Development of a Traffic Management Center-
Intelligent Transportation Systems Lab

By
Daniel S. Turner
Professor of Civil Engineering and
Director of UTCA
Department of Civil and Environmental Engineering
The University of Alabama
Tuscaloosa, Alabama

University Transportation Center for Alabama
The University of Alabama, The University of Alabama at Birmingham, and
The University of Alabama in Huntsville

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November 30, 2005
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<td>This project designed, prepared, installed and pilot tested a Traffic Management Center/ Intelligent Transportation Systems (TMC/ITS) lab for Shelby Hall, on the University of Alabama (UA) campus. This was a Phase I installation that provided six workstations capable of accommodating 12 students in an educational mode, and six students in a research mode. Future stages of development will include advanced ITS research and implementation capabilities as the lab expands into adjacent space, and virtual operation so that the traffic management lab can be operated by faculty members and students at the University of Alabama at Birmingham and the University of Alabama in Huntsville, and by students in Civil Engineering classes outside of the University of Alabama System. The University partnered with the Tuscaloosa Department of Transportation (TDOT) in developing the lab. TDOT allowed the lab to operate as a satellite of the TDOT TMC, with identical hardware, and using TDOT software, command and control features and signals. In addition, faculty and students using the new TMC/ITS lab can acquire and display images from TDOT’s extensive system of pan-tilt-zoom traffic cameras, acquire data from TDOT sensors, view displays and other information from traffic signal control cabinets, and otherwise replicate an operating traffic management center. In recognition of TDOT’s generosity, UA will provide research results to TDOT as appropriate, will focus student lab exercises on traffic situations of concern to TDOT, and will serve as a backup emergency operations center in case of catastrophic loss of the current TDOT traffic management facilities.</td>
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Executive Summary

This project designed, prepared, installed and pilot tested a Traffic Management Center/Intelligent Transportation Systems (TMC/ITS) lab for Shelby Hall, on the University of Alabama (UA) campus. This was a Phase I installation that provided six workstations capable of accommodating 12 students in an educational mode, and six students in a research mode. Future stages of development will include advanced ITS research and implementation capabilities as the lab expands into adjacent space, and virtual operation so that the traffic management lab can be operated by faculty members and students at the University of Alabama at Birmingham and the University of Alabama in Huntsville, and by students in Civil Engineering classes outside of the University of Alabama System.

The University partnered with the Tuscaloosa Department of Transportation (TDOT) in developing the lab. TDOT allowed the lab to operate as a satellite of the TDOT TMC, with identical hardware, and using TDOT software, command and control features and signals. In addition, faculty and students using the new TMC/ITS lab can acquire and display images from TDOT’s extensive system of pan-tilt-zoom traffic cameras, acquire data from TDOT sensors, view displays and other information from traffic signal control cabinets, and otherwise replicate an operating traffic management center.

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Section 1
Introduction

This project designed, prepared, installed and pilot tested a Traffic Management Center/Intelligent Transportation Systems (TMC/ITS) lab for Shelby Hall, on the University of Alabama (UA) campus. This was a Phase I installation that provided six workstations capable of accommodating 12 students in an educational mode, and six students in a research mode. Future stages of development will include advanced ITS research and implementation capabilities as the lab expands into adjacent space, and virtual operation so that the TMC lab can be operated by faculty members and students at the University of Alabama at Birmingham (UAB) and the University of Alabama in Huntsville (UAH), and by students in Civil Engineering classes outside of the University of Alabama System.

This report documents the planning design, preparation, installation and pilot testing of the lab. Section 2 outlines why TMC and ITS will be very important to the transportation future of the state. Section 3 outlines lab planning through installation, and Section 4 discusses the capabilities of the Phase I installation from the viewpoints of education, research and technology transfer. The figures and photographs in the Appendix provide additional insight into the lab.
Section 2
Need for the Lab

Anticipated Changes in Transportation in Alabama

Roadway travel is the dominate mode in Alabama, where one person per vehicle is the norm. Our state’s citizens are among the most mobile in the nation, and have come to expect that they can drive wherever they want, whenever they want, for whatever they want. Few other nations in the world provide such flexibility for their driving citizens.

The Alabama Department of Transportation (ALDOT) has provided an excellent system of Interstate highways and state routes. In addition the county road system is extensive, with one of the highest ratios of miles/person in the southeast. The availability of such a large roadway systems and the relatively inexpensive cost of vehicles and fuel have provided a very high level of mobility to Alabamians and has encouraged individual travel in personal vehicles.

But the “good times” appear to be coming to an end. The cost of fuel is now restricting travel for many individuals, with some electing not to take optional trips or to downsize their vehicles to save fuel costs. Additionally, congestion and delays are growing in larger urban areas. The reality is that Alabamians have absorbed the excess capacity on many roadways by traveling one person per vehicle, so that increases in congestion and crashes are inevitable. This is illustrated by Figure 2-1, which shows that between 1981 and 2001 vehicle travel increased over 100% and the number of registered vehicles increased over 40%. However, ALDOT was able to build only about 6% more miles of highway.

