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Organization and Structure of Traffic Management Centers: Two Case Studies in Michigan

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16. Abstract

This report describes two traffic management centers (TMCs) in the state of Michigan: (1) the Michigan Department of Transportation (MDOT) center, which monitors the expressways in the greater Detroit area and (2) the Oakland County Road Commission center, which monitors the surface streets for the northern Detroit suburbs. The MDOT center consists of two systems: (1) a legacy system of cameras, changeable message signs, loop detectors, and ramp meters on 32 miles of downtown freeways and (2) a newer system of cameras, signs, and loop detectors to expand coverage to 180 miles of freeways. MDOT's goal is to assist in responding to incidents and to communicate traffic information to the public. Since alerts to most incidents occur via 911 calls, a key feature is the collocation of the state police 911 dispatch officers in the TMC allowing the state police access to the MDOT cameras and information. At the time of the interviews, the center was staffed 12 hours per day on weekdays only, though as of December, 1998, it is currently being staffed 24/7.

The Oakland center is fairly new and was originally constructed for incident management. However, with a limited number of cameras and so many miles of surface streets, the role of the center shifted to planning and coordination, so there are no operators in the control center. The center's current tasks include tracking all road repairs, planning for traffic signal timings for major events (at a sports arena complex), and coordinating with government agencies such as the local police. The Oakland center has an extensive network of video-based sensors for monitoring traffic and optimizing the timing of traffic lights; however, that video is not available in the traffic center. The center is planning to add a few cameras for incident monitoring around the sports complex for operation and use mainly by the local police.

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1 Project Overview: The Design of Traffic Management Centers

- **Report 1**: Reviews the current literature and research on human factors considerations in traffic management centers (TMCs) and identifies future research needs (Nowakowski, Green, and Kojima, 1999).
- **Report 2**: Examines two local TMCs in order to obtain a better understanding of the practical problems of TMC design (this report).
- **Report 3**: Develops human factors guidelines for TMC website design.

2 Topics

Topics examined in this report for TMCs in Detroit, Michigan, and Oakland County:

- *Each center's layout, structure, and operation*
- *Practical and human factors issues in the two centers*
- *Differences between actual system problems experienced by the TMCs and problems described in the literature*

3 Detroit TMC Findings

Interviews with operators revealed that their goals were consistent with goals of an ideal TMC identified in the Georgia Tech TMC Design Guidelines (1993).

- 5 objectives of an ideal TMC are:
  - *Maximize the available capacity of the area-wide roadway system.*
  - *Minimize the impact of roadway incidents (crashes, stalls, and debris).*
  - *Contribute to the regulation of demand.*
  - *Assist in the provision of emergency services.*
  - *Create and maintain public confidence in the TMC.*
- MDOT's primary goal: Assist in incident response and communicating traffic information to the public

Detroit TMC Summary		
Characteristic	Preexpansion	Postexpansion
Miles of Freeway	32.5	170.5
TV Monitors	24	24
CCTVs	11	149
CMS	14	57
Ramp Meters	49	59
Loop Detectors	1,240	2,400
HAR Transmitters	0	12
Staffing	12 hr weekdays	24 hrs all days

Features of the Detroit TMC		
Data Collection	Data Processing	Information Dissemination
• Cameras and loop detectors are used to monitor traffic. • CCTVs are used to visually confirm traffic. • Motorist Aid Telephones were removed in 1991.	• A 3-panel video wall with 24 monitors and nine 41-inch projectors is in the control room. • A U-shaped desk faces the wall and houses workstations.	• CMSs, HAR, and the internet are used to relay traffic information. • Major incident reports provided to TV/Radio at no cost.

4 Oakland County TMC Findings

- Primarily concentrated on traffic management and traffic planning
- Manages the FAST-TRAC operational field test

Features of the Oakland County TMC		
Data Collection	Data Processing	Information Dissemination
• 288 Autoscope cameras and 3 CCTVs are used to monitor traffic on 2,700 miles of road. • Automatic operation (not staffed)	• A 3-panel video wall with 12 monitors and nine 31-inch projectors is in the control room. • A desk faces the wall and houses 4 Windows PC workstations.	• Traffic information is relayed to the public through faxes sent to MetroNetwork stations. • A fully functional website is currently being developed.

5 Recommendations and Observations

Recommendation	Benefit
• Collocate police and traffic management personnel • Take advantage of central control of signal timing • Distribute the Georgia Tech Guidelines for TMC design	• Dramatically increase incident response • Increase traffic flow and decrease labor costs • Compensate for low human factors awareness in TMC design
Observations	
• Expansion upon older systems can create compatibility issues between software. • Interest in the commercial potential of TMCs is growing. • The internet can be a valuable resource for traffic information.	

6 References

Georgia Tech Research Institute (1998). *Human Factors Handbook for Advanced Traffic Management Center Design* (2nd ed.). Washington, D.C.: U.S. Department of Transportation, Federal Highway Administration.

Nowakowski, C., Green, P., and Kojima, M. (1999). *Human Factors in Traffic Management Centers: A Literature Review* (Technical Report 99-5). Ann Arbor, MI, The University of Michigan Transportation Research Institute.

PREFACE

This report is one of several being written by the University of Michigan Transportation Research Institute (UMTRI) to assist Matsushita Communication Industrial Co., Ltd. in designing easy-to-use traffic management centers (TMCs). The focus of this project was originally on the development of human factors guidelines for those centers.

In the first phase of the project, the literature on human factors and TMCs was reviewed (Nowakowski, Green, and Kojima, 1999). The review highlighted the value of the first edition (Kelly, 1995) of the Georgia Tech human factors guidelines. The second edition (Georgia Tech Research Institute, 1998) has recently been released, but UMTRI has not compared the two editions to determine the differences.

In the second phase of this project (this report) two local TMCs were examined in detail: (1) the Michigan Department of Transportation (MDOT) control center for the freeways in the Detroit area and (2) a center operated by the Road Commission of Oakland County just north of Detroit. Interviews were conducted at both centers, and we would like to thank Tom Mullin and Ray Klucens of MDOT and Gary Piotrowicz of the Road Commission for Oakland County for their time and efforts to make the interviews possible. These examinations provided a basis for understanding the practical problems of TMC design.

The original plan called for (1) conducting field interviews with operators at other TMCs, (2) videotaping and analyzing operations at MDOT and elsewhere, and (3) prototyping a mock system and developing additional design guidelines for TMCs. However, scrutiny of the existing guidelines indicated they were fairly complete and gains from developing additional general purpose guidelines would be small. That conclusion reduced the need for a detailed examination of general TMC operations.

Since this project began there has been an explosive growth of the use of the World Wide Web as a mechanism for the disseminating traffic information. Although there are numerous guidelines for web design, none are specific to traffic data. Accordingly, the final stages of the project are shifting towards traffic-information web sites (Nowakowski, Lenneman, Kojima, and Green, 1999).

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INTRODUCTION

Background

Two traffic management centers (TMCs) were examined as part of a project to study human factors issues pertaining to TMC control room design. The examination consisted of an informal interview with an operations engineer at each facility and observation of the control room at each facility for about an hour. The first center examined was the Michigan Intelligent Transportation Systems Center (MITSC) managed by the Michigan Department of Transportation (MDOT). At the time of this project, MITSC monitored 180 miles of freeways in the greater Detroit Area. The second center examined was that of the Road Commission of Oakland County (RCOC), a county-managed facility located in a suburb just north of Detroit. The RCOC center was developed as part of the Faster and Safer Travel through Traffic Routing and Advanced Control (FAST-TRAC) project, one of the first operational field tests of Intelligent Transportation Systems (ITS) in the United States. More than 1,000 signals on 2,600 miles of arterial roads are maintained by the RCOC.

Purpose

The purposes of the interviews were as follows:

1. To provide a detailed description of each system's traffic center layout, system structure, and operation.

2. To identify critical issues including key human factors issues encountered by two real TMCs.

3. To determine the difference between the actual system problems experienced by TMCs and the problems described in the literature.

MICHIGAN INTELLIGENT TRANSPORTATION SYSTEMS CENTER (MITSC)

Background

Interviews Conducted

Mr. Tom Mullin, the MDOT ITS engineer for the Metropolitan Transportation Center, and Mr. Ray Klucens, MDOT operations engineer for that center, were interviewed on September 18, 1998, and again on February 25, 1999. Mr. Mullin is responsible for the operation, maintenance, and development of the center. He has been working at MDOT since 1991.

Mr. Klucens is responsible for the daily operation of the center and was the MDOT representative on the task force responsible for system integration during the recent system upgrade and expansion. He was also one of the designers of the legacy system (preexpansion) used to monitor the initial 32 miles of freeway in downtown Detroit. He was able to provide both a designer's and a user's perspective, a unique combination of occasionally conflicting perspectives.

