INTEGRATED EQUILIBRIUM FLOW MODELS
for TRANSPORTATION PLANNING*

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1. Introduction

The conventional transport model (recursive in character) is a combination of three submodels, trip generation, trip distribution and assignment. As a rule, these stages are treated separately as if the travel choices involved in each one were made independently of the other. A careful examination of this procedure, however, reveals some significant weaknesses. Although quite sophisticated models based on behavioral assumptions have been developed for the assignment stage, the models available for the distribution and generation stages are less refined. As a result, serious internal inconsistencies arise. For example, the travel costs that are used as inputs for the distribution and generation stage are not the same as those which are outputs from the assignment stage. As a partial remedy, practitioners have devised in recent years an iterative scheme, in which the above model is imbedded, in the hope that the interrelationship between demand, supply and cost will be taken into account. Unfortunately, the above scheme does not produce in general equilibrium flows (see e.g. [6]). For these reasons we strongly believe that the substitution of the "first generation" recursive transport model by a "second generation" integrated transport model based on behavioral assumptions and the equilibrium concept will be an important step towards better planning of transportation systems.

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Recently some models have been proposed (e.g. [9]) which attempt to combine the functions of generation, distribution and, potentially, assignment into a single process. However, the special assumptions involved make these approaches not generally applicable. Also, the computational methods associated with the above models do not produce in general equilibrium flows (see [6]). In this article we introduce a novel approach for modelling the transport problem based on a behavioral assumption. The success of the behavioral models developed for the assignment problem (e.g. [8] and the references cited therein, [2], [5], [7]) indicates that such an approach might prove fruitful.

We adopt here the natural behavioral assumption that each user chooses his origin, his destination as well as his path so as to minimize his "travel cost". Of course in the above statement "travel cost" should be interpreted in a very liberal fashion. In reality, additional factors such as "attractiveness" of the origins (residential areas) and destinations (places of work) have to be taken into account but these can be incorporated into the model as "travel costs" by a straightforward modification of the network.

Actually we propose here three variants of an integrated transport model, each based on different reasonable circumstances. Interestingly, we establish a mathematical equivalence which reduces these integrated transport problems for a network into assignment problems for a modified network. This equivalence will enable us to employ the experience accumulated with the assignment model in order to study the traffic behavior predicted by the integrated transport model as well as to compute the traffic flow equilibria in a transportation system.