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I am submitting herewith a thesis written by Dean Morgan Miller entitled "*The Police Command and Control System: A Spatial Decision Support System For Law Enforcement.*" I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Geography.


Bruce A. Ralston, Major Professor

We have read this thesis
and recommend its acceptance:





Accepted for the Council:


Associate Vice Chancellor and
Dean of The Graduate School

**THE *POLICE COMMAND AND CONTROL SYSTEM*:
A SPATIAL DECISION SUPPORT SYSTEM
FOR LAW ENFORCEMENT**

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

Dean Morgan Miller
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DEDICATION

This thesis is dedicated to my parents

Mr. Richard H. Miller

and

Mrs. Carolyn M. Miller

who have taught me the value of perseverance and dedication.

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ABSTRACT

Law enforcement agencies typically manage forces at the local precinct level. However, during the 1996 Centennial Olympic Games, in Atlanta, Georgia, centralized management of police forces was required. The *Police Command and Control System* (PCCS) was developed to facilitate the decision making for police commanders during the Olympics. The PCCS is composed of two sub-systems: the Central Manager which is comprised of a suite of tools for situation planning, monitoring and simulation; and a Field Manager comprised of local force management tools.

This thesis examines the development of the *Police Command and Control System*, its use and several of the issues encountered during its development and deployment. A key factor in the development is the types of software used to develop the system and the manner in which the integration of the software is performed. A detailed analysis of the design assumptions and their outcomes is included.

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Chapter 1

INTRODUCTION

Overview

With over two million visitors and nearly three-fourths of the world's population watching, the 1996 Centennial Olympic Games in Atlanta were billed as the largest peacetime event in history. Many of the athletic venues for the games were located within a three mile radius of downtown known as the "Olympic Ring". The Atlanta Police Department had the tasks of providing public safety and security throughout the Olympic Ring and at three Olympic athletic venues, as well as performing their regular law enforcement responsibilities.

Most police departments, including that in Atlanta, operate with localized force management practices. That is, precinct commanders develop schedules, assignments, and beats for their officers. However, in the "crisis" presented by the Olympics, nearly 1,400 of Atlanta's 2,200 sworn personnel were assigned to Olympic duty. Although a common radio system was in use by all Olympic security personnel, the city needed to maintain its own radio system for those not on Olympic duty. The resulting situation hindered communication efforts between Olympic and non-Olympic police forces. Moreover, pedestrian and automobile traffic was expected to hinder the movement of

emergency personnel throughout the Olympic Ring. To deal with these problems, centralized management was required.

The *Police Command and Control System* (PCCS) was developed specifically to help plan and manage resources in crisis situations. The PCCS is a spatial decision support system comprised of two sub-systems: 1) a Central Manager system made up of a variety of planning and managerial overview tools and, 2) a Field Manager system composed of several tools designed to support local managers. Termed a pioneering technology by Vice President Albert Gore (1996), the PCCS was developed to support the Atlanta Police Department's preparations for and management of security during the Olympics. This study is essentially a case study in the development of such a system which places a special emphasis on the methodologies used to implement the spatial aspects of the system.

Spatial Decision Support Systems

For many years, decision support systems have been used to assist in the development of policy. Sprague (1980) defines a decision support system as an interactive computer-based program designed to aid decision makers, through the use of data and models, in solving ill-structured problems. While this definition is somewhat rigid, it provides a good starting point for a discussion of some of the key components in such a system. First, a decision support system must be interactive. The user must be able to change inputs and make specifications that simulate real world events. Moreover, these systems

are not intended to replace a decision maker; rather, they may serve as one of many contributing factors to a decision. Another component of a decision support system is that they use data and models to support the decision making process.

Adding a spatial component to a decision support system results in a spatial decision support system (SDSS). Armstrong and Densham (1990) describe a SDSS based upon six criteria:

1. limited scope of problem
2. the ability to assimilate data from a variety of sources
3. the capability to model
4. the use of graphics in reporting results
5. flexibility in the methods used for decision making
6. extensibility of the system.

Often these systems require the integration of software from two distinct functional areas.

The first area, database management systems, are designed to perform complex database operations and management. The second, geographic information systems (GIS), represents a specialized class of database management system. Such systems are highly optimized to operate on data which have a spatial component; however, they are often ill-suited to perform complex operations on aspatial data.

The development of the *Police Command and Control System* required the use of both a database management system, and a tool for the display and query of geographic information. Both the Central Manager and Field Manager sub-systems relied heavily on each of these types of software systems. In each of these sub-systems a "loose coupling"

(Zhu and Healy, 1992) approach was used to merge the database and mapping software.

Loose coupling refers to a methodology by which two distinct systems are merged to provide the user with a single interface.

