IN MEMORIAM

RICHARD BRANDON KERSHNER

1913 – 1982

Dr. R. B. Kershner died on February 15th, 1982, after a long series of illnesses which, however, did not diminish the brilliance of his mind nor dampen his indomitable spirit. The memory of this inspiring leader, wise counselor, and noble man will remain ever green in the hearts of all who knew him, and the impact of his works will outlive the generations that came directly under his influence.

Richard Brandon Kershner was born in Crestline, Ohio on October 11th, 1913, the second son of James Alexander and Della E. (Shoemaker) Kershner, his father being Principal of a school in Crestline. When young Richard was about a year old, the family moved to Baltimore, where his father became Headmaster of the Franklin Day School. Thus, while Ohio can lay claim to being the birthplace of Dick Kershner, Maryland may take the credit for his physical and intellectual upbringing, which had some very unique features. He attended the Forest Park High School in Baltimore, Maryland's first experiment in high school coeducation. At the age of fourteen, he shipped as a Deck Boy on a freighter plying between Baltimore and Italian ports and made two round trips during that summer, under the long range care of the First Mate, a friend of the Kershner family. About the age of sixteen, he entered The Johns Hopkins University as an undergraduate student of engineering. After his first year, on the strength of his seafaring experience gained on the voyages to Italy, he got a summer job as Ordinary Seaman on a freighter bound for the Island of Kauai (one of the Hawaiian Islands) where it picked up a cargo of sugar. Dick's curiosity about this "garden island" led him to spend more time in its exploration than the normal shore leave allowed, somewhat to the detriment of his pay check. During these explorations he got a first hand lesson from a farmer on the economic values of ripe and unripe pineapples. There is no doubt in my mind that these nautical experiences vastly enlarged the horizons of this young man.

After the second year of his engineering course, Kershner elected to take part in a "new plan" initiated at Hopkins, under which specially qualified undergraduates were admitted to the Graduate School without the formality of an undergraduate degree and could embark on a five year course of study culminating in the degree of Doctor of Philosophy. At the same time, he abandoned engineering (at least temporarily) for his growing love, mathematics.

Kershner's career in the Graduate School at Hopkins was brilliant. His knowledge of mathematics and allied sciences, and his imagination grew, as did his interests and talents in literature, poetry and painting. By the time he graduated at the age of twenty-three, he had written at least a dozen papers, all published in the *American Journal of Mathematics*, a very selective vehicle of publication.

During the same period an event occurred whose influence on his life was fortunate and far reaching. On June 8th, 1935, he married a charming and talented young artist, Mary Amanda Brown, a native of Baltimore, a kindred spirit in the love of the fine arts and other intellectual pursuits. Over the past forty-seven years they have supported each other with courage and understanding through many vicissitudes and shared the satisfaction of seeing their two sons, Richard Brandon, Jr., and James Williamson, well embarked on professional careers.

On being awarded the degree, Doctor of Philosophy, Kershner spent three years as Instructor of Mathematics at the University of Wisconsin, after which he had the signal honor of being invited back to Hopkins as an Assistant Professor of Mathematics. Although his stay at Wisconsin was relatively short, it was a critical determinant in his career for he was adopted as a friend and colleague by that connoisseur of "hard science" genius, Dr. Joseph O. Hirschfelder.

Early in 1941 when gathering war clouds from Europe drove scientists, engineers and military men to examine critically the capability of the U.S. to engage in a modern war, and to find with dismay how really unprepared it was, Hirschfelder's attention was drawn to the scientific problems involved in the internal ballistics of modern guns, and later of rockets, that is, to the complex physical and chemical processes that go on from the time the trigger is pressed until the shell leaves the bore of the gun. Quantitative solutions of the problems involved advanced knowledge of chemistry, physics and mathematics; Hirschfelder immediately asked Kershner to collaborate with him in an extensive theoretical study of internal ballistics, and thus began the *second* or Ordnance Engineering phase of Kershner's career. The results of this work, published as National Defense Research Reports, provided the fundamental basis of understanding not only for the development of hypervelocity guns but also the development of rockets. The contents of these reports are now classical.

After the events of December 1941, Kershner devoted all of his time to ordnance problems, his interest moving from the theoretical to the practical aspects of gun and jet propulsion. At the Geophysical Laboratory he directed the Internal Ballistics Group and took part in the development of hypervelocity guns. At Allegany Ballistics Laboratory, starting with a project that vastly improved the performance of the 4.2 inch mortar used by the Chemical Warfare Service, he designed and tested a 4.2 inch recoilless mortar — a novel development which combined rocket ballistics with gun ballistics.

