies. He was chairman of the Subcommittee on Research Activities in the Department of Defense and related Defense agencies that reported to the Hoover Commission on organization of the Executive Branch in 1955.

Kelly also served on a number of committees advisory to the Department of Commerce and in this connection played an important part in frustrating the move to dismiss Allen Astin, the Director of the Bureau of Standards, for the honest and straightforward testing of a commercial battery additive that showed the product to be ineffective. As Detlev Bronk, then President of the National Academy of Sciences, tells the story:

"[In 1953] I heard of the impending dismissal of Allen Astin by the Secretary of Commerce, Sinclair Weeks. I called Eisenhower, or perhaps Sherman Adams. Eisenhower asked me to see Weeks. When I told him that I did not know the man, he said, 'Don't worry, he'll know you by the time you get there.' I then said to Eisenhower that because Mervin Kelly was a member [of the Statutory Advisory Committee to the Bureau of Standards], I should wish to have him accompany me. Eisenhower said, 'It is up to you to straighten out this job. I'm used to having good staff work, and apparently I'm not getting it.'

"Mervin was superb with his usual very forceful manner, arguing strongly for the integrity of the Bureau, and I insisting that the National Academy would surely back Kelly and his Advisory Committee in strong support of Astin. I recall [Weeks] asking, 'What can I do?' We told him that there was just one thing to do and that was to reappoint Astin. Weeks objected that it would be political suicide. I recall saying, 'I am no politician, but I don't think you are correct, Mr. Secretary.' To which Mervin added, 'We all make so many mistakes, that for a man in public office to make a mistake and admit it will, I am sure, earn him good marks politically'." Weeks reappointed Astin. Moreover, Kelly's conduct so impressed Weeks that he appointed Kelly Chairman of the Department of Commerce's Statutory Visiting Committee, a post that he held for some nine years.

According to Bronk and others, Kelly also played a leading role in the location of the new Engineering Society's building in New York, in providing a sensible procedure for deciding where it should be, and in campaigning to raise millions of dollars from industry to help build it. He also played an important role as a trustee of the Atoms for Peace awards. Of this, J. R. Killian says, "He took a very active part in the work of the board, and his judgment was excellent and his policy views broad." Kelly was also a Member and Life Member Emeritus of the Corporation of the Massachusetts Institute of Technology. Killian says, "I will always remember visiting a number of companies along with him and his persuasive and forceful presentation of the need for corporate contributions in the support of science and engineering and private education." Kelly raised millions for MIT and for other causes.

Kelly's retirement from the Bell Laboratories in 1959 marked the end of an era, for his qualities were unique. One of Kelly's friends and admirers put it thus:

"Why did I like Mervin? He was no fake, a real man, true to himself. He drove himself for the betterment of the labs and expected others to do likewise. He always listened and observed what was said and had the technical know-how to assess it and have it put to use.

"Why did I feel that his successor should be different? No one else could be like Mervin and get away with it. He was the backbone and the strength that has made BTL what it is today."

After Kelly retired from Bell Laboratories, he acted as a consultant to a number of companies, but chiefly to International Business Machines Incorporated. In this capacity, his energy and enthusiasm were no less than in his leadership of Bell Laboratories, but he wisely realized that his role was that of counsellor to the management, including Thomas Watson, Jr., the chairman of the board, and not that of a boss. According to E. R. Piore, vice president and chief scientist of IBM:

"He traveled to all technical locations in IBM that stretch across this country north and south and east and west and which are located in six countries in Europe. Once in the laboratory, he would [as he used to do at Bell Laboratories] spend time with the people at the bench, stimulating discussion and thinking, constantly evaluating the person and the program. Thus he acquired possibly more than any other person, a judgment of men, of programs, and the methods in use. This quality of conversing with the man at the bench, making the man feel at home with Kelly, in no way inhibited him with similar conversations with men up the ladder, including Tom Watson, Jr., and the rest of the group that had oversight over the whole IBM enterprise. Thus he would report to me after his trip and report to Tom Watson also. Mervin was not making a career for himself in IBM. Thus he never fought for his convictions but quietly gave his views—strong, moderate, or negative. This is one reason why his influence was great whether talking to me or to those above me. These conversations dealt with technology, people and management.