Use of Computer Technology by the Atlanta Police

The use of computers by law enforcement agencies has been increasing rapidly; however, rarely are these tools used to support force management. Prior to the development of the PCCS, the Atlanta Police made only limited use computer technology. Personal computers were commonly used simply as word processors or spreadsheet generators. Mainframe computers maintained personnel information and crime data; however, this information was only distributed via printed reports. As a result of these factors, the PCCS represented a major step forward in the technology available to the Atlanta Police.

Chapter 2

REQUIREMENTS AND ASSUMPTIONS

This chapter examines the evolution of the requirements and the assumptions used for the development of the *Police Command and Control System*. The Atlanta Police Department provided the development team with a number of working requirements and assumptions under which the *Police Command and Control System* was designed. The set of requirements under which the system was developed evolved to the deployment of the *Police Command and Control System*.

The funding for the development of the *Police Command and Control System* was provided by a grant from the White House Office of National Drug Control Policy's Center for Applied Science and Technology for Law Enforcement (CASTLE) to the City of Atlanta Police. CASTLE received initial estimates of costs for the program from various vendors. Most expected about three years development time and as much as three million dollars to develop such a system. Since the budget for the program consisted of only seven hundred thousand dollars, Oak Ridge National Laboratory agreed to develop the system. Development of the PCCS began in June, 1995 and was completed in time for a July 15, 1996 deployment date.

Design Requirements

Since the City of Atlanta had never hosted the Olympic Games, police planners thoroughly researched preparations undertaken at other cities which had hosted the games in the past. This research yielded a variety of requirements which were to be incorporated into the design of the *Police Command and Control System*. However, rather than a set of concrete requirements, the city's police planners opted for a generalized outline of a number of tools deemed important for police force management. These tools included the ability to obtain a city-wide overview of event activity and officer locations in the city, an automated analysis of manpower needs throughout the city, a scheduling tool, and a tool to manage forces within the venues. From these required tools the Central Manager and Field Manager systems evolved. Police planners were uncertain which of these tools would prove to be the most useful during Olympic operations. Moreover, the police were certain that other tools would prove useful; however, these tools remained undetermined. This uncertainty led to fluid design requirements.

Since no concrete requirements existed, the system developers chose an evolutionary prototyping methodology which provided incremental working prototypes of the system to the police. Each prototype version of the system included the core set of required tools and a set of prospective tools. These prospective tools were designed to give the Atlanta police ideas for new tools, uses of these tools, and to help them to firmly develop a set of

requirements. Following delivery of each prototype, the police could comment and suggest changes or new tools to aid their Olympic deployment efforts. Several Field Manager tools evolved from this process – timekeeping, and the Pin Map are most notable. Moreover, a third system, the Central Timekeeping System, was deemed necessary. Table 2-1 illustrates the final design requirements.

City-wide Assumptions

A major factor in the design of the *Police Command and Control System* was the expectation that the city of Atlanta would experience extreme traffic gridlock. The expected traffic congestion and the possibility that several simultaneous contingencies could occur helped lead to the development of the *Police Command and Control System*. It was expected that traffic gridlock would prevent the movement of emergency personnel including law enforcement. Thus, a centralized management approach which allowed city Police commanders to manage forces in the most efficient manner from a central command center was required.

Traffic in Atlanta has historically been bad, and with the influx of two million additional visitors, gridlock was expected to occur (Atlanta Police, 1996). Moreover, with many events located in a three mile radius of the downtown area (the Olympic Ring), several downtown and midtown streets were closed or had lane restrictions. The net effect of the

Table 2-1. *Police Command and Control System* design requirements.

Central Manager	Field Manager
Schedule personnel	Perform daily personnel functions
Manage historical data	Manage equipment at a site
Display current schedule	Keep track of officer time
Display events as they occur	Manage officer post information
Analyze current situation	
Review schedules for validity	
Support "what-if" analysis	

street closures and lane restrictions was expected to divert traffic onto already crowded surface streets.

Additional traffic problems were expected as a result of visits from foreign dignitaries. In the United States, traffic is stopped when the President and Vice President are transported along surface streets. With anticipated visits from both the First and Second families, Atlanta expected to experience traffic delays as a result of their movements. Moreover, it was decided that foreign heads of state would be afforded the same security in movement (Atlanta Police, 1996). With nearly two hundred nations competing in the Olympic Games, the traffic congestion created by the movements of heads of state was expected to be significant.

Olympic planners expected additional traffic congestion problems to be related to the large volume of pedestrians present in the city. The Metro Atlanta Rapid Transit Authority (MARTA) expected ridership to be quite heavy during the Olympics. Near the entrances and exits to MARTA stations, and around the Olympic athletic venues, pedestrian traffic was expected to be quite heavy. The increased volume of pedestrian traffic was expected to contribute to automobile traffic congestion in the city.