Other than brief conversations and demonstrations, there were no discussions at the MDOT site with either operators or other management.

History of the MITSC System

Remote freeway surveillance began in Detroit in 1955 under the Freeway Traffic Surveillance and Control Research Project. In 1965, an experimental control system was initiated with the installation of digital computers and closed circuit television (CCTV) cameras. In 1976, the Freeway Traffic Surveillance and Control Research Project was renamed to the Surveillance Control and Driver Information Operation (SCANDI). The first implementation of SCANDI included 4 CCTV cameras, 9 changeable message signs (CMS), 70 motorist aid telephones, 6 ramp meters, and loop detectors along 14 miles of freeway. In 1987, SCANDI was expanded to encompass 32 miles on 4 freeways with the addition of 42 more ramp meters. In 1991 the SCANDI activity was relocated to the new city bus terminal and renamed to the Michigan Intelligent Transportation Systems Center (MITSC). In April 1997, the Michigan State Police Second Regional Dispatch Center (MSPSRDC) moved to be collocated with MITSC. The dispatch officers could then view freeway incidents using the MITSC cameras and monitors, and the MITSC operators were instantly able to see incidents reported via cell phone to the dispatch center. In particular, the teaming of one dispatcher responsible for a particular section of the freeway system with the TMC operator and collocating them has proven to be a wise decision. This cooperation between the MITSC and the state police greatly improved traffic incident management.

The current expansion of MITSC (funded by the ATMS/ATIS Deployment Project) will add 148 miles of freeways to the existing 32 miles for a total of over 180 miles of freeway in the metropolitan Detroit area. The additional infrastructure needed to monitor the new area will include 142 CCTV cameras (for a total of 156), 43 new

CMS's (for a total of 57), 11 ramp meters (for a total of 59), 12 highway advisory radio (HAR) transmitters, and about 1,160 loop detectors (for a total of 2,400).

As of May 1998, the MITSC included 24 television monitors, 13 CCTV cameras, 14 CMS's, 48 ramp meters, 12 HAR transmitters, and 2,400 loop vehicle detectors. In 1999, the control room operations of MITSC were transferred at no cost to SmartRoute Systems (http://www.smatrraveler.com), a private company which provides real-time traffic information on the web for several major cities. In exchange, SmartRoute received free and exclusive access to MITSC's real-time data.

MITSC's Goals

According to Folds, Stocks, Fain, Countney, and Blankenship (1993), the primary goals of an ideal TMC are as follows:

- Maximize the available capacity of the roadway system
- Minimize the impact of roadway incidents (accidents, stalls, and debris)
- Contribute to the regulation of demand
- Assist in the provision of emergency services
- Create and maintain public confidence in the TMC

The interview with MITSC's operations engineer verified that MITSC's goals were consistent with the goals listed above. With the exception of ramp metering, MITSC cannot control traffic flow. Any further control of traffic flow is deemed the responsibility and jurisdiction of the state police.

The purpose for MITSC has not changed since its establishment. However, as electronics (such as computers, networks, mobile phones, and in-vehicle devices) have continued to evolve, the methods used to achieve the goals have changed. For example, as use of mobile phones becomes greater, so has the number of phoned-in incident reports. The widespread use of mobile phones has facilitated the detection and location of incidents by the TMC. The CCTV cameras have also allowed operators to more quickly confirm and pinpoint the exact location and nature of an incident. Furthermore, the TMC can provide incident information to the general public through CMSs, highway advisory radios (HARs), and a real-time traffic web site.

Currently, drivers can easily plan a trip based on real-time traffic and weather information on the Internet, as well as receive updated information enroute through the CMSs and HARs. In the future, technologies may bring these current services directly from the TMC to an in-vehicle driver information systems, and new services, such as parking availability, may also be added.

MITSC System Overview

Table 1 lists the key features of the MITSC system, and Figure 1 depicts the area covered by the MITSC. The system consists of three logical parts: data collection, information dissemination, and operations (data processing). Details of each are described in the following sections.

Table 1. MITSC system features.

Feature	Current System	Comments
Control room	3 operator workstations 3x3 41-inch monitor array 28 20.5-inch monitors	Located in downtown Detroit, Michigan
Monitored freeways	180 miles total 32 legacy system miles 148 new system miles	I-94, I-75, I-275, I-375, I-96, I-696, M-39, M-10, M-59 (Interstate, I, and US designated roads are national roads, and M designated roads are state of Michigan roads.)
Loop detectors	2400 total loop detectors about 1240 are legacy about 1160 are new	Legacy loop detectors are spaced roughly every 1/3 of a mile, while the new loop detectors are spaced roughly every 2 miles.
Cameras	156 total 13 legacy system 142 new system	13 Cohu (color) legacy cameras The new system mounts 1 Sony (color) camera for day use and one Panasonic (b/w) for night use in the same housing; however, only one image is available at a time.
Metered ramps	59 total 48 legacy system 11 new system	
CMS	57 total 14 legacy system 43 new system	Each sign can display 3 rows of 20 characters of text. 14 signs are Vultron flipdisk 43 signs are Vultron fiberdisk
HAR	12	The HARs are installed at the major freeway interchanges and have about a 5 mile range.
Internet connections	1	SmartRoute will provide real time traffic information in the near future.
Cooperation	Michigan State Police RCOC SmartRoute	
System Integrator	Rockwell International Sperry Systems	(ATMS/ATIS deployment project) (SCANDI project)

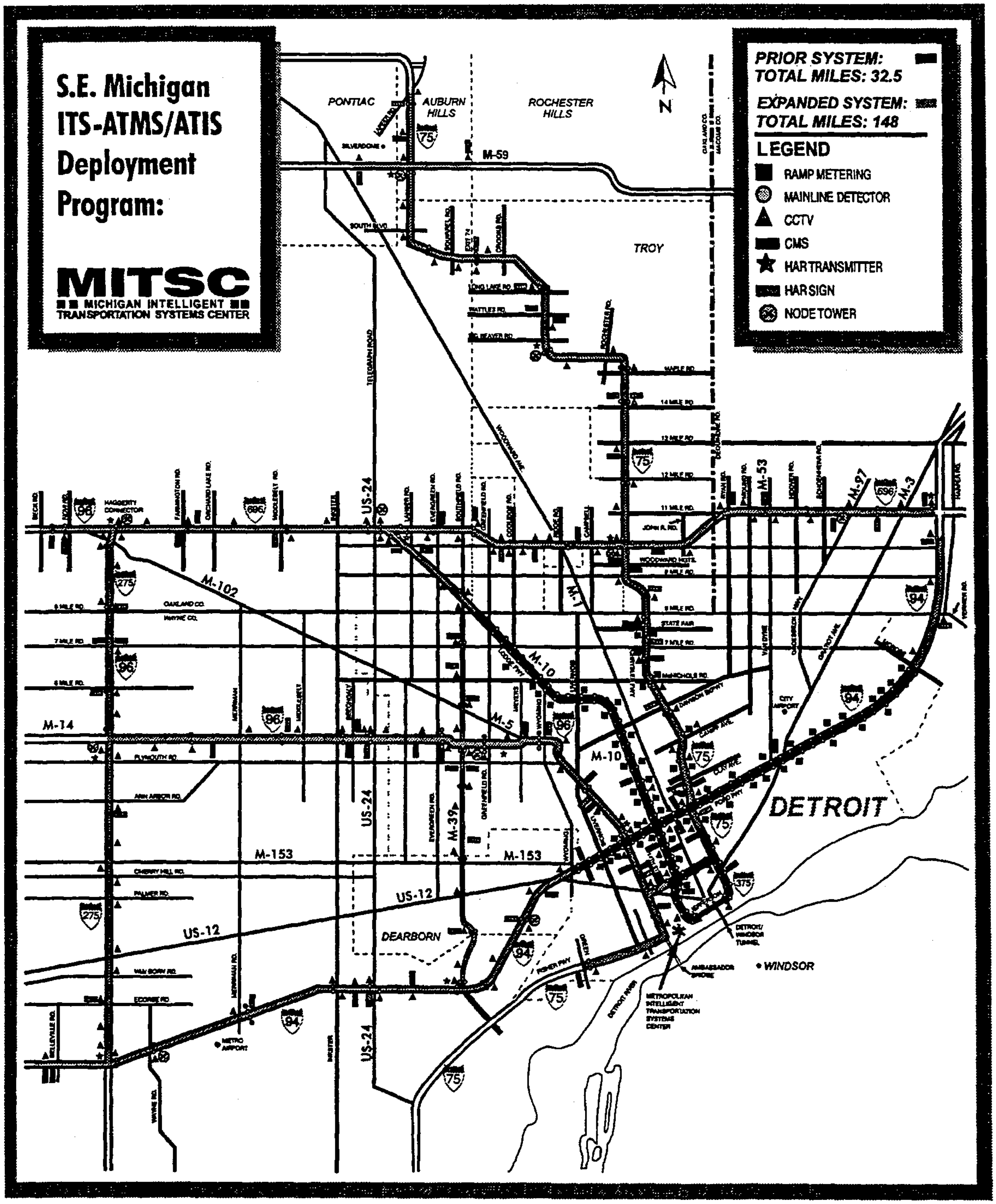

Figure 1. The area covered by MITSC.

