JERZY NEYMAN (1894-1981)--AN APPRECIATION*

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Great personalities, who stand out far above many, who leave behind a legacy of stream of thoughts which influence heavily the future course of thinking in the field, who leave a great foundational heritage to be built upon by the generations to follow and who inspire everyone whosoever comes their way, are not born everyday. Indeed the great Statistician late Professor Jerzy Neyman was one such personality. It was almost a quarter of a century ago when, as a student at Berkeley, I first came into the orbit of this great Statistician. It did not take too long for me to feel particularly impressed by his dynamic personality and the personal touch he would impart to everything that he did, both scientifically and otherwise. His warm and loving welcome to visitors in general and his encouragements and inspirations with a kindliness to the young budding scientists in particular, were always highly contagious to the point of being transmitted in turn to the generations to follow. Indeed Neyman was a great scholar, a great teacher and a fascinating human being, all in one.

Neyman was born to Polish parents in 1894 in Bendery, then part of Romania, now part of Soviet Union. After the death of his father in 1906, his family moved to Kharkov. It was here that he became interested in Mathematics and was specially impressed by the work of Lebesgue on measure and integration. At the same time he was greatly influenced by S. N. Bernstein's lectures on Probability theory, and Karl Pearson's book Grammer of Science. Neyman married Olga Solodovnikova, a Russian girl in 1920. A year later he was able to move to the newly formed Republic of Poland, where he joined the National Agricultural Institute in Bydgoszcz as a Statistician and wrote papers involving applications of Probability

and Statistics to Agriculture. In 1922, Neyman moved to Warsaw, where he worked at the State Meteorological Institute and Warsaw University, from which he received his Ph.D. in Mathematics in 1924. With the help of a government fellowship Neyman then went to England to study under Karl Pearson (KP). There followed a period (1928-1938) of famous collaboration between Neyman and KP's son Egon S. Pearson resulting in a series of joint papers on the theory of testing statistical hypothesis ((1928), (1933a), (1933b), (1936)). Here the demanding need for the consideration of the hypotheses alternative to the hypothesis under test was pointed out for the first time. Other fundamental concepts such as two kinds of errors of rejecting a true hypothesis and of accepting a false hypothesis, power of a test, etc. were introduced and studied, leading to a complete solution of the problem of testing a simple hypothesis against a simple alternative through the celebrated Neyman-Pearson fundamental lemma. Indeed these important concepts have by now become so fundamental in modern Statistics that they are taught in almost all the current text books and courses in Statistics, often without any reference to their authors. Again the last of the above papers is concerned with the theory of unbiased tests, needed to deal with situations involving composite alternative hypotheses, where a uniformly most powerful test generally fails to exist. Simultaneously Neyman's pioneering work on confidence sets ((1935), (1937), (1938a)) along with his famous papers on survey sampling ((1934), (1938b)) also appeared during the same period. The basic idea of all these papers, namely of first setting up a mathematically well defined criterion for comparison of various statistical procedures and then using it to obtain an optimal procedure from among a well defined class of procedures, was almost entirely novel to the contemporary thought. Indeed this same idea became the very basis for Wald's celebrated general decision theory to appear

later in midforties. During the same period there began the famous dispute between Neyman and Sir Ronald A. Fisher over confidence and fiducial intervals. In 1933, Karl Pearson's chair was split in two; R. A. Fisher became Professor of Eugenics and Egon Pearson, the head of Department of Applied Statistics. This helped Neyman return from Poland to join E. S. Pearson's department in 1934, where he was later promoted to a Readership in 1935.

In 1937, Neyman was invited to the United States by Wilks and Deming for six weeks lecture tour, which led him to the American scene. The overwhelming success of this trip brought him several U.S. offers including the one from the University of California at Berkeley, which he finally joined in 1938 as the head of the Berkeley Statistical Laboratory newly established for him within the Mathematics department. Just prior to this two important pieces of his work, one on 'Smooth Test for Goodness of Fit' (1937b) and the other (1939) on his famous 'contagious distributions' appeared. In the first paper he introduces the ingenious device of nearby alternatives which approach the hypothesis at the rate $n^{-\frac{1}{2}}$. This device helps in providing an optimality criterion which is used to study the asymptotic (large sample) behavior of various procedures. The problem considered in the second paper orginated from a live situation involving the distribution of number of larvae on small plots of an experimental field, which eventually led to the important notion of Clustering. This idea of clustering appears in many of his later joint works with Elizabeth Scott on stochastic modeling for live situations arising in diverse areas such as Cosmolgy, Carcinogenesis, Epidemiology, etc. ((1959a), (1964), (1972)). These developments finally led to a class of stochastic processes now popularly known as Neyman-Scott processes.