![Alabama Growth Rates](image.png)

Figure 2-1: Mobility growth trends for Alabama over 20 years
It is clear that the demand for travel will continue to outstrip the availability of highways in the future. This demand can be served by capping the number of annual vehicle miles driven (not likely because Alabamians are used to traveling anywhere they desire), changing modes to higher occupancy vehicles like busses, taxis, and carpools (not likely because Alabamians are used to their individual vehicles), accelerating the highway building program (not likely due to the required lengthy public input process and the high cost of roadway construction), or operating the highway system more efficiently.

The fourth option, improved traffic operations, is the only one that offers promise of accommodating more travel efficiently and safely. But to accomplish improved operations will require education of a generation of designers and operators who understand traffic flow theory and optimization of traffic operations. There will also be a big need for ITS facilities to help optimize traffic flow.

This lab can provide part of the fourth option, by educating tomorrow’s transportation professionals, upgrading skills of existing designers/operators through technology transfer, and as an integral piece in improving traffic operations and safety, incorporating a higher degree of ITS, and improving the transportation future of Alabama.

Support for Transportation Education

Transportation faculty members at UA, UAB and UAH designed a two-year curriculum of rotating courses, which are taught via the Intercampus Interactive Television System in real time. The courses are taught jointly to undergraduate and graduate students. Two of those courses require extensive lab experience in simulation and traffic control techniques. This project developed the laboratory for those courses, in consultation with UAB and UAH faculty members, and practicing transportation engineers.

TDOT has been very supportive of the University Transportation Center for Alabama (UTCA) and its programs. The TDOT Director has hosted field trips to his TMC for the multi-campus ITS class. He suggested that UTCA add an ITS laboratory, and offered (1) to run fiber optic cable to the UA campus, (2) to freely share all real-time traffic data that his organization collects daily, and (3) to allow lab students to control traffic cameras and other data collection devices (as long as they did so under the direction of a professor).

In addition to TDOT interest, transportation faculty members have received encouragement to develop the lab from the Greater Birmingham Regional Planning Commission (which has provided funding for student projects in the past) and the ALDOT.
Section 3
Planning, Design and Installation of the Lab

Planning of the lab began during the design of Shelby Hall, a 200,000 square foot complex dedicated to interdisciplinary research. Four transportation research centers were assigned a lab bay, office space and graduate space in the facility, and two 800 square foot laboratories in the transportation wing were dedicated to TMC/ITS development. The project architect worked with UTCA to configure the labs with a high degree of network connectivity and a fiber optic feed from the University’s central computing offices.

In anticipation of construction of Shelby Hall, TDOT laid fiber optic cable two miles, from its TMC to the University’s computing center. At this point, preparation ceased until Shelby Hall construction was completed and UTCA had relocated its administrative offices to the new building.

Planning

Preliminary planning of the lab got underway in the fall of 2004, with meetings at TDOT and ALDOT, and with discussions between faculty members at UA, UAB, UAH and Auburn University. The Principal Investigator visited two academic institutions that were well known for their ITS labs, to identify capabilities and trends in ITS education and research. In 2005, UTCA engaged a civil engineering alumnus of UA, Selvin Greene, to design and install Phase I of the TMC/ITS lab. Mr. Greene is employed by an engineering consulting firm and is highly respected as one of the leading ITS experts in the state.

Preliminary Design

Mr. Greene met with managers of UTCA, TDOT, UA Telecommunications, College of Engineering IT and other groups. These discussions framed the major issues and began to define Phase I capabilities, which would duplicate TDOT’s traffic management center. All parties agreed that TDOT would provide its software, access to cameras and data, and technical assistance as needed. UA agreed to fund lab equipment, lab renovations, security and other incidentals.

All parties were sensitive to security, since any compromise of the TDOT system could be reflected in traffic flow, and could potentially have traffic safety implications. UA agreed that its satellite operations would be independent of any UA network to minimize the possibility of computer viruses, that all lab operators and students would be trained in security and would sign the standard UA policy statement pledging compliance with UA computing policies, and that the lab would be secured with a card access system that tracked individual users.

All parties agreed that the preliminary design should replicate TDOT equipment and software, while remaining flexible enough to allow future expansion in size, scope and complexity. At this
point, Mr. Greene delivered the preliminary design, which was approved by all applicable authorities.

**Design**

The preliminary design established the scope of Phase I operations, and identified the equipment types needed for operation. The design phase consisted of further technical investigations, specifying individual pieces of equipment, and further defining of how the lab would be used in Phase I. At the same time, arrangements were made for renovations to the lab room and installation of networking, data and fiber optic lines.