Violent crime in Atlanta was not expected to be much of a problem because of a number of factors. First, the increased police and military presence presented by federal, state and

city law enforcement agencies and military reserve units was expected to reduce the amount of street crime that was expected to take place. The sheer volume of the crowds also contributed to the expected reduction in violent crime. The crime that was expected to occur in Atlanta would be largely of the petty variety. These crimes included ticket scalping, prostitution offenses, and pick-pocketing (Atlanta Police, 1996).

Police Assumptions

The City of Atlanta Police Department expected to perform several functions during the Olympic Games. The police had primary law enforcement responsibilities at three athletic venues: the Olympic Stadium, Atlanta-Fulton County Stadium, and the Omni. In addition to venue security and their normal duties, the police were expected to provide public safety and security for the Olympics. To perform this task, the police expected to position a large number of units at street corners throughout the downtown area and around many Olympic venues. Further, police were expected to maintain a number of roving patrols within the Olympic Ring. With the additional workload imposed by the Olympics, personnel resources for the Atlanta Police Department were stretched to their limits.

Scheduling of police officers was a critical factor in the development of the *Police Command and Control System*. The experience from FreakNik, the traditionally black college Spring Break, indicated that officers would become exhausted within about six

days (Atlanta Police, 1996). During FreakNik, officers worked a seventy-two hour work week composed of six twelve hour shifts with only one day off. Moreover, officers had been assigned to provide safety and security on a single street corner for the entire period. Based on the FreakNik experience, police planners deemed that the increased workload of a three week long event would cause significant morale problems for the force. Some rotation of officers would be necessary to alleviate these problems.

Weather played another important role in the police assumptions about scheduling. Daytime temperatures in Atlanta average well over 90 degrees during July when the Olympic Games would occur. Dehydration and sunburn were expected to cause problems for police officers working fixed traffic posts. It was, therefore, decided that rotation of officer assignments should occur to further alleviate any problems from low morale and heat-related sickness.

With all of the requirements faced by the Atlanta Police Department, a force of fewer than 2,000 sworn personnel did not seem large enough. As a result, the police determined that *all* officers would operate on six twelve hour shifts per week. The police expected to increase morale by providing officers a variety of incentives. Commemorative items, meals, relaxed overtime guidelines, and position rotation were among the ideas proposed to maintain morale (Atlanta Police, 1996). Police were expected to work only on their shift, and all schedule changes would be implemented prior to the start of the Olympics.

The *Police Command and Control System* Field Managers were to be deployed in a number of locations. Each athletic venue for which the Atlanta Police had security responsibility would get a Field Manager. Several other locations would receive Field Manager systems. Traffic and Public Safety, Special Operations Services, and the Agency Command Center were each scheduled to receive a system to manage officer deployment. Two additional systems were located at the areas chosen for daily staging. These systems, located at two local high schools, would allow roll call and time keeping to take place at centralized locations prior to submission to the Central Manager.

Two Central Manager systems were to be located in the Agency Command Center. The systems, linked by a local area network (LAN), would communicate with one another to remain constantly synchronized. A third Central Manager, located in the Atlanta Police Department's Olympic Planning Office was to be held in reserve in case of a system failure.

Communication Assumptions

Effective communication between the Central Manager and Field Manager would be critical to the success of the *Police Command and Control System*. The first option for effective communication was based upon the existence of a computer wide area network (WAN). However, several barriers to using WAN-based communication existed. First,

Atlanta did not have a WAN in place prior to the Olympics, and the cost of implementation would have been too great to bear. Moreover, since computer networks are generally more sparse than existing telephone networks, a single well placed terrorist attack (or a network failure) would leave the Central Manager system blind.

Standard telephone communication via modem was another option. However, data transmission rates over standard telephone lines are quite low in comparison to a network. Several additional problems faced the development of telephone communication. Many Field Manager systems would be expected to dial into two Central Manager systems. Telephone traffic logjams could be expected to occur in such a system. To alleviate this problem, a custom communications module would need to be developed which continued calling until a connection was made. Moreover, connections could not be permanent. Finally, the system needed to prevent non-authorized persons and computers from dialing the Field Manager and Central Manager system.

The developers and police determined that a third option for communications represented the best choice. Since a WAN did not exist, it would be necessary to use standard telephone lines. However, much of the data transferred between the systems were expected to be in the form of large data files. The police provided for a local area network to be implemented in the Agency Command Center. A hybrid approach which allowed for some Field Manager machines to be connected to the Central Manager

machines by standard telephone communications, while others were to be connected via a LAN was adopted.

The hybrid communications approach required that a custom communications module be developed. The communications module was to have three primary functions. First, the module was required to call the Central Manager machines until a connection had been established. Second and perhaps most importantly, security authentication was required to allow a machine dialing in to access the computer's files. Finally, the communications module was required to allow communication *from* the Central Manager in the form of updated schedules as well as *to* the Central Manager.

To facilitate communications the Atlanta Police agreed to locate dedicated data transmission telephone lines in each location requiring telephone communications.

