

## RAY K. LINSLEY (1917-1990)

*Alexander Zaporozec*

Ray K. Linsley, an internationally known hydrologist, died November 6, 1990, in Santa Cruz, California. At the time of his death, Ray Linsley was professor emeritus at Stanford University; chairman of Linsley, Kraeger Associates Ltd., and Honorary President of AIH. Linsley and his graduate students contributed greatly to the understanding of hydrologic processes. He was a pioneer in the development of procedures for hydrologic simulation employing continuous deterministic models and was one of the most influential hydrologists of his time.

Linsley advocated the need for water conservation as early as 1955, at a time when emphasis on water conservation was unusual and controversial. In a 1967 speech, Linsley predicted that water may someday prove to be the keystone of peace. "The day may come when water problems will force nations ... toward a goal of international cooperation."

A native of Hartford, Connecticut and a 1937 graduate of Worcester Polytechnic Institute, Linsley received an Honorary D.Sc. from the University of Pacific in 1973 and an Honorary D. Eng. from the Worcester Institute in 1979. He joined the faculty at Stanford in 1950 as a professor of hydraulic engineering after serving as an engineer for the Tennessee Valley Authority and as head hydrologist engineer for the U.S. Weather Bureau. At Stanford he served as Head of the Department of Civil Engineering for eleven years and as Associate Dean of the School of Engineering for three years. In 1975, Linsley was named president of Hydrocomp, Inc. of Palo Alto. In 1979, he founded Linsley, Kraeger Associates Ltd. in Santa Cruz.

Linsley was a Fulbright professor at the Imperial College of Science and Technology in London (1957-58) and Chairman of the Committee on Water Resources in the Office of Science and Technology (1964-65). In 1968, President Johnson appointed Linsley to a five-year term on the National Water Commission. Linsley was the senior author of widely used textbooks such as *Applied Hydrology*, *Hydrology for Engineers*, and *Water Resources Engineering*, and authored many technical papers and reports.

Linsley was a member of many professional and honorary societies, both in the U.S. and abroad. He was elected to the National Academy of Engineering in 1976, received the AWRA Icko Iben Award in 1974 and the ASCE Julian Hinds Award in 1978; and was the AMS Horton Lecturer in 1982.

Ray Linsley was a devoted member of the American Institute of Hydrology and an instrumental force during the formative years of AIH. Linsley served as the Institutes's first Senior Vice President. To honor his immense contributions to the profession and AIH, an award was established in his name in 1986. The Ray K. Linsley Award for major contributions in the field of surface water hydrology is awarded annually by the Institute.

Everyone who knew Ray would agree that it would be hard to find a gentler human being. He was always ready to offer help. His death was a great loss. But memories of Ray K. Linsley - educator, scientist, and utmost professional - will live on.

# A TRIBUTE TO RAY LINSLEY

*Robert L. Smith*

Mr. Chairman, honored guests and fellow members of the AIH. I am most delighted to have the opportunity to participate in this session. I doubt that I can contribute any insights you have not already gained, but my associations with Ray, if I might borrow a water resources planning term, were possibly more multi-purposed than those encountered by many in this assembly. Collectively, the AIH recognizes Ray Linsley as "Mr. Hydrologist" and well it should. In my humble opinion he was the foremost engineering hydrologist this world has known.

My associations with Ray Linsley extended beyond mutual hydrologic interests. I first encountered the Linsley name, not the individual, 42 years ago when we were both candidates for a position at Stanford University. I had no real credentials other than the fact that I was a recent product of the Iowa Institute of Hydraulic Research, was in my second year of teaching experience at Kansas and had some very good friends on the faculty at Stanford as a result of having spent some time there courtesy of the U.S. Army during WW II and who had urged me to apply. However, in due time Stanford advised they had made a decision to hire a man by the name of Linsley who, as noted, had a decade more experience than I could claim. Within a matter of days I came across an item relating to a new text entitled "Applied Hydrology" authored by Linsley, Kohler and Paulhus and I wrote for a copy. I was impressed then, and remain impressed to this day, with the quality of writing encountered in any Linsley publication.

For the next decade Ray and I had little opportunity to interact because I left academic life to administer water planning programs in two different states. Upon my return to the academic arena in 1962, we suddenly had opportunity to interface in a variety of settings which might best be subdivided as engineering education, professional organization activity, public sector practice and private sector practice. In the educational arena he was serving as Chairman at Stanford at a time I was Chairman at Kansas. Moreover, we had occasion to share some graduate students. In education, as in all areas of pursuit, misery loves company and this led to numerous oral and written communications. Moreover, we both pursued academic careers without the hallowed Ph.D. a sin which is becoming less capable of accomplishment as the years go by.

