Session 2793

OAK-TREE: One-of-A-Kind Transportation Research and Education Experiment

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Abstract - This paper chronicles the traffic control course/laboratory named OAK-TREE (One-of-A-Kind Transportation Research and Education Experiment) at the University of California at Irvine and discusses a proposed implementation at Rowan University. In order to address the changing nature of transportation and civil engineering education and research, a partnership was formed between an academic institution and public agencies. This partnership involved the University of California at Irvine and the Department of Transportation from the cities of Los Angeles, Irvine, and Anaheim. The benefits from this partnership includes a laboratory experience based on real-world networks and traffic, the use of state-of-the-practice methods and tools, and the inclusion of curriculum input from practicing engineers. The results from the two years of this experiment demonstrate that such a collaborative effort can be fruitful and can be pursued further. A proposed implementation at Rowan University is discussed at the end of this paper.

Introduction

A survey conducted by Lipinski and Wilson [1] shows that one major concern for transportation employers is finding qualified entry-level transportation engineers. This concern stems from the lack of exposure to state-of-the-art transportation engineering methodologies. This problem can be addressed by including practicing professionals in the development and instruction of transportation engineering courses. This problem is further addressed through the use of real-world engineering projects that are conducted in the field. A partnership between academia and public agencies seems to be a logical way of solving both problems. Pignataro [2] conducted a survey of academic institutions and industry, and concluded that academic/industry partnerships were mutually beneficial and productive.

The College of Engineering at Rowan University is a new college that seeks to address the challenges of modern engineering education and research. One such challenge is the need for the integration of real-world experiences into course curriculum. Another challenge is the growing multi-disciplinary nature of transportation engineering. In addition, there is the challenge of producing graduates who are both theoretically sound and adept at practice. Therefore the transportation group at Rowan University seeks to continue the successful OAK-TREE (One-of-A-Kind Transportation Research and Education Experiment) course developed at the University of California at Irvine (UCI).

One of the benefits of OAK-TREE was the exposure of the students to the state-of-the-practice. This exposure would otherwise not be possible unless students obtained internships while in school. Another benefit is the multi-disciplinary nature of OAK-TREE. Since the popularity of Intelligent Transportation Sytems (ITS) has been increasing, professionals in this area need to be proficient in electrical engineering and computer science in addition to traditional transportation areas in civil engineering. This course exposed the students to traffic control hardware, software, and traffic theory. Because the three city agencies contributed to the course design, they also benefited from OAK-TREE by the hiring of graduates who possessed the skills required in traffic engineering.

Partnerships

The OAK-TREE effort was led by the University of California, Irvine (UCI). Faculty belonging to the Department of Civil and Environmental Engineering and the Institute of Transportation Studies covered fundamental theory in traffic engineering. The university also developed an Advanced Transportation Engineering Laboratory with the assistance from the public agencies. This laboratory has the capabilities of servicing fifty students simultaneously for laboratories. The following is a partial list of the laboratory equipment:

- NEMA, Caltrans 332, and Caltrans 337 fully loaded traffic control cabinets
- Programmed visibility traffic signal head and pedestrian display mounted on a shortened pole

- Other NEMA and 170 type traffic controllers
- Four temporary inductive loop detectors, infrared detectors, Doppler radar, and VIPS (Video Image Processing System)

The university also provided advanced computer laboratories for transportation software instruction.

The City of Los Angeles provided the real-world network for the signal coordination project. A network of 21 signalized intersection in Los Angeles became a laboratory for students. The City of Los Angeles also provided seminars on signal timing and traffic simulation that highlighted the state-of-the-practice. The staff from the Advanced Traffic Surveillance and Control Center (ATSAC) assisted in seminars and laboratories, and donated traffic control cabinets, controllers, and other equipment.

The City of Irvine staff focused on transportation engineering hardware and detectorization. This required instruction in many aspects of electrical engineering. Consequently the multi-disciplinary aspect of traffic control was presented to students. The Irvine Traffic Research and Control Center (ITRAC) staff assisted in lectures, demonstrations, and donated traffic control equipment.

In the City of Anaheim, there are numerous facilities for special events within a short distance. These include Disneyland and Knott's Berry Farm amusement parks that attract tourists from all over the world. The sports complexes in Anaheim include the Edison International Field (Anaheim Angels baseball), and the Arrowhead Pond (Mighty Ducks hockey and Los Angeles Clippers basketball). In addition, there are numerous hotels and convention center facilities. This provides an excellent laboratory site for teaching students about traffic management related to special events. All special events in Anaheim are coordinated centrally at the Transportation Management Center (TMC).