MITSC Data Collection

Vehicle Detectors

MITSC uses both cameras and loop detectors to monitor traffic. Loop detectors are the primary sensors for determining traffic volume and occupancy. The loop detectors are installed in each lane every 1/3 mile and at each expressway exit and entrance in the original coverage area, and every 2 miles and at each interchange in the expanded area. For the 11 new ramp meters, detectors are installed approximately 1 mile apart. There is a mix of 2 and 4 channel detector oscillator units. The original detectors were manufactured by Canoga. The new ones were made by IDC.

Detector malfunctions are determined logically using equations that consist of entrance, exit, and main line detector data. The older system is much more centralized than the new system. The old system sends binary data to the operations center through remote communication unit (RCUs) every 10 milliseconds for processing (to calculate traffic volume and occupancy). In the newer system, volume and occupancy are computed by Matrix model 2070 controllers on the roadside and sent to the TMC every 20 seconds. Speed data is calculated with average vehicle length and occupancy. MITSC does not have any plans to install other detectors such as camera-based image processors (as used by FAST-TRAC), but MITSC plans to acquire 7 miles of road in Troy with 10 existing detector stations using both machine vision and loop detectors. Since the machine vision and loop detectors view the same area, MITSC will be able to evaluate the effectiveness of machine vision vehicle detectors.

CCTV Cameras

The main purpose of CCTV cameras is to verify incident information thus assisting in incident management. Currently installed on the freeways are 149 operator-controlled pan, zoom, and tilt cameras. Thirteen cameras are in the legacy system (manufactured by (Cohu) and 136 are in the expanded system (6 more cameras are planned under the current expansion). In the new system, a color camera (Sony) and a black-and-white camera (Panasonic) were mounted in the same housing. The color cameras are used in the daytime and black and white cameras at night when greater low light sensitivity is needed. Cameras are installed at 1/2-mile intervals in the legacy system and at 1-mile intervals in the expanded system. The installation standard was based upon the maximum camera range needed to cover the roadway and see the details of an incident (given the height of the mounting poles). The legacy system provided partial (25 percent) coverage of the freeways, while the expanded system provides 95 percent coverage. The cameras do not have the resolution to read license plates, except at very close distances.

Motorist Aid Telephones

Motorist aid telephones were previously installed on the Detroit area freeways but were removed in 1991 because they had deteriorated and their replacement was not cost effective. Mobile phones serve the same purpose since all mobile calls made in southeastern Michigan are connected to the five 911 (emergency phone) state police personnel in MITSC. Calls are most frequent during the rush hours.

MITSC Information Dissemination

Changeable Message Signs

The MITSC has 57 CMSs on the Detroit freeway network. Each sign can display 3 rows of 20 characters. Of the 57 signs, 14 Vultron flipdisk signs belong to the legacy system and 43 Vultron fiberdisk belong to the expanded system. To avoid operator mischief (e.g., posting birthday greetings that would be distracting to all motorists) and foster the use of consistently structured messages, the design relies on preprogrammed messages. There are about 45,000 stored messages for immediate access, which is short of the 50,000 to 60,000 messages needed. The supervisor can create additional messages, though the process to create a new message is much slower. Reportedly, only several hundred messages are used with some regularity. General messages referring to accidents or construction (such as "accident ahead, move left") are used most often. MDOT's policy is that if a sign is working, it presents some sort of guidance message such as "Livernois 1/2 Mi" all of the time to assure the public that the sign functions, but incident and traffic messages preempt these.

Highway Advisory Radio

Twelve HAR transmitters are installed at the major freeway interchanges in the Detroit metro area. The transmitters have a range of about a 5-mile radius. Each transmitter has a separate library of 40 prerecorded voice messages. There is no central library of messages. Since the library only contains 40 messages for each transmitter, the system is not very flexible. This occurred partly because there were no usability specifications for the interface. Currently, since the transfer of the control room operations from MDOT to SmartRoute, the HAR system has not been utilized due to SmartRoute's limited experience and understaffing. MDOT was currently considering dismantling the HAR system or purchasing new equipment to upgrade the system.

Ramp Metering

MITSC uses ramp metering at 59 locations, 48 in the legacy system and 11 in the new system. The ramps on I-94 are controlled manually, while ramps on M-10 (Lodge Freeway) are slightly newer and can have computer-controlled programs for different date and time blocks. The purpose of the ramp metering system is to use ramp signals to space out traffic by providing 100-to-200 foot gaps between entering vehicles.

Internet

The MITSC web site home page (http://www.mdot.state.mi.us/mits) provides access to the real-time traffic information for the downtown (legacy system) Detroit freeways. (See Figure 2.) At the time of this report, the MITSC home page also provided links to other Michigan and U.S. travel and weather web sites (including RCOC's traffic information web site, http://www.rcoc.org), as well as information about the Michigan ITS program. (See Table 2.) From the MITSC home page, clicking on the map of Detroit or the link to Detroit Freeway Conditions caused the overview map of the legacy system (with real-time color coding) to appear. (See Figure 3.) From the overview map, clicking on the location of a freeway interchange provided even more overview map, clicking on the location of a freeway interchange provided even more detailed real-time information on the current status of that interchange and the current messages displayed on the CMSs at that interchange. (See Figure 4.) The MITSC web site did not provide information about the expanded system, CCTV camera images, or ramp-meter information.

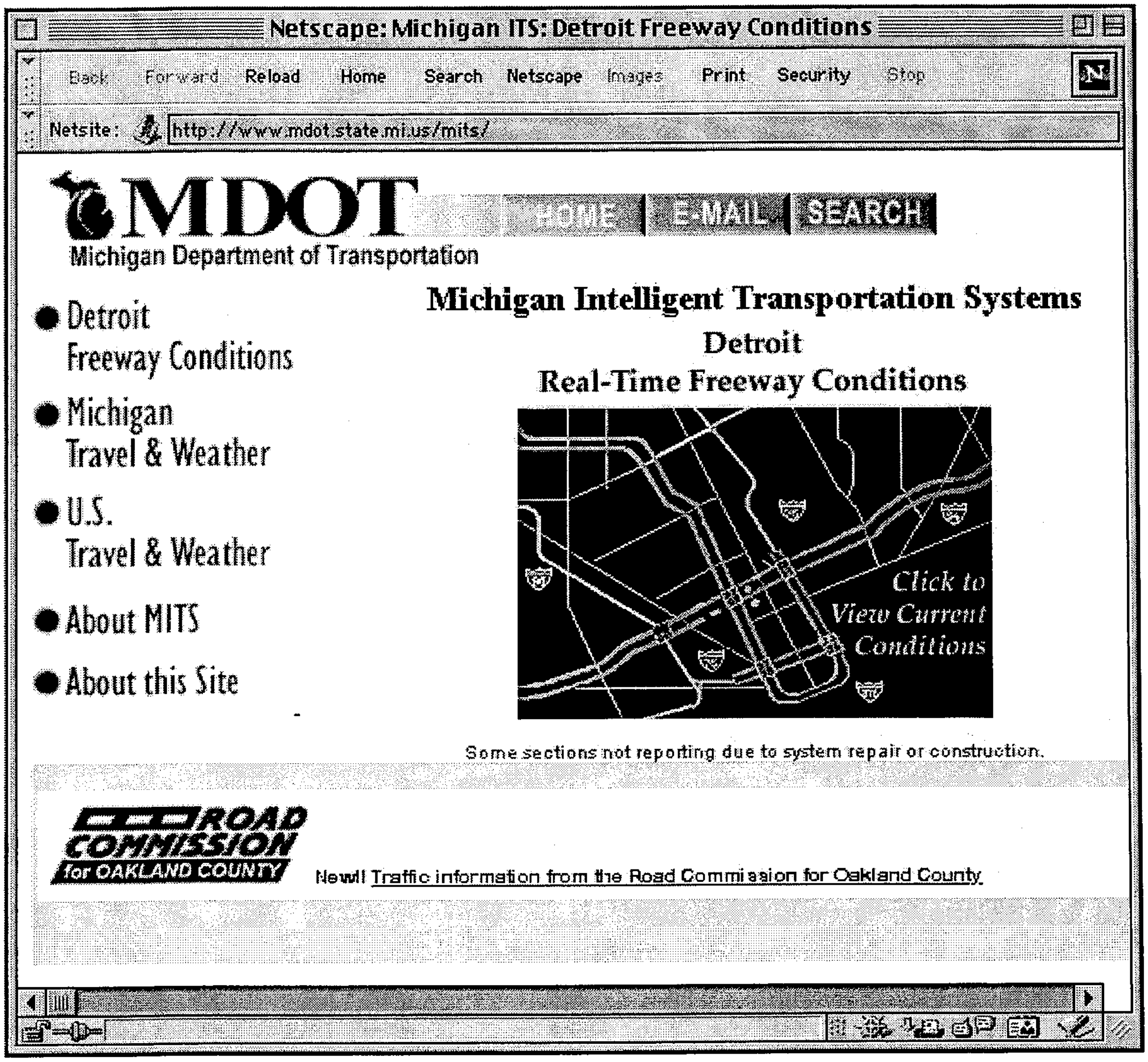

Figure 2. MITSC home page.