During the 60s, and as a result of a 2-year Senate Select Committee study, the federal government embarked on a ten year water resources research program. During its formative years Ray and I both served as did others, but not concurrently, 15-month terms as a Special Assistant to the President's Science Advisor, and as Chairman Committee on Water Resources Research of the Federal Council for Science & Technology. Inasmuch as national and international water issues requiring White House attention do not adhere to 15-month lifespans, this situation produced several additional years of contact on a variety of water matters. Within the professional organizational setting we had opportunity to commiserate on various ASCE and NRC activities. Our private sector contacts came later as he became increasingly involved with Hydrocomp. These several encounters gave me opportunity to observe Linsley in action wearing a variety of hats. Some of the more meaningful impressions he left with me are as follows:

There are several significant sides to Linsley the educator.

First, and especially in this AIH setting, we should comment on Linsley the researcher. I'm often amazed at the number of fellow academics who relate to Ray as an author, but not to Linsley the researcher. In

my mind his foremost research contributions were (a) development of the multi-variate rainfall-runoff relations, and (b) development of continuous deterministic hydrologic simulation techniques. Ray would be the first to note the rainfall-runoff effort was accomplished in cooperation with colleagues at the U.S. Weather Bureau, and the digital simulation models were achieved with the help of some very bright graduate students. Nonetheless, those same colleagues and students, I'm sure, would point to his guiding insights and to his insistence that the concepts utilized could be rationally related to the physical settings encountered. As you know the runoff relations became the basic foundation of the NWS river forecast system, and the computer simulation program initially announced by Linsley and Crawford, subsequently enhanced by other Linsley students, has become the world's foremost continuous hydrologic simulation tool. Moreover, both efforts have withstood the test of time. The basic rainfall-runoff relations are approaching a half century of utilization, and its been more than a quarter century since the release of the initial Stanford report on continuous simulation. The characteristic that best typifies all of Linsley's research is its pragmatic nature. The results were invariably useful. He had little use for applied mathematical exercises so often motivated by the desire to generate a publication. Ray firmly believed that the truly significant developments in hydrologic science have occurred in response to an identifiable applied need.

Earlier reference was made to Linsley the author. Most all assembled here are familiar with those efforts, but a brief enumeration is warranted. During the decade of the 50's we saw the first version of the cooperative effort with Professor Franzini which evolved into the text we now know as "Water Resources Engineering." The same decade witnessed the revised hydrologic effort with Kohler and Paulhus which came to be known as "Hydrology for Engineers." Both of these texts have enjoyed multiple editions, and both became the most widely used text, nationally and internationally, in their respective fields. They, too, have withstood the test of time. I considered it a privilege to utilize both texts for more that a quarter of a century. I have never ceased to be amazed at how well they are written. They epitomize efficiency in writing. Extraneous comment is essentially non-existent. As such they reflect the basic mannerisms of the principle author. A quiet spoken man he refused to engage in idle chatter or unimportant comment.

Linsley the teacher also left a trail of accomplishment. The easiest way to document his success in this endeavor would be to enumerate his graduate students, but such an approach poses the risk of omitting someone. Suffice it to say that many of his students have emerged as leaders in the water resources and engineering hydrology arenas. These, of course, are the tangible measures of his teaching success. However, the aspects of his teaching career which made a more lasting impact on me were the concepts underlying his approach to the assignment. During a sabbatical period I had occasion to observe his head to head contact with students. Mild mannered, soft spoken but firm. He didn't believe in spoon feeding, he gave and he expected honest effort. He relied heavily on a finely tuned, some would say unduly restrictive, admission's policy, but once a student was accepted, Ray was totally committed to achieving successful program completion in a reasonable time. He was strongly committed to his teaching obligations. There are some academics who seem to be committed to full time conference-consulting schedules. Not Linsley; he once confided in me that when a student enrolled in a class scheduled to meet x times in a quarter, he had every right to expect the instructor to appear on x occasions. If one were asked to sum Linsley's approach to teaching in a phrase, my response would be that it was based on the "fairness doctrine."