"His evaluation and identification of people had a profound effect on their careers. He was after the best technical people, and recommended that they be placed in jobs of ever-increasing responsibility. I would judge that this was his greatest accomplishment in IBM.

"There were areas of great technological deficiencies in our laboratories. Mervin was most helpful in smelling them out and articulating the need for correction. Without his presence this would have taken longer."

Some remarks of G. R. Gunther-Mohr are illuminating:

"My first encounter with Dr. Kelly was at the annual research meetings [which Piore used to hold]. He sat there smoking endlessly and often seemed asleep, yet it was clear he was not from the incisive questions he would ask. He never, however, gave the audience a real view of his thinking. We expected higher management was benefiting.

"He had the respect of a wide variety of people. I had the opportunity to accompany him in a trip to Allentown. It was impressive to see how no one talked down to him technically, but took him on as a participant.

"I believe we all miss his presence greatly. I do, especially since in the later years of his association with IBM, I got to know him better. He never retired and was mentally alert even when he had great difficulty in moving about. He was never sentimental about anything, including himself, but clear eyed, hard headed and positive."

Continually pressing for higher achievement, Kelly always prized and promoted ability wherever he found it. Conversely, he was uniformly impatient with mediocrity and almost ruthlessly intolerant of incompetence. His frequently awesome aspect in business did not, however, carry over into private life.

He entertained frequently and was a genial and gracious host. But it was among close friends of long standing that other traits emerged, including an essential simplicity and boyishness that scientists sometimes exhibit. He was an enthusiastic, though not expert, bridge player. For one thing, a consuming desire to be dealt thirteen of a suit tended to impair his concentration on the game. Then, too, there were other distractions.

As he played, he would sit, drumming his fingers on the table, meanwhile singing, not quite under his breath, folk songs that reflected his Missouri background. One of his favorites was "Upon a pole a polecat sat, He didn't know where he was at."

Kelly had a deep love of music, particularly chamber music. A side consequence of this, plus his innate generosity, was the help he rendered the Summit (N.J.) School of Music. This school could not have survived without the sacrifice of time and energy (and some of his own income) that Kelly gave it for years, no matter how busy he was. The Director of the school was an able musician with no financial acumen. Kelly supervised everything about the school that related to money—budgets, tax returns, etc. He even succeeded in setting funds aside so the Director would have some income after retirement.

During one period Kelly did a great deal for Overlook Hospital in Summit, N.J. When Christ Church in Millburn had great trouble with acoustics, he concerned himself deeply with the problem and brought in highly qualified people to help. After his retirement, when the Kellys' longtime housemaid planned to return with her husband to her native region in Germany, Kelly provided funds for the move. When the couple realized that they preferred the United States, he took care of that move, too.

Kelly loved flowers and gardening. During the growing season, he began work in the garden at 5 a.m. In one year he planted 5,000 bulbs, and the garden included some 20,000 tulips, hyacinths and narcissus. After Kelly's death, his wife, Katherine, asked the gardener, "Why doesn't the garden look the same? You still work in it." The gardener replied, "No one loves it anymore." Katherine liked the garden, but she did not need it.

THE PHILOSOPHER OF RESEARCH AND TECHNOLOGY

Kelly had clear and concrete ideas concerning the importance of scientists and engineers, of research and development, and of the organization and management of technical enterprises. His views were important to him. He expressed them persuasively and with remarkable clarity. In justice to him, I believe that they should be reviewed in this memoir.

Kelly had no doubt as to the place of science and technology in man's life. He wrote: "So completely have they dominated the pattern of our growth that when the man in the street speaks of 'progress,' he usually means scientific and technological progress."