Moreover, the location of these lines were to be established prior to deployment of each of the Field Manager systems. Central Manager systems required the location of multiple data lines which had been implemented during the construction of the Agency Command Center.

Conclusion

The above requirements and assumptions were critical to the development of the *Police Command and Control System*. The lack of a concrete set of requirements proved to be a

major obstacle. Since the Atlanta police had never used centralized force management, the uncertainty of requirements required the developers to spend a great deal of time developing prospective tools rather than honing the other areas of the system. This caused unintended delays in the system development and resulted in some system instability.

The assumptions proved critical to successfully developing the *Police Command and Control System*. They provided a basis for which decisions could be made about the development of the system and they helped to define its functionality. Table 2-2 summarizes the assumptions under which the *Police Command and Control System* was developed. Without these assumptions, development of the system would have been much more difficult, and the system would have been less effective.

Table 2-2. Design assumptions for the *Police Command and Control System*.

City-Wide Assumptions	Police Assumptions	Communications Assumptions
Two million visitors	Provide city-wide law enforcement	No wide area network
Overall traffic congestion	Provide security at three venues	Communications over modem for remote locations
Sporadic traffic congestion from dignitary escorts	Officer rotation	Communications over local area network in ACC
Heavy pedestrian traffic	Hot weather	Dedicated data transmission lines for remote Field Managers
Not much violent crime	Six twelve hour shifts/week	
	Central Managers located in ACC	
	Field Managers at remote locations	

Chapter 3

POLICE COMMAND AND CONTROL SYSTEM OVERVIEW

The *Police Command and Control System* is comprised of two sub-systems each of which performs specific tasks for force scheduling, monitoring and management. These systems, the Central Manager and the Field Manager, were developed to aid police planners with the overwhelming task of managing their forces during the 1996 Summer Olympic Games. The Central Manager acts as a depository for all police data within the city. Its functions are designed to facilitate the centralized management of police forces. Field Manager systems operate somewhat differently. Each system is designed to provide local force commanders control over their assigned forces. A variety of management information, such as an officer's location, is transferred to the Central Manager to provide city-wide force commanders an overview of police force allocation.

System Configuration

The *Police Command and Control System* is designed to pass operational data from the Field Manager systems to the Central Manager and planning and scheduling data from the Central Manager to the Field Manager. The system operates on standard personal computers running Microsoft Windows NT version 3.51. The Windows NT operating system allows for easy operation and communication in a secure environment.

Field Manager machines, which require fewer CPU intensive calculations, operate using a standard Intel Pentium microprocessor running at 133 MHz and 32 Mb of random access memory (RAM). The Central Manager system requires significantly more computing power. It operates using an Intel Pentium Pro microprocessor running at 200 MHz with 64 Mb of RAM. To speed data access, each system has a 2.1 Gb high speed hard disk drive which operates via a small computer systems interface (SCSI). Backups for each system are performed automatically onto a removable 1 Gb Jaz disk drive from Iomega.

As originally conceived, eleven Field Manager systems and three Central Manager systems were to be deployed. However, a late reconfiguration of the system resulted in the deployment of only nine Field Manager systems and one Central Manager system. The remaining machines were reserved in case a problem with any machine developed. At deployment, the Central Manager system was located in the Atlanta Police Department's Agency Command Center (ACC). A Field Manager system was located at each of the two police staging areas, Frederick Douglass High School and Glenwood High School. These machines had all the mapping functions discussed below disabled. Three Field Manager systems were located at the athletic venues for which the Atlanta Police had security responsibility – Atlanta-Fulton County Stadium, the Centennial Olympic Stadium, and the Omni. The remaining Field Manager systems were deployed in the ACC – one for the commander of the Traffic/Public Safety unit, one for

administration of the ACC, and two for management of the Traffic/Public Safety police unit. Figure 3-1 illustrates the layout of the *Police Command and Control System*.

Communications between the Central Manager and the Field Manager systems was accomplished in two different ways. Each system in the ACC communicated via a local area network (LAN) which allowed fast communication between the two systems. However, each remote Field Manager required a link over a dial-up modem. To allow this type of communication, the Central Manager was further equipped with two modems which could send or receive information. Each modem used in the deployment of the *Police Command and Control System* required a dedicated telephone data line which was to be accessed only by the Field Managers and Central Managers. Telephone communication was accomplished via the Communications Module, a secure system which managed transmission of data between the two systems. This module maintained a data table of which files to send and their appropriate location upon arrival. A timer on both the Field Manager and Central Manager told the system to look and determine whether any files from the Communications Module needed processing.

