Obituary

George B Dantzig, 1914–2005

George Dantzig, the 'father' of Linear Programming (LP) and the inventor of the Simplex Algorithm, died on 13 May 2005. Many tributes have been paid to him in USA journals and newspapers. I will not, therefore, repeat all the information which can be read in these. Instead, I will recall what I regard as particularly significant aspects of his achievements and personality, some emanating from my personal acquaintanceship with him.

George was very much an American, although the son of Russian immigrants. His father, Tobias Dantzig, was himself a famous mathematician. Nevertheless, George visited the UK on a number of occasions and was awarded the Silver Medal of the British OR Society in 1986, at the Canterbury Conference. I remember him giving a talk to the Mathematical Programming Study Group of the Society at the LSE on that visit. Also, I remember him sitting with us afterwards in the King George IV public house outside LSE, an environment which he enjoyed but which was obviously new to him, as well as his interest in the spectacular night scene of London as we drove across Waterloo Bridge.

His work is well covered in his major and spectacular book 'Linear Programming and Extensions', first published in 1963. He describes in this, and other publications, his early work on Air Force Planning, which was known as 'Programming' and how he created a model, which was very novel at the time. He called this 'Programming within

a Linear Structure', which then became truncated, at Koopman's suggestion, to 'Linear programming'. This type of model turned out to have the same structure as other models arising in diverse areas such as transportation and nutrition. There was no obvious way of solving them and Dantzig invented the Simplex Algorithm. He, like others, was always surprised by its spectacular computational success. Fortuitously, Electronic Computers were also being created. It is sometimes said 'Linear Programming was made for Computers and Computers were made for Linear Programming'. The development of both went hand-in hand.

I sometimes wonder how his initial presentation of the Simplex Algorithm would be viewed today by academic pedants. Initially, convergence could not be guaranteed, but even when it can, it is of exponential complexity, in the worst case. But it works and is capable of solving enormous models. Much more recently, Khachian (who died within days of Dantzig) produced a polynomial complexity, but impractical, algorithm, to be followed by Karmarker with a practical one. However, it is still the Simplex Algorithm, with its many refinements, which is the main engine behind most commercial systems. The Hirsch Conjecture still remains open (for bounded LPs) that, for an m-row model, there will be at most m pivot steps to the optimum. If it were true and a (polynomially bounded) pivot selection rule could be found the Simplex Algorithm would become one of polynomial complexity. But nobody has solved either of these problems.

This was also an exciting time for economics, with many theoretical results emanating from LP. Kantorovitch, Koopmans, and Leontief all won the Nobel Prize for Economics on the back of this work. The work of another Nobel Prize winner, Arrow, also had connections with Dantzig's work. Rumours circulate on why Dantzig did not win the Nobel Prize, from the observation that he was primarily a mathematician to a clerical error! Also significant was his relationship with the much older Von Neumann who (with others) created Game Theory. Another rumour concerns an argument they had on Princeton Railway Station concerning who invented Duality. Of course the property, which is central to LP, also manifests itself in a very illustrative way in 2-Person Games, again with links to economics (consumers versus producers). Leontief's Input–Output models become LPs when made multi-period with alternative growth patterns, and therefore the need for an objective.

One of Dantzig's models had all the economic flows associated with the Government sector *inwards,* reflecting his political views!

Some of his views were controversial. I remember his talk espousing the wish to model the US economy by LP (an extension of his input–output model) in order to demonstrate its maximum productive capability. Also, I remember his talk and book on the idea of a 'Compact City'.

On a personal level, I remember first reading his book when I worked for IBM. I thought I had invented a new method for solving LPs (based on a decision procedure in logic). Phil Wolfe thought he had seen it before and found it in Dantzig's book. It was due to Fourier (usually known as Fourier–Motzkin Elimination). Dantzig and I had many conversations about it later since we were both convinced that we could make it viable by exploiting the sparsity of practical LP models (I now think we were both wrong). His book still deserves a very thorough reading. His interpretation of decentralised planning through a dialogue involving the application of Dantzig-Wolfe decomposition is particularly noteworthy as is his early espousal of Stochastic Programming. As a very much younger person, I was always flattered by Dantzig seeking me out and listening to me at conferences. He wrote me an unsolicited congratulatory letter when my book was first published and I did not know him. This attitude to younger people and his intellectual curiosity have been remarked on by others. I last saw him, and talked to him, at the Mathematical Programming Symposium in Georgia. This was his last. He was not well enough to go to Copenhagen. He had an outstanding and original intellect and a wonderful personality.

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