Kelly was equally clear concerning the source of such progress: "Basic research is the foundation on which all technologic advances rest."

What is the source, the generating force behind new ideas? Kelly said: "But with all the needed emphasis on leadership, organization and teamwork, the individual has remained supreme—of paramount importance. It is in the mind of a single person that creative ideas and concepts are born."

Where should basic research be carried out? Kelly noted that " . . . the academic community has been the principal home of basic research for more than a century. . . ." However, he looked toward industry for substantial contributions to research: "The author believes that at least 10 per cent of most research and development budgets can be profitably employed in basic research. Any company that has 50 or more members of professional staff, that will dedicate 10 per cent of them to basic research, can build a strong, productive, and profitable effort."

If research is to be carried out in an industrial laboratory, that laboratory must have some management. Concerning the management of laboratories and, indeed, of technological manufacturing organizations, Kelly had firm words. In a conference on higher technological education held in London in 1950, he noted that:

"The industrial research laboratory directed by men trained in the research methods of science had its beginnings in my country in the first decade of this century. Dr. F. B. Jewett of the Bell System and Dr. W. R. Whitney of the General Electric Company were among the first men trained as pure scientists with a working knowledge of the scientific research method. The laboratories they founded have become two of the great industrial laboratories of our country."

With respect to Bell Laboratories he proudly said:

"There have been four presidents of Bell Telephone Laboratories, for example, since it was established in 1925. All were trained to the doctorate level in science and had won their spurs in research." In the London conference on technological education, Kelly said concerning the United States:

"Now substantially all members of manufacturing engineering organizations are engineering graduates and the top few levels of management of manufacture are largely filled by engineering graduates."

While Kelly recognized basic research as the source of all technological advances, he understood that a complicated technological process lies between discovery and use. He wrote:

"There has been so much emphasis on industrial research and mass-production methods in my country, that even our well-informed public is not sufficiently aware of the necessary and most important chain of events that lies between the initial step of basic research and the terminal operation of manufacture. In order to stress the continuity of procedures from research to engineering of product into manufacture and to emphasize their real unity, I speak of them as the single entity 'organized creative technology'."

Using the Bell Laboratories as an example of organized technology, Kelly delineated three areas that preceded the manufacture of complicated technological systems:

"The first includes all of the research and fundamental development. This is our non-scheduled area of work. It provides the reservoir of completely new knowledge, principles, materials, methods, and art that are essential for the development of new communications systems and facilities.

"The second we call 'systems engineering'. Its major responsibility is the determination of the new specific systems and facilities development projects—their operational and economic objectives and the broad technical plan to be followed. 'Systems engineering' controls and guides the use of the new knowledge obtained from the research and fundamental development programs in the creation of new telephone services and the improvement and lowering of cost of services already established.

"The third encompasses all specific development and design of new systems and facilities. The work is most carefully programmed in conformity with the plan established by the systems engineering studies. Our research and fundamental development programs supply the new knowledge required in meeting the objectives of the new specific devleopments."

In addition to these three technical areas, Kelly referred to another, the management of buildings, shops, and services:

"The nonscientific duties of management should be minimized for all levels of the research supervision. Through proper organization, direct responsibility for people can be limited to scientists and their aides. Budget preparation, management of shops, services, secretaries and typists, for example, can be done by an intimately associated professional management staff of non-scientists. There should be the very minimum of diversion of the attention of the research leadership and the individual researchers from their scientific programs. This can be accomplished by organizational structures and operations fashioned to free all scientists from nonresearch supervisory duties which, at the same time, provide excellent and economical service in all areas that support the direct scientific endeavor."

While Kelly speaks here of research, he applied this plan to systems engineering and development as well.

Kelly's threefold organization of technological endeavor differed from other existing or possible organizations in a number of ways.