Central Manager

The Central Manager system is made up of several functions used for planning and management of crisis situations. The primary function of the Central Manager is the situation overview and simulation capability. Table 3-1 provides a tabular view of the

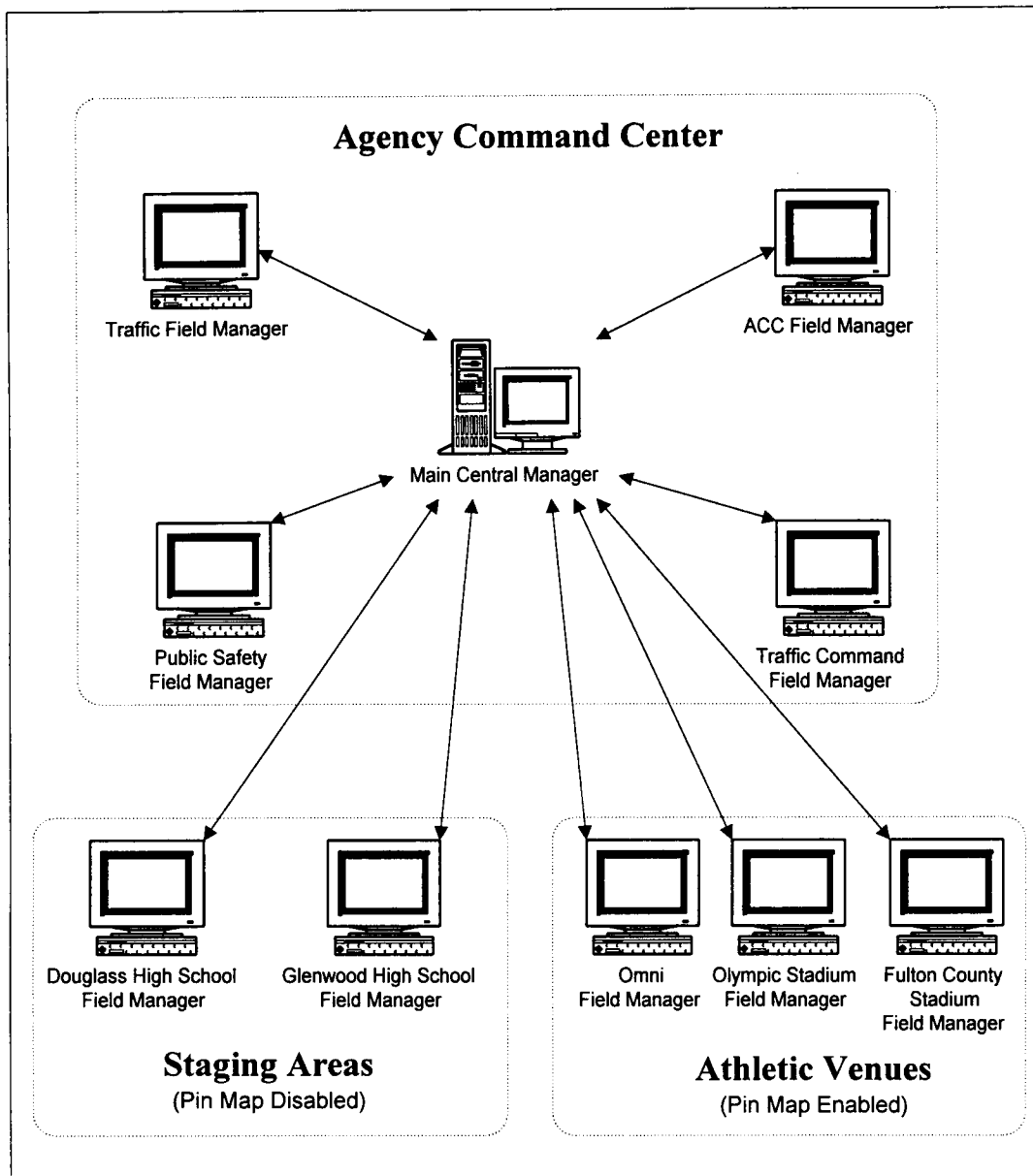


Figure 3-1. Layout of the *Police Command and Control System*.

Table 3-1. Central Manager capabilities.

Capability	Implementation Module
Schedule personnel	Scheduler Module
Manage historical data	Mapping System
Display current schedule	Scheduler & Mapping System
Display events as they occur	Mapping System
Analyze current situation	Mapping System & Event Manager
Review schedules for validity	Scheduler Module
Support “what-if” analysis	Simulation

capabilities of the Central Manager. This function includes the use of a map display, an event window and a live data feed from the city's Computer Aided Dispatch System (CADS). The map display shows a map of the city and what is happening at any given time. Olympic athletic venues are color coded to indicate the level of activity occurring at or around the venue. Officer positions, street closures, and incident information reported from the Field Manager systems are also displayed upon the map screen. All of the data displayed on the map screen are time-stamped for retrieval and review at a later date. The event window displays what is happening in a text-based mode. The user can select an individual event and easily retrieve additional information.