Course and Laboratory Description

The OAK-TREE course was divided into four major topics. The first topic is traffic control hardware. This course was led by electrical engineers from ATSAC, ITRAC and UCI. Every component of a traffic control system was presented from the input file to the output file. The different types of input devices presented were pushbuttons, inductive loops, infrared detectors, Doppler radars, and video detectors/image processing. The students designed detector strategies for various traffic approaches and gap operation. Output devices such as signal heads and pedestrian heads were also introduced. The various processing devices presented were "170 type" controllers, NEMA (National Electrical Manufacturers Association) controllers, field laptops, and computer servers. Some communication options outlined in this course were fiber optic, twisted pair, and ethernet. Other miscellaneous traffic control hardware discussed were conflict monitors, optical isolators, relays, termination systems, and power supply. Figure 1 shows a NEMA cabinet containing detector cards, output relays, controller, and other miscellaneous components.

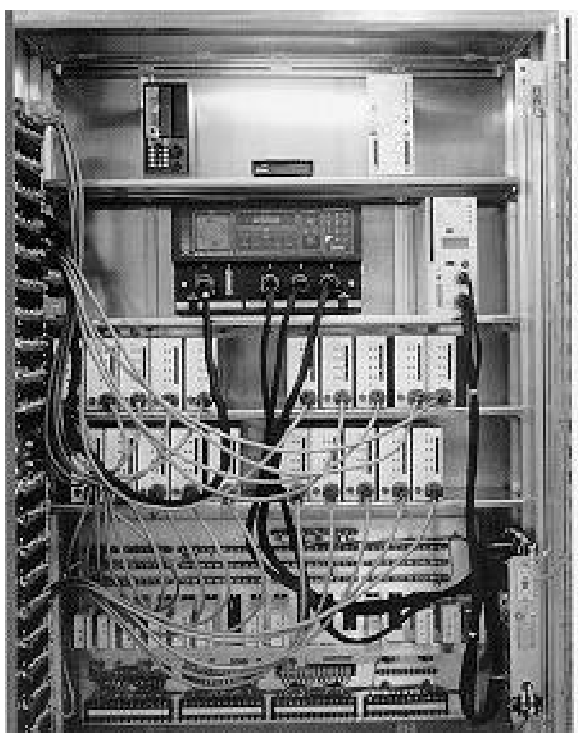

Figure 1. NEMA Cabinet and Controller

The second major topic was signal timing design. This effort was spearheaded by ATSAC and UCI. First, the collection and inventory of traffic data was discussed in class. A pre-study was conducted and is to be the basis of comparison with the final signal timing designs from the students. The network site consisted of 21 intersections in the heart of Los Angeles as seen in Figure 2. This network was bounded by Washington and Exposition Boulevards in the North and South direction, and Vermont and Normandie in the East and West directions. Each signalized intersection was evaluated independently and the signal timing was based on local optima.