Besides research, Kelly classed fundamental development as unscheduled work. He understood that the demonstration of a useful device or a system that embodied really new ideas was uncertain and unpredictable and that things must be carried into practical operation before they could be evaluated.

Kelly's separation of systems engineering from research and development, eventually as a separate vice-presidential area, had roots in a much earlier pattern of system studies in the Department on Development and Research of AT&T, which was transferred to Bell Laboratories in 1934. But, when in 1948 Kelly established Systems Engineering under George W. Gilman, who chose the name, he added a new prerogative: systems engineers were to go beyond planning and to assume a cooperative status with development in the conduct and reporting on projects. Some systems engineers looked on this as a responsibility to control the course of development.

Concerning the three functions into which he divided technological endeavor, Kelly made a number of observations. About research, he said:

"Inspired and productive research in industry requires men of the same high quality as is required for distinguished pure research in our universities.

"They must be given freedoms that are equivalent to those of the research man in the university." Elsewhere he wrote:

"A universal and invariant requirement for building an enduring and successful basic research endeavor in industry is its complete segregation into a single organizational unit or at most with adjacent and closely related applied research."

and:

"Only one who is expert in research can wisely establish the environment, the freedoms, the salary levels and the programs of research." After research, and close to it, came fundamental development:

"Staff members for fundamental development are drawn from our research groups by selecting those having technologic and engineering aptitudes and interests who prefer to move into development and by recruitment from among the most promising of the graduate students of our schools of applied science, such as Massachusetts and California Institutes of Technology."

Kelly's concept of fundamental development is well illustrated by the course followed at Bell Laboratories after the invention of and publication concerning the transistor:

"In accord with our policy of concentrating the efforts of our scientists on research, we immediately formed a closely associated fundamental development group to acquire that body of technological knowledge essential to the development and design of transistors for the many specific communications applications that would certainly follow."

Concerning Systems Engineering, Kelly said:

"Approximately 10% of our scientific and technical staff are allotted to systems engineering. Its staff members must supply a proper blending of competence and background in each of the three areas that it contacts: research and fundamental development, specific systems and facilities development, and operations. It is therefore, largely made up of men drawn from these areas who have exhibited unusual talents in analysis and the objectivity so essential to their appraisal responsibility."

"Systems engineering has intimate knowledge of the telephone plant and its operation and maintains close contact with engineers of the operating organization.

"Systems engineering also maintains close association with our research and fundamental development work.

"Typical examples of recent systems engineering studies that have led to development and standardization are: television transmission over coaxial cables, a broadband microwave radio repeatered communication system, a mobile radio subscriber telephone system, and a new subscriber telephone set."

Kelly illustrated an ideal relation between systems engineering, research and development by the case of the NIKE antiaircraft missile:

"For example, the programming study on the NIKE missile system established that basic knowledge and art were available for the development of a system that would meet the service requirements except for a particular area of radar technology. This area was at once subjected to a research and exploratory development attack. The project was not undertaken until this deficiency was eliminated by new knowledge from research. The NIKE missile system now in production meets the requirements initially agreed upon and in its technical character is in close correspondence with the plan of the initial study.

"I am familiar with large military systems developments where this approach is absent, where research and exploration are intermingled with specific development, probably with the intent of gaining time. Actually, time has been lost."

As to development, Kelly said:

"In the development area most of our recruits have a training of four or five years in electrical, mechanical or chemical engineering. A few trained to the doctorate level are added each year. Their number is limited by the number trained to this level who are initially interested in development and design as a career.

"We hold the view that in the development and design of electronics of today and certainly of tomorrow, more than four or five years of training are required." And:

"The work of specific systems and facilities development is closely programmed. Its projects are organized in the patterns that the studies of systems engineering prescribe."

Kelly goes on to say that development, while a continuous operation, is done in three distinct stages: first the laboratory model; after tests and modifications, the preproduction model, which is field tested; and finally, the final design for manufacture (by Western Electric).