Table 2. MITSC web site sections.

Title	Contents	Comments
Michigan ITS: Detroit Freeway Conditions	index to the pages below	
Detroit Freeway Traffic Map	calculated congestion, accidents, construction closures, CMS contents	updated every 90 sec
Michigan Travel & Weather	links to other Michigan travel sites & weather	e.g., AAA Michigan road construction
U.S. Travel & Weather	links to real-time travel sites elsewhere in the U.S.	e.g., Chicago's real-time web site
About MITSC	a brief history of MITSC	
About this Site	how to use the MITSC site	

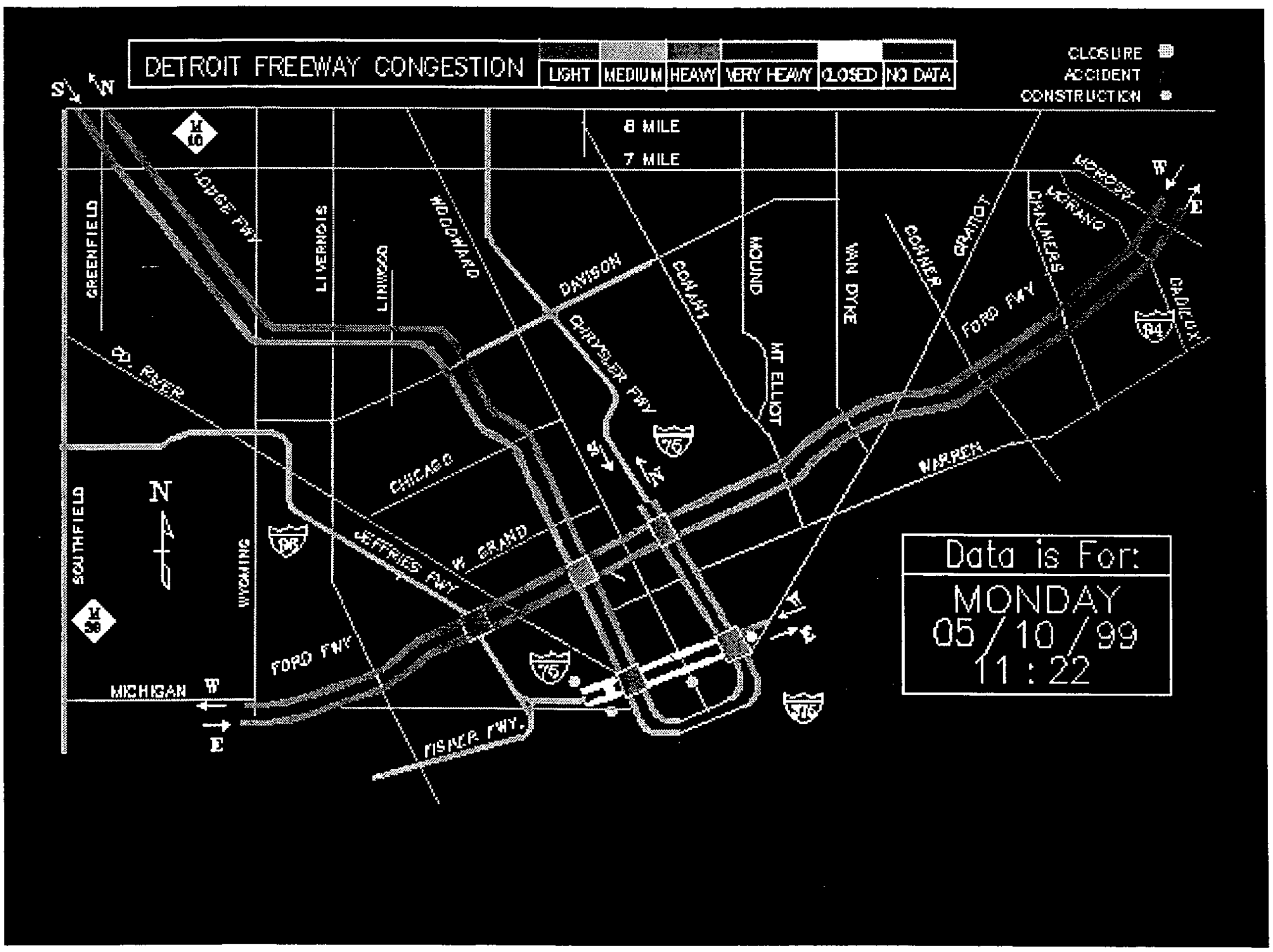

Figure 3. Expanded main map of Detroit traffic.
Note: This image was recorded at a slightly different time than Figure 1.

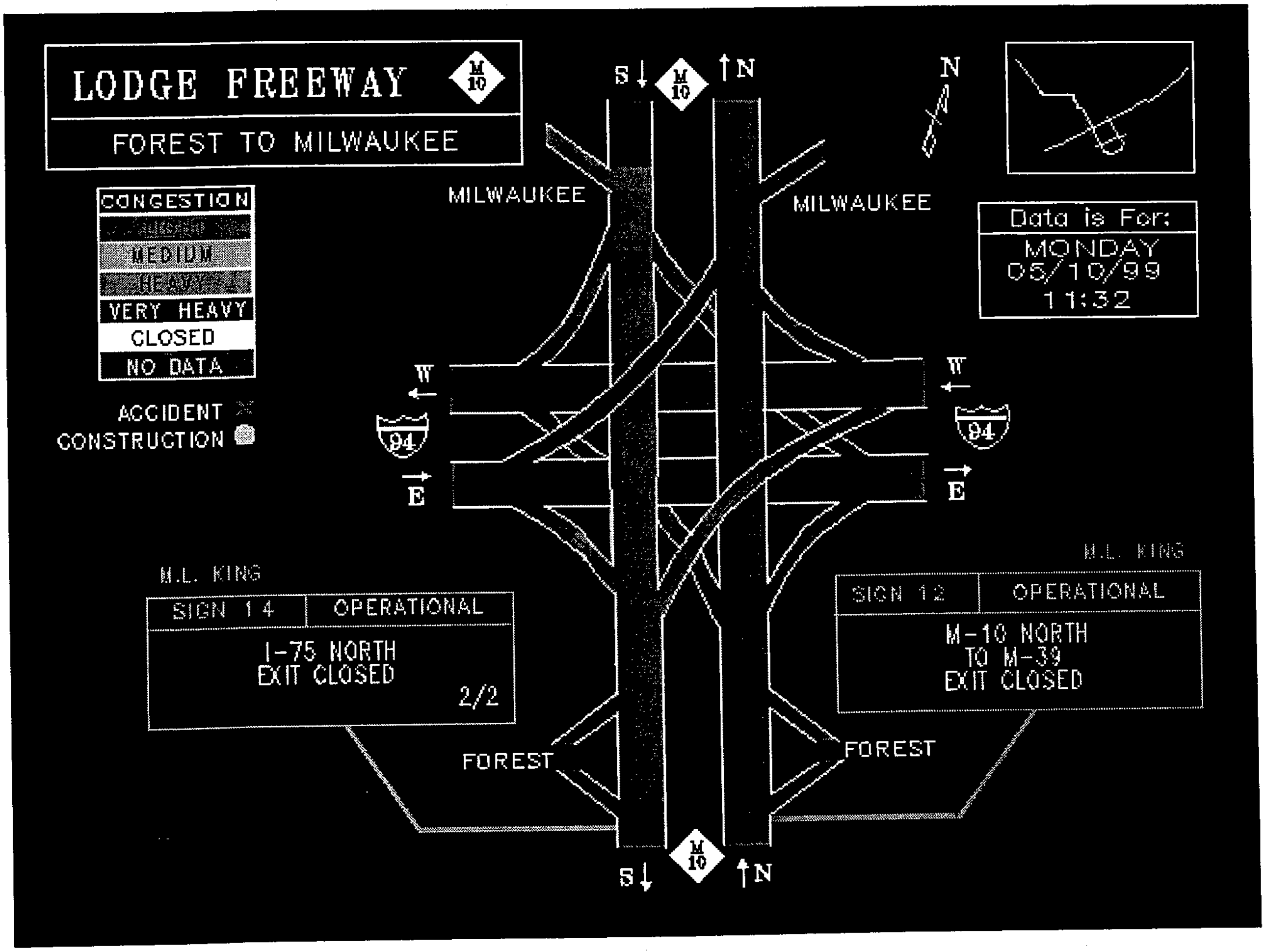

Figure 4. Intersection detail.