The American period at Berkeley was full of academic activities and challenges

for Neyman. He was able to attract a distinguished group of people to join him at Berkeley, notably D. Blackwell, L. LeCam , E. Lehmann, M. Loève, H. Scheffé, E. L. Scott, among others. In 1955, he became the founder and the first chairman of the Department of Statistics at Berkeley. Indeed it was Neyman who was largely responsible for building up the department there, and for bringing it to the status that it has enjoyed ever since. The department and the laboratory became the Mecca in Statistics for visitors from many lands, coming to learn and interact, inspire and be inspired by the ideas emanating from and to the place he created. He always loved to be surrounded by what he referred to as 'The International Intellectual Community'. In the imagery of India, indeed he was like a great Banyan tree under whose shade many would rest and feel inspired by the pleasant breeze of his dynamic visions and thoughts. He could visualise what a great place for the field of Statistics Berkeley could be in the years ahead. To this end he sowed the seed, fertilized, watered and cared for the plant from its infancy to what we find it today.

While Neyman's American period kept him occupied in studying various of empirical and natural phenomena, in many ways he also kept enriching further the theory of Statistics. In this regard worth mentioning are his papers dealing with his theory of Best Asymptotically Normal (BAN) estimates (1949), and his fundamental paper on $C(\alpha)$-tests (1959b) entitled, "Optimal asymptotic tests of composite statistical hypotheses". Quite often in modeling real live situations, the distributions of the observable random variables turn out to be much more complicated than the standard text book type distributions. Often they also involve many nuisance parameters beside the parameter under test. Also the estimators available for the nuisance parameters may not be too good and in particular may be biased. Keeping these nonstandard situations in mind, Neyman

(1959) developed tests for testing a null hypothesis against an alternative in the presence of nuisance parameters. These tests are locally asymptotically most powerful in a class of so called $C(\alpha)$-tests. Later he jointly with E. L. Scott effectively applied these tests to many live situations that they encountered in different areas of applications (see (1979)).

In making great contributions to the theory of Statistical Inference and to Mathematical Statistics in general, Neyman was one of those who laid the very foundations of Modern Statistics. However, Neyman made an equally great impact on the applied aspects of Statistics by applying it quite effectively to many diverse fields such as Agriculture, Astronomy, Biology, Cancer, Cosmology, Energy, Medicine, Pollution, Public Health, Weather Modification, to name a few. He exhibited great insights and understanding for mathematically idealized and yet realistic and simple meachanisms that might possibly underlie some of the natural phenomena that attracted his scientific inquiry. Often this led him to constructing a stochastic model of the phenomenon and to the theory based on it. The comparison of the theoretical consequences of the model with the empirical findings often led him to study further the intricacies of the phenomenon in question. In this connection his collaboration with E. L. Scott over a period of many years in the fields of Astronomy and Cosmology stands out in the forefront. His equally long involvement in the area of Artificial Stimulation of Precipitation (Weather Modification) and the controversies surrounding it, is worth mentioning. Also his two joint papers (1952 a,b) with Grace E. Bates on the theory of Accident Proneness are by now classic. Another classical and yet very important joint paper with T. Park, a Zoologist, and E. L. Scott (1956) is on the 'Struggle for Existence', which involves the study of competition between two species of flour beetles for survival. Another substantive area which interested Neyman a great deal is that of Carcinogenesis. In particular he became

involved in research on the mechanism which might produce the neoplastic cells. He collaborated in experimental studies on the effect of varying doses of Urethane in mice. Of equally great concern for him was the question of the effects of Radiation and Pollution on Health. My own collaboration with Neyman in studying radiation effects on single living cells via stochastic modeling was indeed a very rewarding experience ((1976), (1981)).