Kelly's concept of "organized creative technology," embracing research, fundamental (or exploratory) development, systems engineering, and final development for manufacture is persuasive. His concept of the place of basic research in industry is inspiring and appealing. What, however, are we to make of these in practice?

There seems to be no avoiding Kelly's conclusion that industrial progress is based on the results of basic research. We can note that basic research is sometimes inspired by technological invention. Thermodynamics was inspired by the steam engine. But, whatever its inspiration, basic research lies behind the whole of modern technology. Kelly felt strongly that much basic research should be carried out in industrial laboratories.

During Kelly's career at Bell Laboratories, he experienced (despite the years of the Depression) the relatively stable support derived from the provision of a service as opposed to the manufacture of products for the market place. The exception to this was defense work, but this was done during periods of close cooperation between government and industry in the national crises of World War II and the Korean War. These were circumstances far more favorable to research, or at least to the dedicated effort of first-rate men, than is work in a manufacturing industry where markets as well as revenues fluctuate.

Further, in Kelly's time the effect on science of some government actions and attitudes was less clear than it is today. The consequences to science of antitrust actions that sever service from manufacture (in aircraft and airlines, for example), that render successful companies insecure in their operations and in cooperative relations with universities, and that prevent cooperative research toward common needs, were not yet clear. Further, in Kelly's time the attitude of government toward both science and industry was on the whole friendly and cooperative. Today, the attitude of government has, in many areas, become at once hostile, highly demanding, and minutely dictatorial through statutory and bureaucratic means.

Thus, Kelly may have overestimated the amount and quality of research that could in the future be expected from industry, and perhaps from the nation.

Some of Kelly's ideas concerning the organizational form most suitable for "organized creative technology" have hazards as well as power. The autonomy of research, the prerogatives of systems engineering, and the separation of the management of nontechnological functions from the technological management depend for their success on inspired leadership.

When leadership is uninspired or inadequate, it is easy for research to drift away from the overall purpose of an organization. It is easy for the rest of the organization to disregard research. It is easy for systems engineers to become stale and to lose their feel for the actual state of research on one hand and the current realities of development, manufacture, and operation on the other. It is easy for a large staff organization concerned with buildings, facilities, shops, libraries, and even computer services to put organizational order and budgetary neatness ahead of the real needs and problems of scientists and engineers.

Above all, a technological organization must have the leadership to see and pursue real opportunities and real needs. In an address to a naval research conference, Kelly said:

"The first, and perhaps the most important, factor is the program itself. What shall it contain? What can be discarded at once, and what shall be eliminated after limited exploration? How can comprehensive coverage with freedom from gaps be assured? In an endeavor so broad in scope and requiring such a highly functional organization for its operation, how can unneeded duplication be prevented, and duplication that is worthwhile, though usually small in volume, be provided?"

Such overall planning and programming is possible only when one point that Kelly made concerning the leadership or management of research and technology is held to. Leaders or managers must be technologically trained and technologically competent. Only thus can decisions be based on insight and understanding rather than on salesmanship and hearsay. And, leadership is most effective when it is strong and decisive.

A man with Kelly's energy and insight could by his own knowledge, perception, and authority avoid organizational pitfalls and bridge organizational gaps, but it was no easy matter, even for him.

Mervin Kelly had a large and optimistic view of the place of science and technology in man's world. He had a clear and persuasive plan for its organization. The success of Bell Laboratories vindicated his ideas in a general way. But, the world is complicated and changeable, and even the most experienced and wisest man cannot catch it eternally in a few, clear, understandable words, or in a great many words, for that matter. Kelly's words are wise and worthy of consideration, but they are less than the man and what he accomplished.

BIOGRAPHICAL SKETCH

Mervin Kelly's great-great-grandfather came from Northern Ireland to Virginia. The family proceeded by way of Indiana to Missouri, where Mervin's father, Joseph Fenimore Kelly, went to teach school at the age of 17. There he met and married Mervin's mother, Mary Etta Evans, whose Welsh parents were Missouri farmers.