As part of the recent agreement to staff the control room, SmartRoute was given exclusive marketing rights to the Detroit real-time freeway traffic data. Real-time traffic information from Detroit is currently forecast to appear on the SmartRoute web site (http://www.smartraveler.com) in 1999. It was still unclear at the time of this report if MDOT will continue to provide its current web site under the agreement with SmartRoute or when (and by whom) the web site would be expanded to include the full 180 miles of freeway that is planned. Also in debate is whether or not the web site will display real-time incident and construction data.

TV/Radio Stations

Metronetworks (http://www.metronetworks.com), a private company, provides many of the local TV and radio stations with traffic, news, sports, and weather. In the past, MDOT supplemented this information by providing real-time reports to TV/radio stations for free by phone or fax. However, since the transfer of the control room operations to SmartRoute, only major incidents are reported for free. Under SmartRoute, the stations do, however, have the option of purchasing more detailed traffic information. Three of the local TV stations (channels 2, 4 and 7 or Fox, NBC, and ABC respectively) have helicopters used to obtain traffic information when there are major developments.

MITSC Operations

Control Room Facility and Equipment

The control room (see Figures 5 and 6) is about 3,600 square feet excluding the conference room and the adjacent state police dispatch center. The MITSC control room is divided into 4 parts: (1) storage area, (2) debugging space, (3) the control room, and (4) the state police dispatch center. A conference room with a glass wall overlooks the control room.

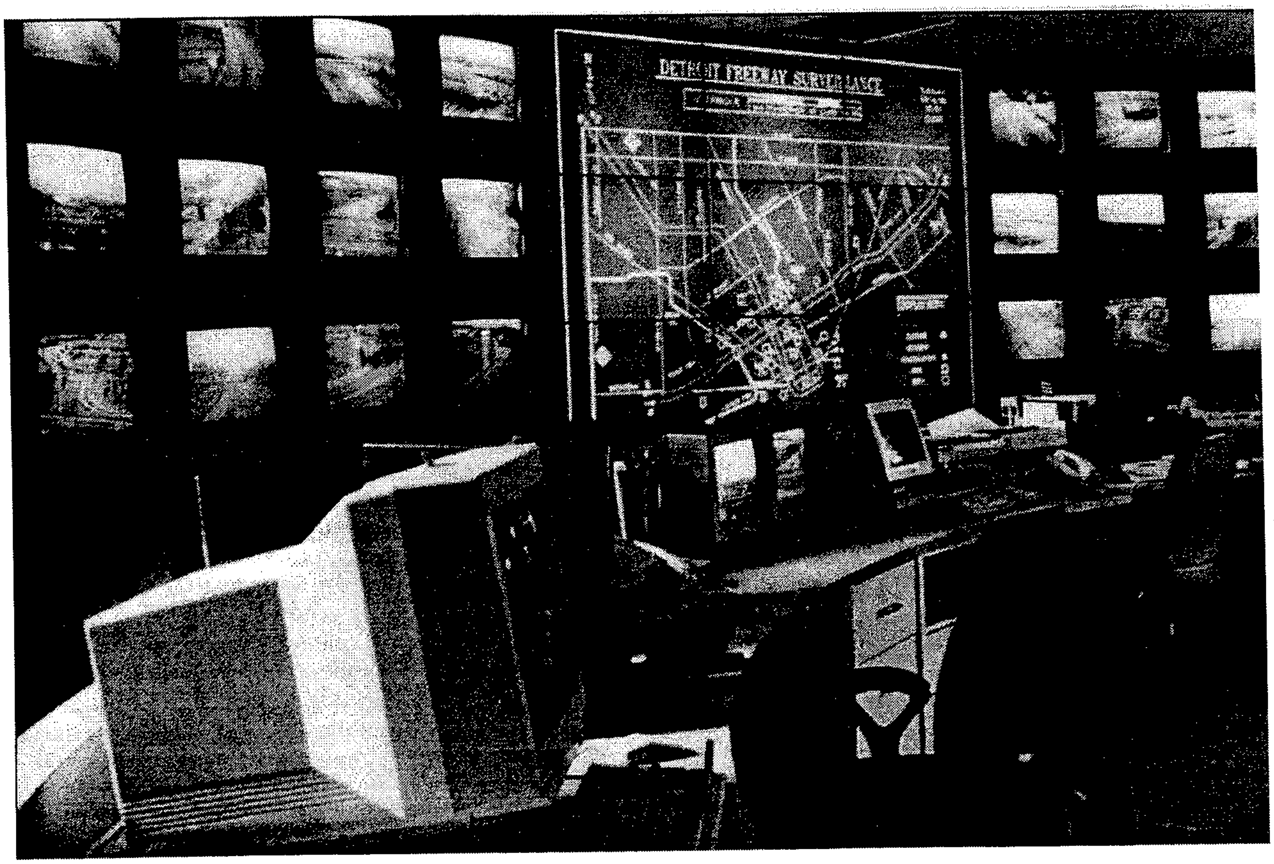

Figure 5. Front of the MITSC control room.

The control room consists of a large video wall in the front of the room, a large U-shaped operations desk, and a supervisor's desk. The video wall consists of three panels. The left and right side panels each have 12, 20.5-inch monitors (3 rows and 4 columns). The center panel has 9, 41-inch projectors (3 rows and 3 columns). The left and right video wall panels are angled slightly in to allow better viewing. The 9 central projectors can be integrated to display a single camera or computer image (as shown in Figure 5), they can be integrated to display a single image on 4 screens bordered by 5 separate camera images, or they can display 9 separate camera images.

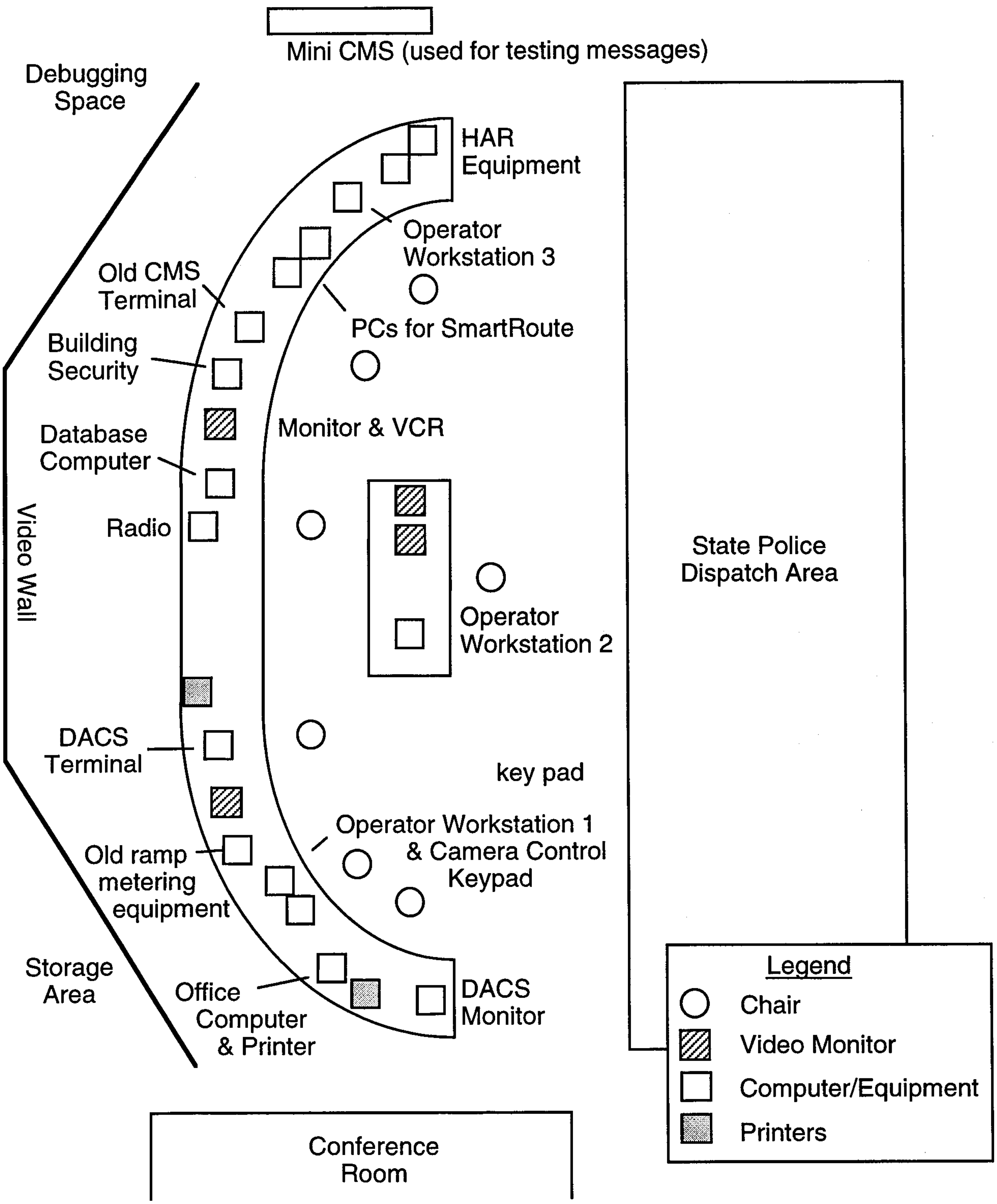

Figure 6. MITSC facility layout.

