

MODELING FOR REAL-TIME TRAFFIC CONTROL IN
THE RHODE ISLAND INTELLIGENT ROAD

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16. Abstract This is the final report for Phase 1 of the project "Modeling for Real-Time Traffic Control in the Rhode Island Intelligent Road (RIIR)". To support the RIIR a traffic flow model needed to be developed that could be used to design and evaluate control strategies. The objectives of this project were 1) to support the RIIR project by developing a traffic flow model of the RIIR that can be used to design and evaluate real-time traffic control schemes, and 2) to increase the awareness and interest of engineering students in transportation issues and transportation engineering. The proposed project was a three-year project. In the first year (Phase 1), the principal investigator developed a suitable model applicable to the existing road network and the existing traffic control schemes. In the second and third years (Phases 2 and 3), it was proposed to use this model to design and analyze the effectiveness of new proposed real-time traffic control strategies for the RIIR. The selected traffic model is based on Webster's method, which can be used to set signal timing and to estimate the resulting average vehicle delay for situations where only hourly average flow rate data is available. This model was used as the basis for a course project implemented in the Spring 2000 semester in EGR106 Foundations of Engineering, by having the students do an analysis of traffic signal timing at two intersections in the Kingston RI area. The students programmed a method for setting signal timing, and then compared their calculations with the actual signal timing used at these intersections.			
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ABSTRACT

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Follow-on proposals for Phases 2 and 3 must await decisions by the URITRC regarding the future of the.

INTRODUCTION

This is the final report for Phase 1 of the project "Modeling for Real-Time Traffic Control in the Rhode Island Intelligent Road". The Rhode Island Intelligent Road (RIIR) concept was proposed by the URI Transportation Research Center (URITRC) to serve as a testbed for advanced real-time traffic control concepts. The proposed location of the RIIR is the Kingston RI section of Route 138 from the West Kingston area east to the Route 1 interchange. To support the RIIR a traffic flow model needed to be developed that could be used to design and evaluate control strategies. The objectives of this project were 1) to support the RIIR project by developing a traffic flow model of the RIIR that can be used to design and evaluate real-time traffic control schemes, and 2) to increase the awareness and interest of engineering students in transportation issues and transportation engineering.

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was proposed to use this model to design and analyze the effectiveness of new proposed real-time traffic control strategies for the RIIR. To date, only Phase 1 has been funded.

Some time was spent studying available traffic models and selecting one that is appropriate for the RIIR. The selected model is based on Webster's method (1, 2, 3). This model was used as the basis for a course project. This project was done in the Spring 2000 semester in EGR106 Foundations of Engineering, by having the students do an analysis of traffic signal timing at two intersections in the Kingston RI area. The students programmed a method for setting signal timing, and then compared their calculations with the actual signal timing used at these intersections.

WEBSTER'S METHOD

The timing of traffic signals obviously affects the traffic flow through an intersection. If one lane is given a red signal for too long, an excessively long queue of vehicles can develop in that lane. It is easy to see that the length of the green signal should depend somewhat on the traffic volume in that direction. Signal timing is divided into phases. A phase is that part of the cycle allocated to a particular traffic stream, or combination of traffic streams, having the right of way simultaneously. The cycle time is the time for all the phases to occur. The total cycle time is the sum of the actual green times, the yellow times, and the all-red time.

Over forty years ago Webster developed some simple formulas to compute the optimum cycle length and green times. He also developed a simple formula to estimate the average vehicle delay produced by these signal settings. Methods more accurate than Webster's have since been developed, but these require much more data and are more difficult to use; yet for many traffic conditions they give results that are only slightly more accurate than Webster's.

Factors are used to adjust the flow data. The passenger car equivalent factor is used to convert straight-through volumes of buses and trucks to straight-through volumes of passenger cars. This factor is necessary because buses and trucks require more time to cross intersections than do cars. Turning vehicles also require more time to pass through the intersection. Thus turning movement factors are used to convert turning traffic volumes into equivalent straight-through vehicles. Different factors are used for left and right turns, because the time required for such turns is different.

A particular lane might have a small per vehicle delay but must service a large number of vehicles. Thus a more important quantity than per vehicle delay is the average lane delay, which is the product of the per vehicle delay and the adjusted flow rate. The total intersection delay is the sum of all the lane delays in every lane in every phase. Another important quantity is the maximum lane delay, which indicates the lane experiencing the most delay. An approximate value of the average queue length in each lane can be obtained from Webster's method (3). Details regarding traffic data adjustment factors and Webster's method can be found in many textbooks on traffic engineering, such as (1).

Webster proposed a formula for the optimum cycle length to minimize the total intersection delay. For many intersections traffic data is sparse and consists only of hourly averages. Thus more advanced mathematical methods for traffic signal timing cannot be applied, and a simple method such as Webster's is all that one can use. This is the case for the currently-available data for the RIIR. Available traffic data for the Kingston area was helpfully provided by Beta Engineering of Lincoln RI. The data consists of hourly traffic averages, and is aggregated into different days of the week and morning, afternoon, and evening time frames.

Therefore, Webster's method was appropriate for this project, which could not require specialized mathematical knowledge not possessed by freshmen.

THE STUDENT PROJECT

Webster developed his formula so that traffic engineers could make hand calculations using tables (hand-held calculators had not yet been invented and computers were not widely available in 1958). However, now MATLAB, which is the required programming language for EGR106, can be used to program the calculations necessary to compute the optimum cycle time, by computing the delays for many cycle lengths. The students were asked to program these calculations, compare the results with the signal timing obtained from Webster's model, and then compare the values with the signal timing actually used at two intersections: Route 138 at Upper College Road, and Route 138 at Route 108. Because Webster's method does not apply to adaptively actuated signals that change their timing based on traffic, we had to take care to select times of day when the traffic flow is evenly balanced on all approaches.

Each team was assigned a different intersection, day of the week, and time of day. In that way the class could cooperatively analyze a local area of interest in detail. The students enjoyed examining the operation of a local intersection, with the possibility of reducing traffic delays by improved signal timing. Each team submitted a final report and made a presentation to the class.

The project provided a good way to educate the students about teamwork. Programming projects provide excellent opportunities to develop teamwork skills in students, and we used the project for this purpose. Tasks in such projects are easily divisible; each team member can have responsibility for writing one subprogram. Communication skills are developed when the team must write specifications that each subprogram must follow in order to be compatible, when the team makes a presentation to the class, and when the team writes the final report. We emphasized that these reports must properly document the program, using a variety of tools such as comments, pseudo-code, flow charts, and structure charts. Team coordination skills were developed in assembling and testing the completed program. Teaming roles, such as presenter, scribe, facilitator, and timekeeper, were also taught with this project.

FUTURE WORK

The students enjoyed the project and commented that it made them more aware of traffic issues and transportation engineering as a possible career. It is intended to use this project again in future offerings of EGR106.

Follow-on proposals for Phases 2 and 3 must await decisions by the URITRC regarding the future of the RIIR.

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