Mervin Joe Kelly was born on February 14, 1894, at Princeton, Missouri. His father was then principal of the high school at the Mercer County seat. Shortly thereafter he bought a hardware and farm implement business at Gallatin, Missouri. There Mervin received his grade and high school education, graduating as class valedictorian at the age of 16.

During his school years, Mervin worked at various odd jobs during the summers. He kept the store books for his father and had a newspaper delivery route. By the time he was 16, he had saved just enough money for tuition at the Missouri School of Mines and Metallurgy, at Rolla. His ambition was to become a mining engineer, a career that would take him to far-off places. "I was really pretty lucky to go to Rolla," he once recalled. "In those days, not too many youngsters got to go to college." To make ends meet, he took a job with the State Geological Survey, which allowed him to sleep in a room over its headquarters. Working nights and weekends, he managed to earn $18 a month cataloging and numbering mineral specimens.

Mervin was a brilliant student, particularly in chemistry and physics. At the end of his sophomore year at Rolla, he was appointed an assistant in chemistry, for tuition and $300 a year. The next summer he worked in a Utah copper mine. This changed his mind about metallurgy, and on returning to Rolla he switched to a general science course. The heads of the chemistry and mathematics departments volunteered to give him special instruction. When he graduated from Rolla in 1914 with a B.S. degree and honors in science, Kelly decided that he wanted "to make a life in academic research."

Kelly taught physics and studied mathematics at the University of Kentucky, receiving his master's degree in 1915. On November 11, 1915, he married Katharine Milsted, a Rolla girl. He once called her his "most candid critic."

The Kellys went to the University of Chicago and he received his Ph.D. in 1918. While at Chicago he was an assistant to Professor Robert A. Millikan, and he participated in the famous oil drop experiments for measuring the charge of the electron. From his work with Millikan, he developed the conviction that it was necessary to undertake basic investigations of nature in order to be able to manipulate nature in a practical way.

When World War I came, Frank B. Jewett, who later became the first president of Bell Laboratories, offered Kelly a $2100 a year job as a research physicist in the Engineering Department of the Western Electric Company. His initial work was in providing practical vacuum tubes.

In 1925 the research and development work of Western Electric was incorporated separately as Bell Telephone Laboratories. Kelly worked as a physicist until 1928, as director of vacuum tube development from 1928 until 1934, and as development director of transmission instruments and electronics during 1934–1936.

In 1936 he was appointed director of research. He became executive vice president in 1944 and president in 1951. On January 1, 1959, he was named chairman of the board of directors. He retired from Bell Laboratories on March 1, 1959.

Kelly served on the board of directors of Bell Laboratories from 1944 until his retirement and was a director of the Sandia Corporation, a subsidiary of the Western Electric Company, from 1952 through 1958. In addition, he was a director of the Prudential Insurance Company of America, Bausch and Lomb Optical Company, Tung–Sol Electric, Incorporated, and the Economic Club of New York. He acted as a consultant to the International Business Machines Corporation, Bausch and Lomb, Ingersoll–Rand Company, and the Kennecott Copper Corporation.

Mervin Joe Kelly died on March 18, 1971, at Port Saint Lucie, Florida, where he had a second home, at the age of 77.

THE FOLLOWING INDIVIDUALS, through personal communications, provided material for this biographical sketch: Richard M. Bozorth, Harald T. Friis, Detlev W. Bronk, James R. Killian, Emmanuel R. Piore, G. R. Gunther-Mohr, and Estill I. Green. Other information was obtained from Bell Laboratories; Harald T. Friis, *Seventy-five Years in an Exciting World,* San Francisco Press; and William Shockley, *Bell Laboratories Record,* Vol. 50, December 1972.