Behind the left video wall panel is a storage area for paper, computer supplies, etc. However, the storage space is reportedly inadequate. Behind the right wall is a working space for software debugging and other tasks. The limited space behind the central wall is for monitor maintenance.

Maintenance and installation of cabling in the control room was facilitated by a raised floor. The floor tiles are squares with 24-inch sides. Square carpet tiles have been laid upon the floor tiles and have 18-inch sides. The size difference between the floor and carpet tiles complicates the removal of the floor panels for rewiring or maintenance.

Located in front of the wall are several operator workstations. To confirm incidents and identify disabled vehicles, the operators use a keypad to select CCTV cameras to be displayed either on the video wall or on any one of four monitors located near the operator workstations. Video can also be sent to any of the 5 monitors in the state police dispatch center. One control-room monitor is connected to a VCR and can record the output of a single camera. In the past, incidents have been recorded to review state police procedures and determine the best way to handle incidents without causing additional incidents or traffic problems. Confirmation of incidents or maintenance problems can also be obtained using a radio system for communicating with freeway maintenance crews.

Also located in the front of the room is a terminal to the DACS mainframe computer, which processes all of the loop-detector data for the central (downtown) Detroit area (the legacy system). The DACS mainframe monitor displays the current traffic information for the legacy system and also serves as the web site real-time graphic. This monitor allows operators to confirm the information provided on the Internet. The DACS terminal allows MITSC to check the loop detectors for malfunctions.

There are two different types of CMSs, the legacy signs and the new signs. Consequently, there are separate systems to control the signs. A single computer (running UNIX) in the front of the control room controls the 14 legacy signs. The 43 new signs are controlled by the three operator workstations running Windows NT. One of the workstations handles downtown Detroit, a second handles the northern part of the network, and a third workstation handles the southern part of the network. The legacy system signs can be accessed from the operator workstations via a telnet link to the old computer system. However, the Windows NT CMS user interface and telnet CMS interface are different, complicating the operations. This problem of balancing consistency yet providing for improvements often occurs for incrementally updated control rooms.

A major drawback of the new CMS system is that each CMS must be independently controlled. Most situations require messages to be displayed on a series of signs. It can sometimes take 10 to 20 minutes to post the messages. During this time period, the traffic situation can become much worse because the signs do not forewarn motorists. During the preexpansion period, the center was staffed only on weekdays, and the CMSs were set to an automatic mode to display preprogrammed messages (for planned events). Currently, this practice is not needed since the center is staffed 24 hours per day, 7 days per week.

A database computer (running Windows 3.1 and located in the front of the control room) is used to assist in planning for events and the overall management of incidents. Statistical data on congestion and incidents has been recorded since the early 1990s. There is also a NeXT computer and printer used for routine office tasks (word processing, spreadsheets, and construction information faxes) located in the front of the control room.

The most recent additions to the control room were the SmartRoute workstations. SmartRoute has been testing equipment to collect and disseminate real-time traffic information from MITSC sensors. Since the MITSC wants to explore new technologies and methods to aid in incident detection and traffic-information dissemination, new equipment for pilot projects is often added from time to time to the control room (e.g., by universities or private companies). Provisions for this equipment were not included in the original control room design, and thus, there is often a shortage of outlets, electric power, and workspace.

Notably absent from the control room are sources of information to confirm traffic, the weather, and broadcast traffic information. There are no radios or TVs (for access to local news or weather) since cable is not available where the control room is located. The absence of nearby windows creates a sense of detachment from current conditions, both in terms of weather and the time of day. This is viewed as a trade-off for the ability to keep the room slightly dark-adapted to allow better viewing of the cameras and prevent computer glare problems.

Conference Room

The conference room is on the left side of the control room and is used for meetings with visitors. Although there is a transparent glass wall separating the conference room from the control room, the monitors on the video wall are difficult to see because of the sharp viewing angle from the conference room.

State Police Dispatch Center

The State Police Dispatch Center is located behind the control room. Because the video wall can be seen well from the dispatch center, the dispatchers can readily confirm traffic conditions. The original control room design would have resulted in the dispatch center being terraced above the MITSC staff, but low ceilings prevented this. As an attempt to compensate, each dispatch operator was provided with a single monitor. MITSC operators can send video from a single camera to the dispatcher's monitor to assist in emergencies.

Personnel

Until recently, the MITSC operations engineer had 8 part-time operators reporting to him. All of the operators were full-time college students recruited from Wayne State University or other local universities near MITSC. The requirements to be an operator were as follows:

1. Knowledge of the Windows operating system
2. Knowledge of the local freeway system
3. An interest in traffic control systems
4. Proactive thinker

At that time MITSC operated on 2 shifts. The first shift is from 7 a.m. to 1 p.m., and the second shift was from 1 p.m. to 7 p.m. (weekdays only). Three or 4 operators were used on each shift. Operators were hourly employees ($11/hr without benefits) and worked up to 20 hours per week for 3 to 4 years while they attended school.

MDOT planned to operate MITSC 24 hours per day, 7 days per week, using 3 shifts. Their predicted staffing requirements were 3 operators per shift on weekdays (1 of whom is a spare or backup) and 2 operators per shift overnight (1 as a spare). However, since SmartRoute assumed operational responsibility for the control room, the staffing has been reduced to 2 day shifts of 2 operators and 1 night shift with 1 operator. Some of the previous MITSC operators became SmartRoute employees.

Relationship with Other Organizations

The state police in MITSC have five emergency 911 (phone) stations and 4 radio dispatchers on duty. Calls from mobile phones used in southeastern Michigan are directed to this center for immediate response by the state police. Calls which do not fall under the state police jurisdiction (motorist calls which are not freeway related) are transferred to the appropriate local agencies. The CCTV monitors visible to the dispatchers are useful in responding to freeway incidents.

The MITSC also has a relationship with RCOC. The MITSC can see any one of three cameras maintained by the RCOC, and the RCOC can view any one of the 149 cameras maintained by MITSC. Remote control of cameras is provided; however, it may be locked out by the controlling agency. The MITSC also receives the intersection map and information on construction from RCOC. However, there is no relationship between operators because there are no operators in the RCOC. Any direct communication that does occur is generally between managers by phone.

Since 1994, the Freeway Courtesy Patrol (FCP) program sponsored by City of Detroit, AAA Michigan, MDOT, and others has continued to provide responsive mechanical and personal assistance to motorists on selected segments of I-75, I-94, I-96, M-10, I-696 and M-39. Although MDOT is one of sponsors, MITSC presently has nothing to do with operations of the courtesy patrol. However, there are plans to revamp the courtesy patrol and possibly bring it under MITSC management.

MITSC management has also been very open to the use of MITSC as a test site for research by local universities. From time to time, their equipment and personnel are present in the control room.

ROAD COMMISSION FOR OAKLAND COUNTY (RCOC)

Background

Contact Person

Mr. Gary Piotrowicz, an engineer with RCOC, was interviewed on October 27, 1998. Mr. Piotrowicz was responsible for FAST-TRAC project management and now oversees the control room. He had previously been involved with traffic operations during the Olympics in Atlanta, Georgia, with the Federal Highway Administration (FHWA).

RCOC Overview

The RCOC manages the FAST-TRAC operational field test, one of several major projects in the U.S. combining advanced traffic-management systems (ATMS) and advanced traveler-information systems (ATIS) elements. The RCOC traffic operations center was originally planned as a staffed incident management facility. However, the facility is not currently being utilized in that manner for the following 3 reasons:

First, the 2,600 miles of main roads and 100 miles of other roads under RCOC's jurisdiction exceed what can be feasibly covered with surveillance cameras. Second, mobile phone calls reporting incidents (via 911) are usually received before operators watching cameras are likely to detect incidents, and there is no centralized authority since the area monitored by the TMC spans many towns that have independent police forces. Finally, there are numerous alternate routes for traffic when incidents occur on Oakland County roads (compared to the limited alternatives for freeway traffic).