The preliminary layout of the lab is shown in the Appendix as Figure A-2, and a preliminary guide for the type of work station is shown in Figure A-3. Both of these were intended to serve as guides during final design and development of the facility. Mr. Greene, TDOT managers and technicians, City IT managers, and UA IT managers worked to ensure that all aspects of the lab would function as intended. At this point Mr. Greene developed final equipment specifications, and individual items were ordered by UTCA.

**Agreement**

The City of Tuscaloosa and UA developed a formal agreement defining the responsibilities and rights of both parties. It included provisions for establishing the facility, security, computer and software access, network connections, ownership and maintenance of equipment, use of the UA lab as an emergency backup center for TDOT, and other management items. TDOT and UTCA managers initiated the document, which was coordinated with managers, IT personnel and approval authorities prior to final crafting by attorneys. Both parties were delighted with the final agreement.

**Installation**

In November, UA completed the renovation of the lab and installation of all support cables. Mr. Green, UA technicians and TDOT technicians installed and tested the equipment over a two week period. On December 7, 2005 the Phase I lab became operational and its first official activity was a demonstration to members of the UTCA Advisory Board. The first instructional use was a laboratory conducted by three groups of CE 350 – Transportation Engineering students on December 9, 2005.
Section 4
Lab Capabilities and Future Expansions

Current Lab Capabilities

The completed Phase I lab will be used for four main purposes:

- **CE 350 Lab (undergraduate transportation course)** – This will be a fun demonstration of video cameras, data collection, Autoscope use, signal timing, ITS sign control, etc. There will be one simulation demonstration, and one or two lab exercises so that students can do manual data reduction from display screens, followed by a capacity or signal timing exercise.
- **Graduate Course** – There are many options here, including data collection by various sensors, data reduction, and ITS/HCM/traffic operations labs and projects. This can also breed many MS thesis projects.
- **Faculty and Graduate Student Research** – It is anticipated that faculty and students will immediately begin applied research on Alabama traffic management situations and ITS applications.

The phase I implementation is being assisted by a project funded by the Department of Civil & Environmental Engineering. Dr. Steven Jones will be the Principal Investigator for this effort, which will develop and pilot test teaching modules, laboratory exercises and other instructional materials.

Potential Future Capabilities

It is anticipated that the lab will change rapidly as additional functions are undertaken, and as additional hardware and software become available. Potential future phases including the following activities:

- Take the lab online for access by UAB, UAH and Auburn University.
- Implement additional educational opportunities, in the form of online classes, labs and technology transfer opportunities.
- Acquire more real time data from other cities and ALDOT.
- Add ITS development and implementation actions, and as these activities increase expand the lab into adjacent lab space.
- Become the state’s right arm for all ITS activities.
- Install traffic video cameras on the UA campus, with live feed to the ITS lab.
- Obtain other data types (ITS system, traffic signal cabinets, etc.)
- Investigate the West Alabama Regional Commission as a potential repository for TDOT traffic data. That would allow transportation specialists at the Council to use the data to calibrate transportation models, etc. That would also provide an unlimited data source for ALDOT/MPO research for faculty and graduate students.
- It is anticipated than many additional opportunities will arise as the lab develops.
Conclusion

This project successfully developed a versatile traffic management center/ITS lab for education, research and technology transfer purposes. It is a satellite of the TDOT traffic management center, and thus uses real data from real traffic cameras and sensors. Students can acquire and manipulate data, and immediately feed the data to modern engineering software for optimization, modeling and display purposes. The lab has been designed to accommodate a wide range of future activities, as traffic control changes and as new software and hardware become available. It is anticipated that the lab will develop rapidly as faculty and graduate student research activities are initiated.

The University is grateful for the skills and efforts of the designer, Mr. Selvin Greene, to the managers of the Tuscaloosa Department of Transportation for encouragement and for sharing their TMC, and to the many individuals who participated in the planning, design, installation and pilot testing.
Appendix

Lab Photographs and Drawings

Figure A-1: Space prior to lab renovation
Figure A-2: Preliminary lab conceptual drawing
Figure A-3: Workstation design selected during preliminary design
Figure A-4: Workstation as developed
Figure A-5: Workstation screen, typical view
Figure A-6: Completed phase I lab
Figure A-7: Completed phase I lab, first lab session, December 2005
Figure A-1: Lab space prior to renovation
Figure A-2: Preliminary lab conceptual drawing

New storage

Traffic camera views projected onto wall

Existing GRA window

GRA office

Table with printer

Plotter

Six work stations with a computer and two displays each

Three extra tables

Approx location, equip. rack and fiber termination

Three extra tables

Entrance to L205 to become card access
Figure A-3: Model workstation selected during preliminary design
Figure A-4: Workstations as developed
Figure A-5: Workstation screen, typical view
Figure A-6: Completed phase I lab
Figure A-7: Completed phase 1 lab, first lab session, December 2005