Neyman was a great organizer of statistical and scientific conferences. Often he would pick a major area of human endeavor involving challenging statistical problems and would attract and invite top people working in that area for participation in the exchange of views and to enable them and the statistical community to interact with each other. Around the end of Second World War he launched the first Berkeley Symposium on Mathematical Statistics and Probability in order to help the statisticians and the users of statistics to review the state of the subject. These symposia were held once every five years until the sixth Berkeley Symposium held in 1970. The number of volumes published for each subsequent symposium increased as more areas of application were included. In 1973, Neyman helped the U.S. National Academy of Sciences mark the 500th anniversary of the birth of Copernicus and edited the Copernicus volume entitled, "The Heritage of Copernicus". Again in early 1981, Neyman felt the need of a conference where people working in the areas of Carcinogenesis, Mutagenesis and Radiation Biology would meet and exchange ideas. He was not eager to wait for the time it needed to secure Federal funds for the meeting. Neyman went ahead and made from his personal funds a grant to cover all the expenses for the conference, which turned out to be a great success. The proceedings of the conference, which he helped edit together with LeCam appeared in (1982), after his death.

Although Neyman officially retired in 1961, yet he continued being Professor Emeritus called on active duty and maintained a full schedule of research and teaching until he was striken with a heart attack, which took his life almost two weeks later on Wednesday, August 5, 1981. He continued working even in the hospital bed until his death.

Neyman was a scientist with the true spirit of enquiry for the TRUTH. He would not accept anything unless he did his own digging into its depth and to his satisfaction. And if he found some inconsistencies, hewould be quite outspoken to say so, politely and yet firmly.

Neyman's scientific achievements led to many honors and recognitions. This included U.S. National Medal of Sciences, Guy Medal awarded by Royal Statistical Society, Samuel S. Wilks medal awarded by the American Statistical Association, election to the Foreign Associateship of the Royal Society, London. He was also a member of the U.S. National Academy of Sciences, foreign member of the Swedish and Polish Academies of Sciences, honorary member of the Royal Statistical Society and of the London Mathematical Society. He was also awarded honorary doctorate degrees by the University of Chicago, University of California, University of Stockholm and the Indian Statistical Institute, Calcutta.

As a person, Neyman was a noble soul and a great human being. Although he was not a religious man, yet I always saw him being quite godly in whatever he did in everyday life. He was always compassionate, loving and considerate to his fellow beings and was helpful to those who needed help, including the wild racoons that he would feed every evening as they visit his home. In 1963, during a lecture tour to the southern states, Neyman got his first close view of the plight of blacks in the South. On his return he recounted to his colleagues sometimes with tears in his eyes the pitiable conditions and the struggles of the blacks in the South. This led him to actively launch fund raising campaigns for

for Dr. Martin Luther King's Southern Christian Leadership Conference, among others. Neyman always showed a great concern for students and staff and enjoyed the role of a father figure. I once introduced one of my students to him at a meeting, he immediately said "My Grandson". He was very hardworking, energetic, not easily dismayed by set backs. His usual quote was "Life is complicated, but not uninteresting," which he changed in his last year or so to "Life is very complicated, but not very uninteresting". Neyman knew many languages including Polish, Ukranian, Russian, French, German, Latin, and English. Sometimes at gatherings of a few friends, he would be delighted in reciting poetry and humming ballads in some of these languages.

Neyman had also a great sense of humor. I remember once sometime in the midsixties when the Late Professor Alfréd Rényi was visiting Berkeley, a dinner was organized in his and Mrs. Rényi's honor at the faculty club. Professor Michel Loéve who was there at the dinner, was particularly delighted as he was able to chat in French with Mrs. Rényi. During the dinner, Neyman, of course, made his famous Polish toast, "To all the ladies present--And some of those absent!". After this Professor Loéve got up and said that next time when we invite Professor Rényi we must insist upon his bringing Mrs. Rényi with him. On this Neyman got up and said, "Next time, we invite Mrs. Rényi--and we do not mind if Mr. Rényi accompanies her."

The story of Neyman will not be complete without the mention of the Constance Reid's recent book 'Neyman from Life', published by Springer-Verlag in 1982, where the author has been able to put together the life of Neyman, his work and his remarkable personality, in her very pleasant and loving sytle. We are all very grateful for her memorable contribution.

Neyman was one of those rare human beings who always left part of him with whosoever came his way. I am sure those of us who were directly or indirectly in touch with Neyman will always miss this multi-faceted man, his enriching ways both as a person and as a scientist. For myself, I shall always cherish the memory of his most dynamic and inspiring personality.

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