Accordingly, a lane closure on a freeway has much greater and more immediate consequences than a closure on a surface (city) street. Furthermore, the RCOC has little means to inform drivers, in real-time, of incidents or traffic conditions (since they lack a network of CMSs and HARs, and local roads generally do not warrant mentioning by radio or TV broadcasts). Hence, the RCOC emphasizes the dissemination of information on planned events and construction.

History of the RCOC

The RCOC realized in the late 1980s that building roads to provide additional capacity was impossible financially, environmentally, and politically. After investigating different traffic strategies for traffic congestion, the RCOC pursued installation of a computerized adaptive-traffic-signal system, the Sydney Coordinated Adaptive Traffic System (SCATS), along with video-camera-based vehicle detectors (Autoscope). An important part of the effort was the development of the Transportation Information Management Systems (TIMS), a semiproprietary system to interact with SCATS. The initial phase (70 million dollars) was paid for primarily by funds from ISTEA, the federal ITS legislation (1991). In 1997, RCOC replaced all the Autoscope controllers with 261 newer models and the five old regional microcomputers with new PCs. The total project cost was $1.2 million.

RCOC's Goals

The RCOC concentrates on traffic management and traffic planning. The RCOC maintains and controls 1,100 traffic signals in Oakland county. Traffic flow is optimized by locally and remotely adjusting signal parameters such as green time, red time, and so on. Signal timing adjustments depend both on time-of-day variations in traffic (e.g., rush hour) and event-driven activities (schools opening or closing, sporting event times, etc.).

RCOC Data Collection

Vehicle Detectors

Autoscope cameras (288 controllers) have been installed at 251 intersections, a significant increase from the original 28. The Autoscope units were developed by Image Sensing Systems and obtained by RCOC from the distributor, Traffic Control Corporation. Data on traffic volume and occupancy from Autoscope is used by SCATS to optimize traffic flow. As a result of extensive use, the system is quite robust. Due to the high bandwidth requirements, the video data from Autoscope cameras is not available remotely. For research purposes, VCRs can be temporarily installed at intersections to record such data. In part, there were significant concerns about requests for and access to those recordings in disputes concerning motor vehicle crashes. However, volume and occupancy data is available remotely from the SCATS Information Server (SIS) via the PC in the control room.

CCTV Cameras

The RCOC currently operates 3 surveillance cameras and will install 3 additional cameras near several major malls throughout the County. The camera system will be designed to allow for dual operation by the local police and RCOC.

RCOC Information Dissemination

The primary method for communicating information on congestion to the public is through the local radio and TV stations (via fax to MetroNetwork stations). RCOC also provides information access to the utilities, local contractors, and government agencies to assure the coordination of road repairs. The RCOC gets data on lane closures, road repairs, and parades from the permit department and also receives data on crashes, abnormal congestion, bus delays information, etc. from the SMART project (http://its.engin.umich.edu/tpeg/SMART.html). RCOC also receives event data from the Silverdome in Auburn Hills. RCOC does not operate CMSs, HAR sites, or other similar systems.

To supplement current activities, the RCOC has been working on the development of a web site targeted for full operation in November of 1999. Some information is currently available on the web (http://www.rcoc.org). At present there are no web-site interface-design guidelines, and the RCOC planner will most likely make on-the-spot decisions concerning the site content and format. The interface will be developed using ArcView, as an extension of the software being used for other applications at RCOC.

RCOC Operations

Figure 7 is a sketch of the RCOC control room and Figure 8 is a picture of the video wall. The video wall at the front of control room consists of three parts: a left and right monitor bank with 6, 25-inch monitors each (3 rows by 2 columns), and 9, 31-inch projectors (3 rows by 3 columns) in the central wall. The central bank of projectors can be integrated to show a single camera scene or the congestion overview map.