The map display for the Central Manager system contains in excess of 400 Mb of spatially referenced data. Many of these data are linked to other data such as personnel records or the current work schedule. Venue footprint data are linked to electronic floorplans which may be displayed with current locations for officers. Video data can be linked to street data to provide a real-time view of current traffic conditions.

The situation simulation module allows the user to perform "what-if?" analyses. Used in conjunction with the Central Manager's event management functions, the user may create simulated incidents and monitor their effect upon the current situation. Moreover, the situation simulation module allows the user to play back any previous day's events, officer locations, and incidents. As a planning tool, the simulation module allowed the

Atlanta Police Department to view the schedule of Olympic events and determine the proper locations for their forces and appropriate times for shift changes, meal breaks and relief breaks throughout the city.

The schedule manager module provides a suite of tools used to create and manage schedules for personnel. The schedule manager operates by allowing the user to allocate available resources to user-defined requirements. Qualified volunteers for duty are selected first followed by personnel selected at random from among those officers qualified to perform specific tasks (i.e. explosive ordinance disposal, etc.). Any shortfall in available resources is spread across the individual sites scheduled. The resulting schedule may be analyzed in a variety of ways. Graphical analysis allows the user to examine shortfall at each site on any specific day of the contingency period. Moreover, the user can "drill down" into the site and determine which duties are being given short shrift. Scheduling typically involves several iterations of defining resources, requirements, and analysis until an appropriate schedule can be produced.

Field Manager

The Field Manager system is the primary daily operational tool of the *Police Command and Control System*. Operational information is transmitted to the Central Manager machine to keep the system updated. The Field Manager is comprised of several tools including roll call, time-keeping, an emergency action checklist, and an electronic pin

map. This system allows site commanders the ability to manage forces locally while keeping the Central Manager system apprised of what is happening. Table 3-2 summarizes the capabilities of the Field Manager system.

The daily roll call and time-keeping functions of the Field Manager system allow the site commander to track personnel and work hours. This information is used by the pin map function to determine the officers currently on duty or if anyone is absent. The emergency action checklist module helps the user to follow proper police procedures in dealing with uncommon situations (e.g. defections and requests for asylum). Each step can be checked as completed and notes about that step may be recorded. When the user has finished the checklist it can be saved and reviewed for historical purposes.

The electronic pin map is the primary function for force management within the Field Manager system. The pin map contains a variety of tools used for tracking officer positions, incidents, and traffic restrictions. Moreover, if the Field Manager is used at an athletic venue, the pin map contains electronic floorplans upon which officers can be located. In such a case, the site commander has the option of positioning officers on any of the levels within the venue. Location information is transmitted to the Central Manager, where all officer locations and levels are displayed upon the screen.

Table 3-2. Field Manager capabilities.

Capability	Implementation Module
Perform daily personnel functions	Personnel Manager
Manager equipment at a site	Equipment Manager
Keep track of officer time	Timekeeping Module
Manage officer post information	Pin Map

System Development

With the exception of the mapping system, which was developed using *MapInfo Professional 4.0* and is discussed in Chapter 6, the *Police Command and Control System* was developed almost entirely using Microsoft *Visual FoxPro 3.0 (VFP)*. This relational database management system allows developers to create forms-based user interfaces which may be bundled into applications for re-distribution. The advantage of using *VFP* over other rapid application development tools such as Microsoft *Visual Basic (VB)* or Microsoft *Visual C++ (VC++)* is that all database operations may be handled natively rather than requiring the use of Open Database Connectivity (ODBC) to perform database updates. ODBC requires more development overhead and can occasionally operate slowly. *VFP* and *VB* are interpreted languages which operate more slowly than their compiled cousin *VC++*. However, the product development time required to use *VC++* is much greater. Given that the development time for the *Police Command and Control System* was very short, required a great deal of interaction with databases, and the requirements for the project were constantly shifting, *VFP* was easily the best development platform.

Conclusion

Given that Atlanta was expected to experience traffic gridlock, redeployment of police forces required a city-wide view of situations as they developed. Since local police commanders cannot see what is happening throughout the city, the interaction between

the Central Manager and the Field Manager is quite important. The Central Manager allows the police commander to view the situation in the city and determine the appropriate response. Local commanders operating Field Manager systems are given discretion regarding the actual positioning of their own forces.

Centralized management of forces is a concept that is somewhat foreign to police in this country. Local police commanders are normally given the discretion to schedule and position their forces; however, during a crisis such as the that presented by the 1996 Olympic Games, a city-wide view may be necessary. In such cases, the centralized management functions of the *Police Command and Control System* allow central police commanders to view the overall situation and to schedule the required officers. Local police commanders maintain much of the flexibility of positioning and managing their forces; however, schedules are produced at the Central Manager. Moreover, the commander at the Central Manager can indicate where forces should be concentrated.