At this time there were becoming apparent characteristics of Kershner's thought and action that later on marked his leadership in scientific and engineering enterprises: imagination in concept, enlightened common sense in analysis and planning, decisive, sometimes intuitive choices among engineering options, courage in demonstration. No matter how well conceived and planned a development may be, unknown factors lurk in the background, Nature gives up her secrets very reluctantly, and the only real confirmation of a development is an experimental test of the product in the environment where it is designed to function. In the case of ordnance devices where free energy is released with great violence, such experimental tests always involve considerable risk; if successful, they may give rise to overoptimism; if unsuccessful, they are certainly embarrassing. After being convinced that he and his colleagues had done all they could, Kershner paid little attention to the reservations of the timorous, and boldly went ahead with the crucial experiment, confident that the outcome would provide information. In later years his decision to launch satellites TRANSIT 1-A and TRANSIT 1-B provided a classical case of the wisdom of timely exposure of new developments to what Faraday has called *"the touch of the Ithuriel spear of experiment."*

When, in 1946, Kershner joined the staff of the Applied Physics Laboratory, it became evident to his friends that he was really turning from "pure" mathematics to "impure" mathematics — that his interest in ordnance engineering was now established. In speculating on the motives behind this decision, I am persuaded that two predominated. (1) Although hostilities had ceased, it was by no means certain that another conflict might not soon threaten the security of the United States and that, therefore, the needs of its Armed Services, especially the Navy, for advanced weapons and equipment were still very urgent. He felt he could contribute to the filling of these national needs, and elected to channel his talents in this direction. Incidentally, Kershner was familiar enough with history to realize how much the peaceful institutions, including the schools and universities, of a country had been devastated when the military shield protecting them crumbled. (2) Like Galileo, he enjoyed the intellectual stimulation presented by the complicated and practical problems of creative ordnance engineering and the thrill of seeing children of his brain go into action.

The principal task of the Laboratory at that time was the development of a rocket launched, ramjet propelled, beam rider guided supersonic missile for the defense of ships against aircraft (afterwards called TALOS). It was the policy to supplement work in the laboratory and the engineering shop by detailed observations of the behavior of the major subsystems during flight in appropriate test vehicles, a launching test vehicle, a ramjet test vehicle, a supersonic guidance test vehicle. After spending a year or so in the study of launching problems and the development of a launching rocket on a scale hitherto unrealized, Kershner turned his attention to problems of guidance and control at supersonic speeds. In this area, new to him, he contributed personally to the design of an advanced guidance and control vehicle — the STV-3. This vehicle performed so well that the Navy concluded that it might readily be engineered into a useful tactical guided missile, authorized the Laboratory and its contractors to proceed with this engineering development, and adopted for it the name TERRIER proposed by Kershner. There followed a series of complex and exasperating engineering problems, exacerbated by the atmosphere of urgency created by the Korean conflict and the Government decision to put TERRIER into large-scale production. TERRIER was not only a test vehicle for TALOS; it became the pilot for the large-scale production of TALOS and other antiaircraft guided missile systems, notably TARTAR.

TARTAR, a younger brother of TERRIER intended for service on smaller warships such as destroyers, was designed *ab initio* by Kershner and his associates, giving them an opportunity to exploit new, imaginative concepts and to turn to good effect the satisfactions and frustrations they had experienced in the care and nurture of the adolescent TERRIER. In this their success was phenomenal.

New concepts included the replacement of booster and sustainer rockets by a single dual thrust motor, and attainment of steering and control by fins which could be folded during storage and released immediately on launch. These two innovations led to a third, the design of a turret with integral launcher about the size of the standard 5 inch gun turret in which two score or so of missiles could be stored and from which they could be launched automatically in rapid succession. Another innovative concept was a flexible parallelogram mechanical linkage which stabilized the pointing direction of the guidance antenna, as the missile maneuvered.

The many problems that beset the large-scale production of TERRIER missiles awoke in Dr. Kershner and his lifelong friend, Dr. A. Kossiakoff, the feeling that something was fundamentally wrong with the prevailing design philosophy, whereby an airframe was first constructed and then the components were installed and connected together as convenience dictated. In this mode of construction, the performance of the missile could be assessed only by a long series of tests of the complete assembly. Remedy of the deficiencies revealed by these tests was a complicated and in many cases an almost impossible job. Kershner and Kossiakoff explored the idea of building the missile from mechanically and electrically separable sections, each of which together with its subsections could be tested independently in terms of quantitative criteria derived from the requirements of the whole system. The electronic, hydraulic and mechanical components were assembled and tested in self-contained sections, each associated with a specific function of the missile and each mating with others by electrical and mechanical connections that closed simultaneously. Since each section was specifiable in terms of quantitative inputs and outputs, sections performing the same function were interchangeable from missile to missile. The validity, and the economic, reliability and fabrication advantages of this brand new concept of missile construction were demonstrated by a group inspired by Dick and supervised by Roland Larson, in one of the Laboratory's finest achievements, the timely, economical and successful conduct of the TERRIER 1-B program.

