

# EDULOG.*nt* Transportation Optimization Software



Optimization in a transportation system consists of developing the most efficient a system of bus routes and schedules as possible within the guidelines of existing or potential transportation policies.

This optimization activity includes several stages of graphic review to consider all of the street network data along with student needs and transportation policies. The objective is to develop a set of routes and schedules with the minimum fleet requirement and travel distance while efficiently serving all eligible students. It is another major achievement of EDULOG's research and development effort that enables us to create an extremely effective route building scheme. EDULOG has consistently been acknowledged to be the only company capable of providing true *global* optimization in all three of the major routing functions: stop location, run building, and route coupling.

The routing and scheduling optimization software is the core of the EDULOG system. These programs were first created more than ten years ago and have been continually modified, refined, and enhanced through the years. EDULOG's optimization system has evolved through several generations of development so that the present system for personal computers has all of the effectiveness, flexibility, and versatility of the version available for larger computers.

The EDULOG approach is based on a very solid mathematical background, and the mathematical algorithms have been enhanced for increased performance in response time and the quality of solutions produced. More importantly, the whole procedure of building bus routes has been modified to be extremely user-friendly, easy to train on and operate, and *totally* automatic. The latest improvement has been the integration of interactive graphics with the optimization software so that solution review and adjustment can be done graphically.

The main functions of the optimization process (which can be operated interactively or in a batch mode) are:

- Run Building
- Route Coupling

The run building process can be executed for a given destination school or a selected group of schools. In the latter case, all bus runs produced by the system will have multiple service to the selected schools. The process can be further restricted to a specified group of bus stops, or a group of students. The run building procedure typically follows these steps:

- A. The operator defines the parameters for the optimization process including: the destination school (or group of schools) to be considered, the bus stops (or students) selected for routing, and the load and time factors for each run. These parameters are then stored in a file and can be retrieved if another run of the program is wanted.
- B. The run building programs are executed. The programs globally generate an optimal set of runs based on the pre-selected stops according to operator-specified time and load limits. Runs are created by sequencing stops for the most effective routing pattern while satisfying transportation policies.
- C. The resulting runs are available for transportation staff review through terminal interactive graphics. Any of the standard reports available on the system such as passenger lists by bus stop, bus stop listing on runs, etc. can be generated to help in the evaluation.
- D. Computer plots are generated to further help the evaluation of the results.
- E. From the run review, it may be desirable to change some of the parameters defined in Step A, as well as perhaps change some service requirements and then repeat the process at Step B above. This process can be executed as many times as required until satisfactory runs are produced. Once a set of runs has been generated, stops may be added, deleted, moved to another run, or exchanged with other stops. The operator can “freeze” any run, group of runs, or part of a run and re-optimize the remaining stops according to the same or different time and load constraints. In this case, or in the case where only minor corrections are required, the on-line interactive programs can be called upon to perform the final fine-tuning of the runs for operation.

EDULOG was the first company to develop a system with the ability to automatically build multiple bus runs to a specific school or cluster of schools while using full vehicle capacity and minimizing time and distance in travel. This capability has been honed by years of use, and the savings realized by our clients are well documented.

The route coupling software combines a specified group of bus runs into bus schedules with the objective of minimizing fleet requirements, travel distance, and wait times. The process can be conducted for any group of specified runs so that the least number of buses is used to transport all eligible students. Operation of the software is similar to the route scheduling process:

- A. The operator defines the parameters for the route coupling process: the group of runs involved, the particular restrictions on vehicle types and capacities, the time windows within which the runs can be

at schools, etc. The parameters are stored in a file and can be retrieved and changed for another run of the process when needed.

- B. The route coupling is executed. The programs create coordinated bus schedules using the least number of vehicles while minimizing distances, deadhead travel, and wait times.
- C. Hard-copy reports are generated for review (or review can be carried out through interactive graphics). At this point additional simulations for school start/stop times and arrival/departure times can be performed to further minimize vehicle requirements.
- D. The review may lead to changing some of the run parameters and repeating the process at Step B above or, if the results are satisfactory or close to being so, the on-line interactive programs can be called upon to fine-tune the schedules.

We believe that the EDULOG route coupling optimization software has fully proven the value of automatically performing route coordination to maximize vehicle usage by scheduling multiple trips.

Because EDULOG operators can access all software to construct bus routes and schedules and also update the geographic and street network information, there is no limit to the simulation activities that the district can conduct, as long as the parameters considered in the simulation process are the same as those supported in the run scheduling and coupling processes or the interactive maintenance programs.

The optimization programs are fully integrated and interactive with other EDULOG software such as the boundary planning/redistricting and boundary optimization programs. This allows the transportation optimization software to create what-if scenarios for simulated attendance boundary changes, school closings, opening of new schools, changes in school start/stop times, and changes in bus arrival/departure times to measure their effects on transportation.

Simulation activities are supported by both types of EDULOG software: the route maintenance system allows small scale route change simulation whereas the route global optimization system allows the district to simulate the complete network.