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Comments on "A Suggested Computation for Maximal Multi-Commodity Network Flows"

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The L. R. Ford Jr. and D. R. Fulkerson paper, "Suggested Computation for Maximal Multi-Commodity Network Flows" (*Management Science* 1958), is a foundation study for two important developments in the management sciences. One is applied and the other is theoretical.

The basic theory for single-commodity network flows was developed primarily by Ford, Fulkerson, and Dantzig and documented in a series of publications in the late 1950s and two famous books (*Flows in Networks* by Ford and Fulkerson and *Linear Programming and Extensions* by Dantzig). This *Management Science* 1958 manuscript introduced the concept of multiple commodities sharing the same capacitated network. In the introduction they state the major differences between the multicommodity version and its single-commodity cousin.

> Simplex bases are not triangular, hence addition and subtraction do not suffice to solve such problems by the simplex method, the max flow min cut theorem, true for single commodity networks is false, and no simple-minded modification of the labeling process seems to work.

It is precisely these properties that make this problem difficult. The multicommodity network flow problem has become an important model in the management sciences with numerous applications in the area of distribution networks and telecommunication design. Some of the first applications solved by the KORBX linear programming system based on the interior point algorithm of Narendra Karmarkar of AT&T were large multicommodity network problems for military airlift applications. In recent years, multicommodity models regularly appear in the telecommunication design literature. All the work on this family of problems traces it roots to this famous *Management Science* 1958 publication.

All serious students of the management sciences have heard of Dantzig-Wolfe decomposition and many of us have used this algorithm in our own research work. However, not everyone knows that it was this *Management Science* 1958 publication that inspired the work found in "Decomposition Principle for Linear Programs" by George B. Dantzig and Philip Wolfe (*Operations Research* 1960 **8** 101–111). On page 102 they state the following: "Credit is due to Ford and Fulkerson for their proposal for solving multicommodity network problems as it served to inspire the present development." All the work on decomposition also traces its roots to this famous *Management Science* 1958 publication.

Key words: queue; network; steady state