About the time (1955) of the installation of TERRIER on the cruiser *Boston*, the first warship in the United States Fleet, and indeed in the world, to be equipped with a guided missile system, a new, very large problem area in ordnance engineering was arising, namely the development of the POLARIS System. This major undertaking involved the development of a large-scale multistage solid fuel rocket, guided with high precision, and a specially designed nuclear submarine from which this missile could be launched at submerged depths. Upon the request of the Special Projects Office of the Navy, the Laboratory undertook to assist in any appropriate way in the development of the POLARIS System, and Dr. Kershner was given responsibility for this commitment, and indeed, for a time was known as SP-007. In the course of the next five years, he contributed a number of ingeniously designed engineering components to the POLARIS System, but much more important, by drawing on his experience of the strong and weak points of the TERRIER development, he conceived and set in motion a program of systematic, scientific investigations of the performance of the complete POLARIS System under realistic conditions. This program continued and, extended by R. C. Morton, provided the Navy with accurate knowledge of the performance of the system in meeting the requirements placed upon it by the highest command concerned with U.S. strategy. Knowledge so gained made the POLARIS System unique in the arsenal of the U.S. It also enabled the Laboratory to accumulate an accurate and realistic knowledge of the adequacy of all the engineering components to meet the requirements in accuracy and reliability posed by the tactical operation of the system as a whole, and to enable it to suggest and, at times, develop necessary modifications in these components.

One of these requirements led Dick Kershner into the third phase of his career, namely Space Systems Engineering. In order to obtain the accuracy needed for the success of its mission, it was of paramount importance that a POLARIS submarine know at all times its position on the Earth with high accuracy. Although the submarines carried the best navigation equipment obtainable, the best was not quite good enough. By careful study of the Doppler shift in the radio waves emitted from the Russian satellite, SPUTNIK I, members of the Laboratory staff, notably W. H. Guier, G. C. Weiffenbach, H. B. Riblet, H. D. Zink, and F. T. McClure, hit upon the concept of a satellite navigation system that promised fair to be just what POLARIS needed.

Kershner undertook the job of reducing this concept to practice. Relying on the experience gained in the TERRIER 1-B program, he brought together a group of colleagues with whom he had worked at the Laboratory, each one experienced in one or more of the technical areas in which the new problems lay, and filled them with enthusiasm for the new task. This nucleus of what is now the APL Space Department was soon reinforced by knowledgeable scientists and engineers recruited for their interest in the subject. Under Kershner's leadership this has grown to be a very powerful and imaginative group whose expertise ranges from mathematics, physics, and chemistry through engineering of all kinds, to highly skilled fabricators and technicians.

It required great faith, courage, determination and imaginative skill on Kershner's part to lead this band across the wilderness of doubt to the promised land. The country abounded in scientific specialists who declared in no uncertain terms that the objectives set for the TRANSIT Satellite Navigation System were theoretically impossible, and with engineers who forboded very short lives for the satellites even if they were ever made. However, like a great general, Dick led his forces forward at full speed, overcoming engineering obstacles with technical skill, outflanking natural obstacles by imaginative scientific concepts, and demolishing man-made roadblocks with Ciceronian argument and rhetoric. Ten months after the establishment of the Space Department, a satellite was launched which, during its brief career, demonstrated that faith in the achievement of the goals Kershner had set was amply justified; six months later this was strikingly confirmed by data from a satellite in orbit. The ambitions of Kershner and his colleagues in the Space Department are aptly expressed in Addison's *Cato*:

> Tis not in mortals to command success
> But we'll do more, Sempronius,
> We'll deserve it.

Kershner's superb ability as a leader in the science and art of systems engineering, born in the turbulence of the recoilless mortar, refined in the fires of the TERRIER Program, nourished in the exigencies of the POLARIS Program, came to flower in the systems jungle of the TRANSIT. Satellites in orbits far above the Earth, designed and built at APL, had to communicate very precise, timely information to submarines in a language that could only be heard and interpreted by sophisticated electronic receivers and advanced computers which, although designed by the Space Department, had perforce to be engineered and built by two contractors expert in building equipment to meet the special requirements for use on Naval submarines. When all these elements were brought together in an operations exercise, the system worked perfectly the first time, a phenomenon so rare in modern technology it deserves a special accolade. Furthermore, many of these satellites have been functioning well for many years, some as much as fifteen and more, although reliability experts, on general principles and not too much detailed knowledge of the satellites themselves, had predicted life times of a few months at most.