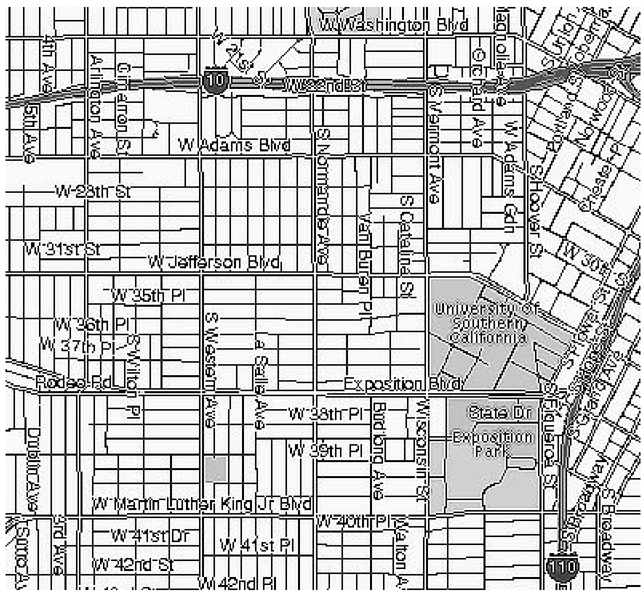

Figure 2. City of Los Angeles Field Site

The third topic is a continuation of the second topic and involves the coordination of multiple intersections. This process requires extensive use of traffic control simulation/optimization software. The Highway Capacity Software was utilized for determining the level-of-service of the existing intersections and to evaluate intersection performance under different traffic flow conditions. PASSER II and Transyt-7F software packages were utilized to optimize and coordinate the signal timings of the intersections in the network. TSPLOT was used to represent graphically the green bands and to evaluate the progression of traffic platoons. The laboratory projects were preformed both inside the UCI Traffic Control Laboratory and in the field. The students first had the opportunity to practice on traffic control equipment in a laboratory setting. Three full traffic control cabinets were used for different hardware and signal timing exercises. After the students completed and simulated their signal designs on software, their signal plans were implemented in the field site. The ATSAC staff supervised the students in the field and made sure that the changes complied with city safety standards and conventions. Floating car studies were conducted to determine delays throughout the network. The results were very successful when compared with the pre-study.

The last topic was a discussion of special events management headed by the City of Anaheim TMC and UCI. Figure 3 shows the Anaheim field site which consists of amusement parks, sport facilities, entertainment centers, and convention facilities. The design components presented were the formulation of Variable Message Signs (VMS), the recording of Highway Advisory Radio (HAR) instructions, the coordination with local police enforcement, and the incremental signal modifications using the Urban Traffic Control System (UTCS).

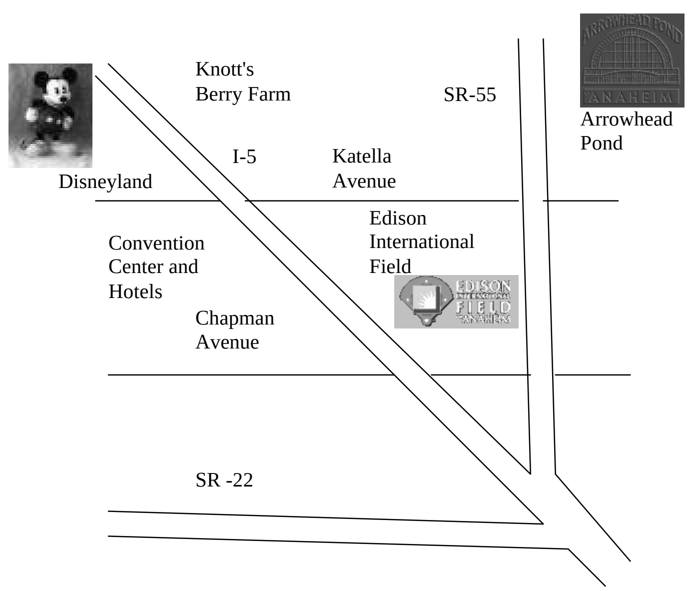

Figure 4. City of Anaheim Special Events

Student Feedback

A survey was conducted at the end of the course and the results were very positive. The list of questions was extensive in order to paint a complete picture of the course experience. The following three questions were particularly important:

1. Did integration of material among the three cities provide a broad picture, and was it effective?
2. Should the team concept of professionals and professors be tried more often?
3. Did field trips complement theory with real-world engineering practice?

The responses from these three questions are shown in Figure 5. It can be seem that the majority of the students agreed with the OAK-TREE approach and valued the academic/public sector partnership. These results show that such a course involving academic/public sector partnerships is accepted by students. The different types of institutions contributed different aspects to the learning experience of the students. The students received instruction in fundamentals of traffic control and were able to see the traffic theory realized in real-world environments. The theoretical and the practical aspects of the course complemented each other and gave the students a more complete picture of the traffic control design process.