Working in tandem, the Central Manager and the Field Manager systems give the police a powerful tool for managing crisis situations throughout the city. The following chapters provide the reader with a more in-depth analysis of the tools available to Central Manager and Field Manager users, their application to centralized police force management, and their usage during the 1996 Centennial Olympic Games.

Chapter 4

CENTRAL MANAGER

This chapter provides a detailed description of the *Police Command and Control System* Central Manager system. The Central Manager is the primary gathering place for city-wide information display and analysis. The primary tools included in the Central Manager are the Scheduling module, the Event Management module, the Mapping module, and the Communications module. When the Central Manager system is operational, it sends and receives data from one or more Field Manager systems.

Interface

The basic Central Manager interface is designed as a multi-windowed application. Figure 4-1 illustrates the main Central Manager interface. The basic interface consists of the Mapping module, the Computer-Aided Dispatch graph and the Incident Window. The other modules in the Central Manager may be accessed from the main menu. A toolbar is located along the top of the display and is designed to allow rapid access to a variety of mapping functions. As the other modules, such as the Scheduling module are launched, the main interface is replaced by the interface for each module. Figure 4-2 illustrates one such case, the Scheduler module.

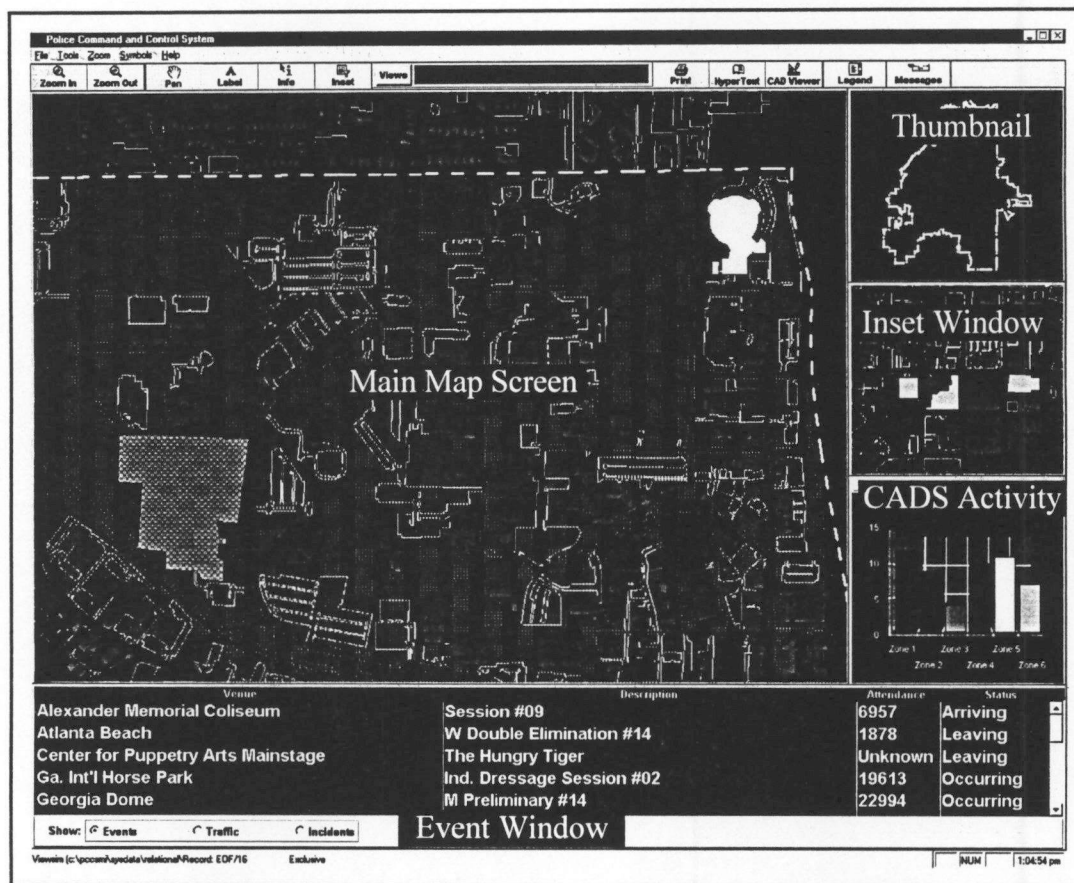


Figure 4-1. The main Central Manager interface.

Schedule Manager

Resources Requirements Run Schedule Schedule Analysis Schedule Management

Select Resources Edit Resources

Resources	Requirements	Run Schedule	Schedule Analysis	Schedule Management																																																																																											
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Figure 4-2. The Scheduler module interface.

Scheduler Module

Traditionally in police work, officers are scheduled at the local precinct level. However, the workload presented by the 1996 Olympic Games required a different approach. With far too many requirements for law enforcement to fulfill, the Scheduler Module operates using a heuristic algorithm which analyzes the requirements against the available personnel, matches the officers with law enforcement requirements, and allows police planners to analyze and make modifications to a tentative centrally developed schedule. This process may require several iterations to arrive at a workable schedule.

