A dual-mode transportation system involves, in general, both an on-guideway and an off-guideway operation. The on-guideway portion offers essentially personal rapid transit amenities. The requirements in the vehicle in reference to braking capabilities on the guideway are then similar to those of PRT vehicles. The off-guideway braking system requirements are similar to those of buses, trucks, or automobiles. The integration of a braking function into a dual-mode system must be basically a compromise among on-guideway and off-guideway braking operations. In general, the compromise may be accomplished by use of either different braking systems (on different vehicles, as in a pallet-pod operation, or in the same vehicle) or by use of the same braking system suitable for on- and off-guideway operations.

Criteria against which braking systems may be measured are those of safety, economics, energy management, and environmental impact. By considering these criteria and the limitations set by the braking system's interfaces, an organized set or matrix of interrelations is developed from which desirable and undesirable aspects of integration of braking functions into a dual-mode system can be determined.

The significance of the interfaces is such that these become the controlling factors. The actual braking hardware now available, with proper design and application, is adequate for the tasks of stopping dual-mode vehicles. The braking function of necessity includes its controls, especially as headway is lowered to tenths of seconds on guideway where the limitations are the more restrictive. Off guideway, service braking is more restrictive, and emergency braking can be considered as back-up braking. Fail-safe braking is possible only when all interrelations are properly evaluated. Fail-safe, in the paper and in general, can mean only that under a failed mode the function is put into a back-up mode and probability of failure is reduced. A safety analysis such as fault-tree analysis is preferable to reliance on fail-safe concepts.

AUTOMATIC LONGITUDINAL CONTROL OF A MERGING VEHICLE

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Various facets of merging a vehicle into an automated high-speed stream of traffic are considered: a merging system structure, a set of typical requirements for an individual merging maneuver, the geometric and time constraints on that manuever, and a simple on-board vehicle controller for accomplishing it.

Since a means of providing continuous position reference information to a merging vehicle is now available, a position controller was selected for detailed study. This effort consisted of two parts. The first involves a simulation study of various controller designs and their response to large disturbance conditions [3 percent grade and 13.4-m/s (44-ft/s) wind force]. The second was a quasi, full-scale effort in which the behavior of a specially instrumented dual-mode vehicle was evaluated in various merging situations in which the terminal speed was 26.8 m/s (88 ft/s).

The findings to date from this ongoing study are as follows: (a) the details of the trade-off between the minimum required ramp length and the terminal merging error; (b) the development and validation of a model that resulted in data that closely correlated with those from full-scale tests; (c) the parameter range over which this model is valid; and (d) the conditions under which control of a merging vehicle, a corresponding comfortable ride, and excellent disturbance suppression can be obtained. A potential difficulty with the controller studied is the peak tracking error, which could cause difficulty if closely spaced merging vehicles were being simultaneously controlled.

Data were also collected for terminal speeds of 30.5 m/s (100 ft/s). The conclusions drawn are the same in both cases.

This controller will also provide good tracking both in steady-state constant speed operation and in organizing situations (e.g., position move-up and move-back commands). In effect, it could be used for all phases of longitudinal control, except perhaps emergency braking.

The major shortcoming is the somewhat large peak error incurred in merging operations. This error could be greatly reduced by using a more complex controller. One promising choice is currently being evaluated by analog simulation and will be subsequently tested under the partial full-scale approach described in the paper. Beyond that, plans are to conduct corresponding "complete" full-scale tests in which an externally generated reference trajectory is used.