Ray's approach to governmental policy issues was both orderly and as quantitative as possible. He acknowledged the role of politics, but was firmly committed to the concept that professionally qualified advisors had an obligation to (a) examine alternatives and (b) express results in terms the interested

laymen and policymakers could comprehend. He detested pure subjective judgements and continually sought ways to provide some objective measures of alternative actions.

I remember well the problems which arose when it came time to submit final recommendations on how much money should be allocated to different sections of the federal water research program. The many federal agencies could not agree to an acceptable allocation formula, and the matter reverted from the FCST to PSAC, the President's Science Advisory Committee, and to Ray's desk. He devised a scheme wherein several factors were ranked on a scale of 1 to 10 via the exercise of professional value judgement. Then the product of these rankings became a relative weighing factor for each research segment. The ranked factors included such items as the magnitude of expenditure required to make a measurable gain, the probability of achieving success, the time required to achieve success, etc. He then assembled a panel of non-agency water experts and had them singly, and then collectively, undertake an evaluation sector by sector. A suprisingly clear picture of relative requirement emerged, and PSAC had no trouble endorsing an allocation pattern.

A few years later Ray was appointed to the National Water Commission. This 5-year study of national water policy is probably the most exhaustive ever undertaken, and represented his most intensive effort in the public sector. Former staff and commission members have long extolled his contributions to this exercise. Again, the final report was permeated with the need to consider alternatives. Although the report was intended to cover the waterfront, and did, it received little formal congressional attention because it did not cover Watergate. Unfortunately, the time schedule for report submission to congress coincided with the period when Congress was preoccupied with the Watergate episode. Nonetheless, many of the arguments advanced in the report are influencing our modern day approaches to water management.

Finally, I would like to comment on Linsley the professional. He was dedicated to the concept that the engineering and hydrologic professions should always strive to improve the quality of their product. Three examples will serve to illustrate.

During his tenure as Chairman of Civil Engineering, Ray served as a co-founder and as Director of a new graduate program in what was termed engineering-economic planning. The program was designed to provide training in the social, political and economic considerations which impact engineering efforts; especially public infra-structure developments. In essence, it was formulated to provide engineers insight to the identification and evaluation of alternatives. It was a deliberate attempt to broaden the engineer's educational emphasis from quantitative design to one which also included quantitative planning. Ray was firmly convinced that the big decisions are made in the project formulation, not the project design, stage. He felt that far too often the absence of interdisciplinary appraisal resulted in the wrong plan. His motivation was one of improving the quality of the overall engineered product. Now a quarter of a century later most of the major engineering firms have embodied the principles espoused by this pioneering effort.

A second example would be the international hydrologic program initiated in South America in the late 60's which extended into the 70's. I refer to the program developed in cooperation with the Venezuelan public works ministry. It was a summer (U.S. sense) program designed to educate engineers from all over South America, and it awarded a Master's degree upon completion of three summers of study...From a teacher's viewpoint an initial summer assignment of this nature can be exhilarating. To sustain such an effort for the better part of a decade is a major workload with little of the normal academic rewards or recognition. When asked why he made such a commitment, Ray's answer was most direct and along these

lines...South America has many undeveloped water resources. Those nations cannot afford to initiate major water development internally, or with the aid of international consultants, unless they have an adequate inhouse cadre of trained hydrologists and hydraulicians. Again, his motivating concern was with the quality of the engineered product.

The third example is known to all assembled here. The AIH did not happen by accident. Linsley, a pioneer in the hydrologic utilization of the digital computer, was also deeply concerned with the misuse of that tool. A proliferation of software programs, the passage of various well intentioned but often unrealistic environmental laws at all levels of government, and other related factors created a plethora of hydrologic opportunity. People posing as hydrologic experts using available software, but unaware of the accuracy or limitations of the assumptions on which the programs were based, became a major concern. Both the reputation of the profession and the public welfare were becoming increasingly fragile. Again, preoccupation with the quality of the professional product became paramount. Thus, we saw his active support for the establishment of the AIH. It was his hope and vision that the AIH could provide the forum necessary for establishing and maintaining adequate standards for the hydrologic profession.

In closing, one would simply note that Linsley the researcher, the author, the teacher, the public citizen, and the professional, never wavered from the quality objective. The old adage, if a job's worth doing, its worth doing right, was his consistent strategy. Upon his election to the National Academy of Engineering, the citation read "for leadership in hydrology and water resources planning through distinguished teaching, research, professional practice and service to government." It could not have been stated more accurately.

Thank you.