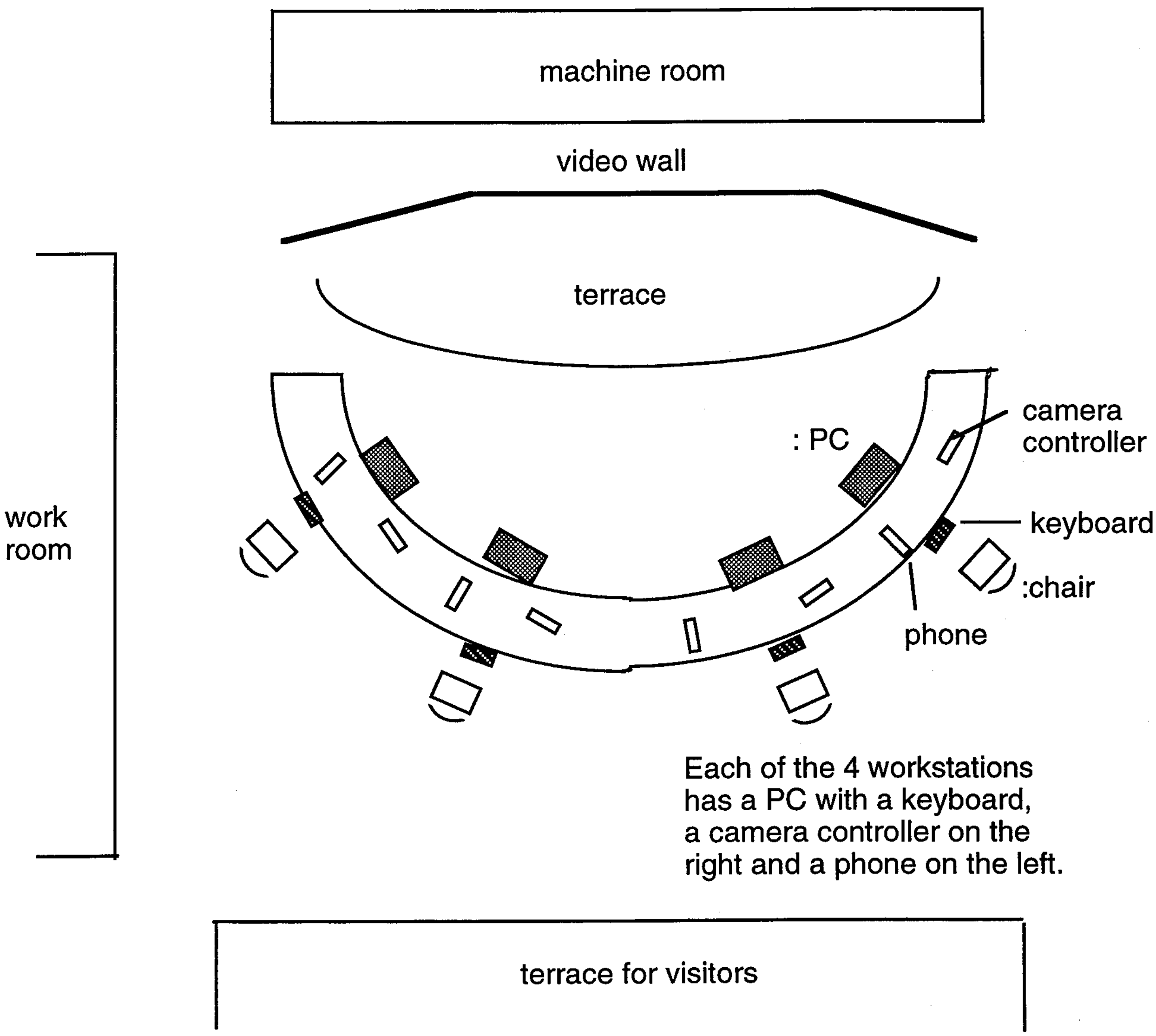

Figure 7. Sketch of the RCOC control room

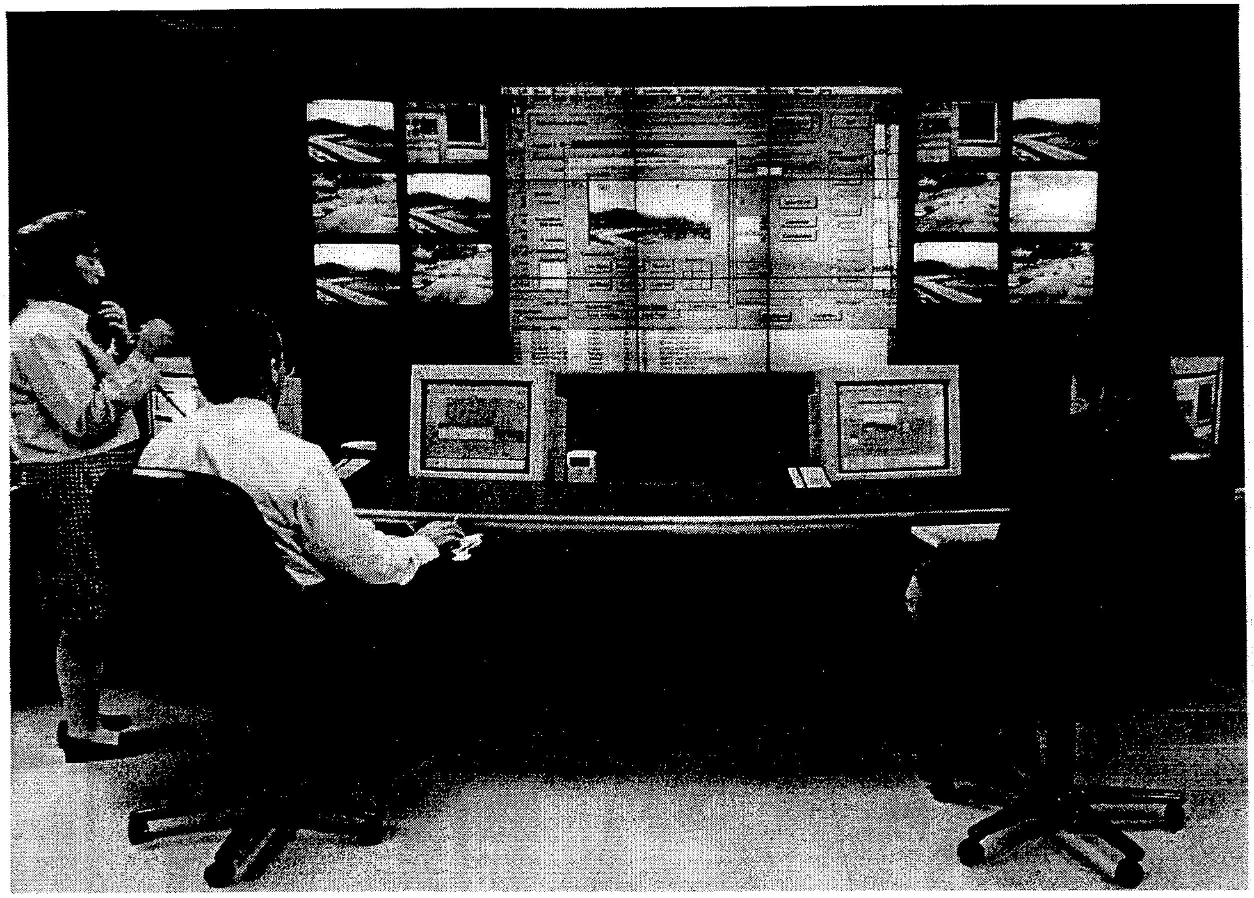

Figure 8. Video wall at the RCOC center

Four PCs running Windows are used to control the system. Each can display the status of each signal controller and vehicle detector, adjust the parameters for the signal controllers, and access the Southeast Michigan Council of Government (SEMCOG) map database. Each PC can also display the real time congestion on arterial roads.

Specifically, control is achieved via two proprietary, RCOC-specified applications running under Windows. The SCATS system graphically displays the operation and status of each traffic-control signal. The second system, the traffic-information management system (TIMS), graphically represents the traffic conditions on the streets throughout the county. The TIMS system was based on ESRI's ArcView GIS platform with custom programming added by the contractor (Rockwell) for the traffic management center. TIMS utilizes data from SCATS to calculate the flow of traffic through the intersections and plot congestion on the county map.

Interviews with RCOC revealed that the user interface requirements were developed through informal discussions. Operator input was provided by the RCOC project leader, who had previously been an operator at the Atlanta TMC (but has no formal human factors background). No written human factors guidelines were used or referenced. There was considerable give and take, with the systems integrator working hard to satisfy RCOC's requests.

One feature added by the RCOC was a demo mode to facilitate operator training. Software camera pan, zoom, and tilt controls were added to the TIMS interface. RCOC would have preferred to have both the TIMS and the relevant video shown on the computer monitor to avoid constantly reaccomodating between computer-based controls and the video wall image. It was also observed that the custom TIMS interface often violated typical Windows GUI guidelines and user expectations. For example, a point and click action was used to obtain additional information for some features, but not for others.

The interface to access the SCATS from within the TIMS was also not functional. Problems were also observed with map content. A feature to selectively remove or declutter street names was needed, along with consistent naming of streets on the map.

The Impact of Traffic Signal Optimization on Traffic Flow

Presently, about one third of signals in Oakland County are controlled by SCATS to automatically optimize traffic flow. For all other signals, the traffic engineers generate written work orders for the field crews initiate changes. Such changes are not made instantly and are costly to implement. In an evaluation of the SCATS systems by Michigan State University, travel time and speed on Orchard Lake Road, a main road in Oakland County improved substantially (Table 3).

Table 3. Travel Times and Speeds on Orchard Lake Road

	Northbound			Southbound		
	Fixed-time plan	SCATS	Percent change	Fixed-time plan	SCATS	Percent change
Travel time (min)						
Morning peak	6:19	5:02	-20.3	6:2	5:49	-8.6
Nonpeak	7:14	4:56	-31.8	6:16	5:19	-15.2
Evening peak	7:21	6:49	-7.3	6:21	5:56	-6.6
Speed (mi/hr)						
Morning peak	29.45	36.95	25.5	29.26	31.98	9.3
Nonpeak	25.71	37.70	46.6	29.68	34.98	17.9
Evening peak	25.31	27.29	7.8	29.29	31.35	7.0

Relationship with Other Organizations

As discussed earlier, the RCOC can send images from one of its three cameras to MITSC in exchange for receiving images from any one of MDOT's cameras. The relationship between the RCOC and the MITSC may evolve in the future, but currently there are limited benefits. Even if a freeway became blocked by an incident, the infrastructure required to effectively divert traffic off the freeway and onto the surface streets does not exist.

Within Oakland County, data is exchanged through ERINet (Emergency Road Information Network). For wide dissemination, RCOC sends data to MetroNetworks, who in turn pass along the data to commercial radio stations. Finally, RCOC can also obtain information about SMART bus delays (they have automatic vehicle locators, AVL) through a SEMCOG (Southeast Michigan Council of Governments) map database.

CONCLUSIONS

1. The primary goal or goals of a traffic management center will vary from location to location. At MITSC, the primary role was to improve traffic flow through ramp metering, to identify incidents and coordinate responses with the state police, and to provide traffic information to the public via CMSs and radio broadcasts. At RCOC, the system was used to fine tune traffic-signal timing, even though the original intent was to improve incident responses.

2. Collocating police and freeway traffic-management personnel in the same room and giving the police the ability to see incidents directly was an excellent way to improve incident response.

3. Central control of traffic signal timing not only provides the expected improvements in traffic flow, but significantly reduces the cost of signal timing tailoring as there is no need to send a road crew out to each signal when the timing is changed.

3. Formal consideration of usability by experts did not occur in either of the control rooms examined. Although the control center personnel were experienced and had a personal sense of what led to usable systems, they were not aware of specific technical material on the topic (e.g., books, guidelines). One potential solution would be for the FHWA to distribute multiple copies of the Georgia Tech Guidelines (Georgia Tech Research Institute, 1998) to every existing and planned traffic management center.

4. Integration of legacy and new systems can be a major problem as was the case at MITSC. If old software (often with a text-based user interface) is to be preserved, then the user interface is likely to be inconsistent with current graphical user interfaces, creating problems for operators.

5. TMCs have changed as technology evolved (e.g., the introduction of mobile phones and wide-scale use of 911 calling).

6. Operators often value feedback that their information is being received. Some need was noted to provide the operators with the weather channel, CNN headline news, local TV broadcasts, and Internet access inside the control room. This desire was more prevalent at MITSC since they are collocated with the state police dispatch center. Since many of the dispatchers were retired police officers, there was a desire to have access to current police events that were reported on the local news, especially during times of crisis.

7. As traffic information becomes a more marketable commodity, the desire for commercial use of the information and commercial opportunities for center control may grow.

8. Use of the web as a source for both pretrip traffic information and construction information is growing, and thus, traffic management centers are concerned about the design of traffic-information web sites.

The authors were surprised by the differences between the two traffic management centers examined, and the pronounced differences that seemed to occur between other centers not formally examined. Although all centers seem to be physically similar with an overall congestion map flanked by a wall of monitors showing traffic at various locations, the manner in which they use the information and coordinate with others differs greatly. Their real value is not the control room as a physical entity, but their ability to (1) contact the police, fire, ambulance, tow trucks, and other emergency services and get them to a scene quickly, (2) inform the public of congestion and incidents during their commute, and (3) provide the public, government agencies, and private organizations with information on congestion-inducing events (sports activities, parades, school activities, etc.) so that travel can be planned around them. Although there has been considerable emphasis on the collection of traffic data via camera, loop detectors, and so forth, the real value lies in its dissemination.

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