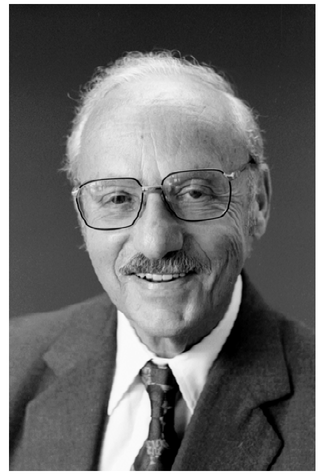
George B. Dantzig 1914–2005



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By J. Dupačová and D.P. Morton

George B. Dantzig is well known as the father of linear programming. This “underestimates his paternal accomplishments” as is compellingly illustrated in the recent book [3] entitled *The Basic George B. Dantzig*. Dantzig made either fundamental or founding contributions in mathematical statistics, linear programming, network optimization, integer programming, nonlinear programming, stochastic programming, large-scale optimization, and complementarity problems.

Dantzig’s discovery of what came to be called linear programming was presented at the meeting of the Econometric Society at the University of Wisconsin in Madison in 1948. His abstract from this meeting appeared in Econometrica [5] and his early linear programming papers appeared, inter alia, in [6, 7] and in the collection edited by Koopmans [8, 9, 10].

Looking back from the early 1980s, Dantzig’s own characterization of linear programming as written in [17] was:

> linear programming is a revolutionary development giving man the ability to state general objectives and to find, by means of the simplex method, optimal policy decisions for a broad class of practical problems of great complexity

and he summarized his most important contributions to linear programming as follows:

> • Recognizing (as a result of five war-time years as a practical program planner) that most practical planning relations could be reformulated as a system of linear inequalities.
>
> • Expressing criteria for selection of good or best plans in terms of explicit goals (e.g., linear objective forms) and not in terms of ground rules which are at best only a means for carrying out the objective not the objective itself.
>
> • Inventing the simplex method which transformed a rather simple, possibly interesting approach to economic theory into a basic tool for practical planning of large complex systems.

From the very beginning, Dantzig aimed for *computable, large scale dynamic models with well formulated objectives.* He was aware of the need for further extensions of linear programming, as evidenced by his book [16].

George Dantzig began his research career in statistics as a doctoral student under Jerzy Neyman at the University of California, Berkeley. He famously mistook two unsolved problems presented in a mathematical statistics course of Neyman as a homework assignment. Dantzig's solutions became his thesis, and this work was published as [4] and [11].

The fact that the ideas of duality and of the celebrated simplex method have been set in connection with Dantzig's thesis, part of which was devoted to the proof of the Neyman-Pearson lemma, cf. [11], is not broadly known. Nevertheless, Dantzig's professional knowledge of mathematical statistics definitely led to another pioneering step—finding a way to deal with incompletely known parameter values occurring in most practical linear programming problems, i.e., the field now known under the name stochastic programming.

From the time linear programming was discovered, Dantzig recognized that the "real problem" concerned programming under uncertainty. Dantzig's vision in his early papers was truly remarkable. His 1955 paper [12], which introduced linear programming under uncertainty, fully presents the simple recourse model, the two-stage stochastic linear program with recourse and the multi-stage stochastic linear program with recourse. This paper also identifies special cases in which the random parameters can be replaced by their means and emphasizes when this is not possible. With characteristic modesty, Dantzig continually pointed to Martin Beale [2] as the field's co-founder.

Dantzig's 1961 paper with Madansky [13] on applying the Dantzig-Wolfe decomposition principle [14, 15] to solve two-stage stochastic linear programs recognizes connections to Kelley's cutting-plane algorithm and precedes Benders decomposition and the well-known L-Shaped method of Van Slyke and Wets [23]. That 1961 paper concludes with the remark, "An interesting area of future consideration is the effect of sampling the distribution" to statistically estimate cut gradients and intercepts. Three decades later, such methods were developed by Dantzig, Glynn and Infanger [19, 20] and by Higle and Sen [22].

Dantzig's discoveries were continually motivated by applications. As he tells it, the decomposition principle was largely developed on a plane flight from Texas back home to Santa Monica after visiting an oil company and initially miscalculating the size of their linear program. In 1956, he and Ferguson [21] extended earlier work on an aircraft allocation problem to include uncertain customer demand. Dantzig said (see, e.g., [1]) that he fails to see the difference between the so-called pure and non-pure mathematics and doesn't believe there is any. He further said, "Just because my mathematics has its origin in a real problem doesn't make it less interesting to me—just the other way around."

Dantzig's awards are many and include the National Medal of Science from U.S. President Gerald Ford. He was member of the National Academy of Sciences, the National Academy of Engineering, and the American Academy of

Arts and Sciences. The “Stochastic Programming Orchard” in [24] vividly illustrates his impact through his numerous students and colleagues. His early doctoral students in stochastic programming include John Birge, Richard Van Slyke, Roger Wets and Richard Wollmer.

To conclude our reminiscences, let us mention that George Dantzig was one of the leading personalities in the early days of IIASA Laxenburg and has also visited Prague as an invited speaker of the 4th International Conference on Stochastic Programming organized by the Faculty of Mathematics and Physics of the Charles University, Prague in September 1986. His contribution appeared in Ekonomicko-matematický obzor [18].

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