Although still a major matter of interest, for all systems must be improved to meet present and future needs, the TRANSIT Satellite Navigation System was only the first of Kershner's Department's adventures in space. Since its inception in 1959, it has designed, built and put into orbit some 47 satellites, most of which are now in orbit around the Earth. Their missions are many and varied, ranging from the utilitarian, for example navigation satellites, to the collection of data on the physics and chemistry of the upper atmosphere, or a mixture of both. Magnetometers carried on one of the early TRANSIT satellites still provide scholars all over the world with experimental observations to support advanced studies of the Earth's magnetosphere. Our knowledge of the figure of the Earth, i.e., the shape of its gravitational field, has increased by leaps and bounds, thanks to the data obtained from these satellites. Not only the Navy, but also the Army, Air Force, the Department of Defense, and especially the National Aeronautics and Space Administration have sponsored the development of these satellites.

Even a catalog of the scientific discoveries and the ingenious methods and devices that Kershner has inspired in his career in space technology would occupy more space than is proper here. I must leave to the interested reader the task of finding these for himself in the voluminous publications of the APL Space Department. A list of Dr. Kershner's own publications is appended.

The receipt of four Distinguished Public Service Awards, the highest awards the Government can confer on a private citizen, constitutes another feature of Dick Kershner's career that can be called unique. The Department of the Navy presented him with three of these awards, one for the TERRIER development, one for his contributions to the POLARIS Program, and one for the development and operational introduction of the Navy Satellite Navigation System (TRANSIT) — the last named being presented to him personally by the late Vice President Hubert Humphrey. By its Distinguished Public Service Medal, the National Aeronautics and Space Administration recognized his outstanding contributions to Space Technology and the number of "Firsts" covered by these contributions. His work during World War II earned for him the Presidential Certificate of Merit. The Hays Award, by which the Institute of Navigation recognized his contributions to this subject, brought him great satisfaction, as did also the First Award of the Satellite Navigation Division of this Institute, which he received in April, 1981, for the "inspiration and leadership" with which he "brought to the world its first satellite navigation system." But the recognition of his accomplishments by his *alma mater* brought to him the greatest satisfaction of all. At the Commemoration Day Convocation on February 22, 1981, Dick received from the hands of Milton Eisenhower himself, the Johns Hopkins University Eisenhower Medal. This is the University's highest honor, given in recognition of devoted service to Hopkins and for achievements that reflect credit internationally on the University.

Like many of the creative scientists and engineers before him, Dick Kershner was an artist at heart, sharing with them an intuitive, almost passionate, love of form, structure, and pattern (order) in all things. As a scientist he thought about Nature in terms of the "primary properties" of matter, abstract properties such as mass, motion, symmetry, etc., which can be weighed and measured, properties which are independent of the human observer — building blocks in the structure of science. As an artist, he had the gift of arranging matter so that its "secondary properties" — color, design, taste, etc., — appeal and give pleasure to men and women — the gift of composition. His skill as a writer of prose and poetry, as a photographer and also as an architectural designer bear witness to this gift. He designed his own houses and, of particular interest here, gave us the basic design concept of the Library at the Applied Physics Laboratory.

The artist and the mathematician in Kershner conspired in his perceptive observations of people, their foibles as well as their virtues. The artist could penetrate facades concealing what Roger Bacon pinpointed as the chief stumbling blocks to truth: *"the influence of fragile or unworthy authority, custom, the imperfections of the undisciplined senses, the concealment of ignorance by ostentation of seeming wisdom."* The mathematician could analyze and expose these with devastating logic. He loved to prick the bubbles of conventional "wisdom," but he did so gently, so gently, indeed, that sometimes his targets were very slow to realize they had been hit. His short paper exploding the prevailing management philosophy that adding more workers would make up time in the execution of a delinquent (tardy) project is a good example of his keen observation and incisive thought.

There were four phases in Dick Kershner's professional career: productive student and expounder of mathematics, resourceful ordnance engineer, innovative leader in space technology, and wise elder statesman. Throughout his life, one can perceive two threads of continuity: continuity of interest and continuity of purpose. His newer interests may have overshadowed his older ones to some extent, but never eclipsed them totally. For example, in 1950 (and in 1974 for the second edition), he was coauthor with L. R. Wilcox of a book entitled, *The Anatomy of Mathematics,* and as late as 1968 he published a paper, "On Paving the Plane," an excursion into pure mathematics. The cultivation of his intellect and the focussing of it on the practical problems of mankind constituted the dominating purpose of his professional life.

High above the Earth, satellites in their orbits keep a ceaseless watch, sending to all who may ask the messages that guide them in their travels on sea and land. By their very presence and unceasing activity these satellites proclaim another message testifying to the imaginative thought governing the design of the system of which they are parts, of the skilful and meticulous care that characterized their construction and the dedication to the service of humanity that motivated their creators. The harmonies resounding from this celestial system are interwoven with melodies from the mind of a remarkable man. Their music excels words in summarizing the denouement of his life. The epitaph of Richard Brandon Kershner is written in the skies.

R. E. Gibson
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