George Bernard Dantzig Nov 1914 - May 2005

George B. Dantzig, one of the founding fathers of Operations Research and creator of the simplex method, passed away on May 13, 2005, in Palo Alto, California.

Dantzig began his study of mathematics at the University of Maryland (to receive his A.B. in Mathematics and Physics in 1936) and continued at the University of Michigan, where he received his Master's degree (1937). Afterwards he went on to pursue his mathematical interests in Washington D.C. at the U.S. Bureau of Labor Statistics from 1937 to 1939. Seeking a deeper understanding of mathematical statistics, Dantzig was successful in entering the PhD program at UC Berkeley under the guidance (and with the support) of Jerzy Neyman. The onset of World War II interrupted his studies from 1941 to 1946, when he worked for the Combat Analysis Branch, U.S.A.F., Washington D.C., but he returned in 1946 to finish his doctorate.

Also in 1946, Dantzig was appointed as the Mathematical Advisor to the U.S. Air Force Comptroller. His mission at this time was "to find a way to compute more rapidly a time-staged deployment, training and logistical supply *program*"[1]. His research leads him to formulate a model which focused on linear relations (as familiar at that time from *activity analysis*). What proved unusual at the time was the fact that he employed a linear objective to be minimized. Thus, this was apparently the first formal instance of a *linear programming problem*. Drawing from his PhD thesis, he "proposed in the summer of 1947" the simplex method, "and by good luck it *worked*". Due to Dantzig, the "first large-scale application of the simplex method was to the determination of an adequate diet at least cost". This work, carried out at the National Bureau of Standards, continued through the fall of 1947. The diet problem involved 9 equations in 77 non-negative variables, and the objective was to find a cost-minimal diet. At the time, the immense scope of the problem was readily apparent: "Using hand-operated desk calculators, 120 man days were required". Given the astounding development in computer technology since the 1940's, it is clear why linear programming in general, and the simplex method in particular, could develop to such a powerful tool even for large scale applications. On the other hand, among models from OR applications, at present linear programs seem to use the highest proportion of computing time.

In 1952 Dantzig took an appointment at the RAND Corporation, where he began to consider a wide variety of optimization models and their corresponding mathematical issues. Much of this work was motivated, in part, by practical problems: implementation issues of the revised simplex method (with W. Orchard-Hays), duality theorems (with A. Orden), the dual simplex algorithm, the minimal number of tankers to meet a fixed schedule as well as maximal flows in networks (with D.R. Fulkerson), (mixed) integer programming, shortest paths in networks, machine-job scheduling, solution of large-scale traveling salesman problems, the decomposition principle and the corresponding algorithm for linear programs (with P. Wolfe) with possible applications to a variety of decentralized business organizations (as just one famous example the National Biscuit Company in the U.S.), stochastic linear programming (then called programming under uncertainty; in part together with A. Madansky), multistage (i.e. dynamic) linear programming, and numerous other applications.

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[1] G.B. Dantzig: Reminiscences about the Origin of Linear Programming. OR Letters, **1** (1982)43-48.

In 1960 Dantzig joined the faculty of the Operations Research Center at UC Berkeley both as a Professor and Chairman. In 1963, he published *Linear Programming and Extensions* (which due to its subtitle: *A RAND Corporation research study* was substantially influenced by his activities at RAND). This proved to be the standard text on the subject for many years. Furthermore, he continued to do research in most of the topics mentioned above, as well as adding new ones, for example linear complementarity problems (with R.W. Cottle).

Finally, in 1966 Dantzig moved to Stanford University, where he took a position as Professor for Operations Research and Computer Science. Here again his activities were concerned with some of the above problems, but also new ones arose: the investigation of the stability of nonlinear optimization problems (with J. Folkman and N. Shapiro), particular problems of control/dynamic programming, the expected number of steps of the simplex method, and importance sampling within a Monte Carlo approach to solve stochastic programs. Due to the fact that he actually dealt with many practical problems, he became aware of the fact that an institution was needed to address the wide scope of these various types of optimization issues. This was the impetus for the formation the Systems Optimization Laboratory at Stanford University, well known among practitioners and scholars for its efficient and reliable commercial optimization software package MINOS. Dantzig's particular interest in the nation's energy problems spurred him to seek possible applications in this area for mathematical programming. This eventually lead to the Energy Modeling Forum on the campus of Stanford University, where, starting in the 1970's, the multi-period investment and production model PILOT (which dealt with the U.S.'s energy supply) was set up as a dynamic linear programming problem.

Due to his impressive and groundbreaking work in the development of Operations Research (in particular in the area of Mathematical Programming), Dantzig received numerous awards. Among others, he received the U.S. President's National Medal of Science, the John von Neumann Theory Prize, the National Academy of Sciences Award in Applied Mathematics and Numerical Analysis. He was honored by various academic institutions: he became a member of the National Academy of Engineering, a fellow of the Econometric Society, the Institute of Mathematical Statistics, the American Academy of Arts and Sciences, and the Operations Research Society of America. He received honorary doctorates from eight universities.

The pioneering work of George B. Dantzig lies at the core of a great deal of the scientific activities of TC 7, the IFIP Technical Committee on System Modelling and Optimization, and of most of its Working Groups. This is readily evident by simply looking at the recurring themes of all general TC 7 Conferences since the start: particularly the development of algorithms and the corresponding theory in linear, nonlinear, discrete programming, in operations research, and their application in many areas. This core basis is now tied together to another major theme of TC 7, namely the use of optimal control as a broad platform to address ever complex modeling situations, which are also rooted in carrying out realistic simulations.

It is abundantly clear that TC7 is greatly indebted to George Bernard Dantzig for his person, devotion, and work. Those of us who had the honor of personally knowing George Dantzig will certainly remember his lasting activities --- even after his retirement in 1997 (!) he continued to participate in the scientific life. Many of us also have fond memories of his character. George Dantzig had a modest and friendly air in conversation; he was always frank,

fortright, and sharing when asked about certain problems of mathematical interest. He was also a careful listener and readily dispatched excellent advice and valuable correspondence. He will be greatly missed.