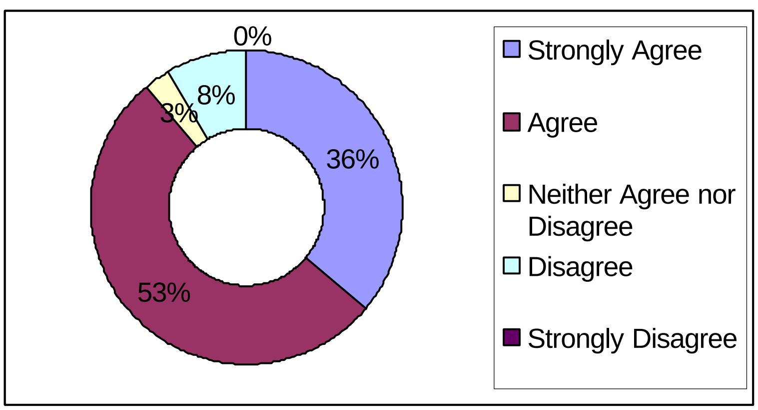

Figure 5 (a). Response to Question 1

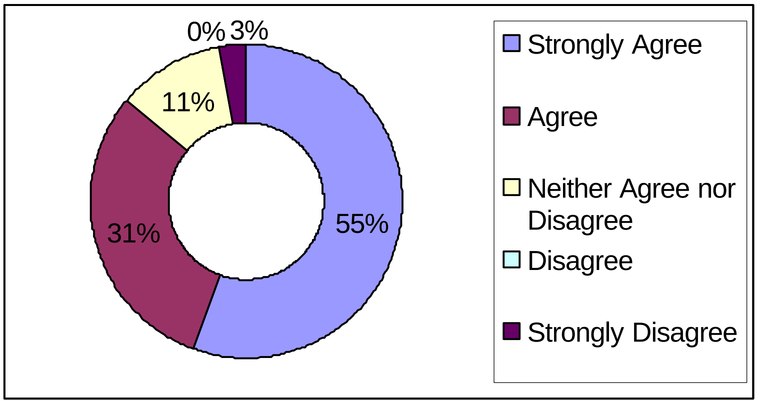

Figure 5 (b). Response to Question 2

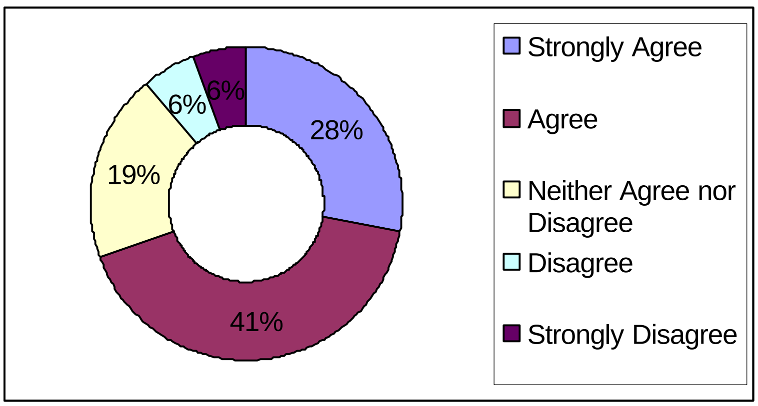

Figure 5 (c). Response to Question 3

Figure 5. Course Survey Results

Future Directions and Rowan Implementation

Despite the successful result from the two-year implementation of OAK-TREE, there are many areas that can be improved in this course. The Rowan University implementation seeks to address previous deficiencies from the outset. One problem that was encountered was the class size. In the two years that this course was offered, the enrollment was approximately fifty students per section. This class size translated into large project teams of greater than five persons per team. The large team size stretched the laboratory resources, and led to uneven distribution of work among team members. The proposed Rowan implementation would involve class sizes of 15-20 students and small project teams of less than five persons per team.

Another area of improvement that is needed is the upgrade of computing equipment and lecture facility. This will not be an issue at Rowan University because of the adequate computer facilities. The college of engineering has several "smart classrooms" that are equipped with various multi-media capabilities. These facilities will be able facilitate computer software instruction.

The last area that needs to be addressed is to improve the coordination among the various agencies. This is often a source of difficulty with any team taught efforts, and was especially difficult in this case since the course had to be accommodating to the work schedules of traffic engineering professionals. There are several possibilities for improving coordination. First, more effort can be expended on planning the course and the development of a course packet instead of using separate handouts for each sub-topic. Another possibility is to make such topics more independent so that they could be re-scheduled based on professional work schedules.

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References

1. Lipinski, M.E., and Wilson, E.M. Undergraduate Transportation Education - Who Is Responsible. *ITE Journal*, Vol. 63, No. 8, Aug. 1993, pp. 29-32.
2. L.J. Pignataro. Cooperative Education for Transportation Engineering Students. *ITE Journal*, Institute of Transportation Engineers. 1992 Oct, V62 N10:31-34.