AWARDS, HONORS, MEMBERSHIPS

AWARDS

Presidential Certificate of Merit, 1947
Medal of the Industrial Research Institute, 1954
Christopher Columbus International Communication Prize, 1955
Air Force Exceptional Service Award, 1957
James Forrestal Memorial Medal, 1957
Air Force Association Trophy Award, 1958
John Fritz Medal, 1959
Mervin J. Kelly Award of the American Institute of Electrical Engineers, initial award, 1960
The Golden Omega Award, 1960
The Hoover Medal, 1961
Centennial Medal of Honor, University of Missouri at Rolla, 1970

HONORARY DEGREES

University of Missouri, D.Eng., 1936
University of Kentucky, D.Sc., 1946
University of Pennsylvania, LL.D., 1954
New York University, D.Eng., 1955
Polytechnic Institute of Brooklyn, D.Eng., 1955
University of Lyons, Doctor Honoris Causa, 1957
Wayne State University, D.Eng., 1958
Case Institute of Technology, D.Sc., 1959
University of Pittsburgh, D.Sc., 1959
Princeton University, D.Eng., 1959

MEMBERSHIPS

National Academy of Sciences
American Philosophical Society
American Academy of Arts and Sciences
Royal Academy of Sciences (Sweden)
American Physical Society (Fellow)
Acoustical Society of America (Fellow)
Institute of Electrical and Electronic Engineers (Fellow)
Sigma Xi
Eta Kappa Nu
Tau Beta Pi
Rochester Museum of Arts and Sciences
University Club of New York
Baltusrol Golf Club of Springfield, N. J.

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KEY TO ABBREVIATIONS

Bell Lab. Rec. = Bell Laboratories Record
Bell Syst. Monogr. = Bell System Monograph
Bell Syst. Tech. J. = Bell System Technical Journal
Bell Teleph. Mag. = Bell Telephone Magazine
Electr. Eng. = Electrical Engineering
J. Franklin Inst. = Journal of the Franklin Institute
Phys. Rev. = Physical Review
Phys. Today = Physics Today
Proc. I.R.E. = Proceedings of the Institute of Radio Engineers

1919

With R. A. Millikan and V. H. Gottschalk. Effect upon the atom of the passage of an alpha ray through it. Proceedings of the National Academy of Sciences, 5:591–92.

1920

With R. A. Millikan and V. H. Gottschalk. Nature of the process of ionization of gases by alpha rays. Phys. Rev., 5:157–77.

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1926

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1932

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1934

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1943

The American engineer. The Bridge of Eta Kappa Nu, September; also in Bell Lab. Rec., November, p. 122(A).

1945

Science as a force in our civilization, past, present, and future. (Talk presented before Science Club) Kearnygram, 18:1–2. (A)

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Radar and Bell Laboratories. Bell Teleph. Mag., 24:221–55.

1947

Our country's preparedness research and development program—a cooperative undertaking of our military, university and industrial laboratories. (Address given at Navy Research Conference, Wash., D.C., November 18–19) Published in pamphlet form.

1949

Radar Systems and Components; with an Introduction by M. J. Kelly, pp. 1–8. New York, D. Van Nostrand Co. 1042 pp.

1950

Bell Telephone Laboratories—an example of an institute of creative technology. Proceedings of the Royal Society (London), Series A, 203:287–301; also Bell Syst. Monogr. 1794.

1951

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Dr. C. J. Davisson. Bell Syst. Tech. J., 30(Part I):779–85; also Bell Syst. Monogr. B-1876.

1952

Communications and electronics. Elecr. Eng., 71:965–69; also Bell Syst. Monogr. 2026.

1953

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Research and development problems of engineering management in the electronics industry. (Paper presented at Institute of Radio Engineers Convention, New York City, March 23–26) Proc. I.R.E., 41:425; also Bell Syst. Monogr. 2070 (A).

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1955

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1961

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1962

The role of the engineer in a world of change. (Technical paper presented at the Design Engineering Conference and Show, Chicago, Ill., April 30–May 3) Design News, June 27. (A)