The planning process for the police deployment during the 1996 Olympic Games required the identification of duties and responsibilities for the various agencies charged with providing Olympic Security. This process was completed prior to the start of the development of the *Police Command and Control System*. The Atlanta Police Department was given responsibility for three athletic venues (the Centennial Olympic Stadium, Atlanta-Fulton County Stadium, and the Omni) and pedestrian traffic management in addition to normal police operations. At that point police planners needed to determine the manpower required to fulfill each of these tasks. Based upon the schedule of events and the size of the athletic facilities, it was determined that police requirements for Olympic duty were quite significant. As a result, centralized scheduling was incorporated as a requirement for the *Police Command and Control System*. The result of this effort is the Scheduler Module.

The Scheduler Module allows users to add and edit police requirements, and to generically assign available resources to meet these requirements. Once this initial assignment is complete the Scheduler is run. This process matches specific police personnel with the requested requirements. Officers with specialized job functions are scheduled by assigning them specialized duties (i.e. bomb squad). Specialized police duties also requires the input of specialized requirements designed to retrieve officers qualified to perform these functions. Within each requirement classification (e.g. Roving Foot Patrol) each officer in the pool of qualified officers is assigned a random number. Individual officers are selected for duty by sorting the pool of officers on their random number and selecting enough officers to fulfill the requirement.

The workload presented by the 1996 Olympic Games resulted in far more requirements than available personnel resources. The Scheduler Module was designed to deal with such situations. In the event that too few personnel were available to meet the law enforcement requirements, the Scheduler evenly distributed the shortfall in available personnel. Such a case was present in the early runs of the Scheduler; however, police commanders ultimately allocated additional personnel to Olympic duty and retained fewer officers for normal police operations (Atlanta Police, 1996).

The Scheduler Module further provides a set of tools to help determine the sufficiency of a tentative schedule, perform schedule analysis and manually make changes to the schedule. These tools include a variety of tabular and graphical analysis functions for both the input requirements and the tentative schedule itself. The schedule management tools also allow the user to print individualized schedule reports and mailing labels so that schedules can be efficiently distributed. The use of these tools is described in the *Central Manager User's Guide*.

Mapping Module

The main interface of the Central Manager is the Mapping Module. It gives the user a variety of functions designed to provide police commanders with an excellent overview of what is happening throughout the city. Activity levels at the various venues are displayed on the map by color-code – yellow represents persons arriving or leaving a venue, and orange represents an activity currently occurring at a venue. Emergency situations are depicted by shading the venue footprint red. Moreover, officer locations, both inside venues and outside venues can be displayed. These positions, sent from the Field Managers, are stored historically so that following a deployment the user can “play back” a situation to study how it was handled.

The Mapping Module consists of three main windows on the display screen. The first and most important is the main map display. It is the primary information center for

items displayed upon the map. Two smaller map displays are present for the user. The map inset window is provided for the user to get an up close view of a small area in any part of the city. This window is located to the center-right of the main map display. The thumbnail window, located at the upper-right of the main map display gives the user an overview of what is being displayed in each of the other map windows. This window consists of a city outline map and indicators which allow the user to view the relative location viewed in the other map windows.

The Mapping Module provides the user a set of basic mapping functions which are located on the toolbar. These tools, which allow the user to zoom in on a location, zoom out, pan the map display, save and retrieve views, and to show or hide the map legend, are used both by the Central Manager and the Field Manager. Use of these tools is described in the *Central Manager User's Guide*. Several advanced mapping functions are also available in the Mapping Module. These tools are available to assist the user in locating officers, streets, or addresses.

Certain features in the Mapping Module are available for "hot links" which allow the user to click the mouse on an object and retrieve information about that object. The hot link feature is one of the most useful operational management tools in the Mapping Module. The user can click on a venue footprint and display a variety of information. Several different types of hot links exist within the Mapping Module. Computer-Aided Design

(CAD) files, schedules, photos, or animations are all available for the different “hot linkable” objects displayed on the map. For example, the Olympic Stadium contained a variety of hot linked items. The user could view the entire schedule for the Olympic Stadium, who was scheduled to be at the Olympic Stadium at any given moment, floor plans for each of the venue’s eight levels, aerial photos of the Olympic Stadium, or three dimensional animations designed to help police managers determine lines of sight. The special hot links to display venue floor plans also allowed users to view the officer positions on the selected level.

Hot link information is retrieved from one of two locations. Schedule information is queried from the current schedule to determine who is scheduled or who is currently at a location. Other hot links such as venue plans and pictures are stored in a hotlinks table which contains references to the type of hot link to be performed, and the files required for the action. As a hot link is requested, the mapping system determines the type of link to be performed and the actions required. Photo information is displayed using LView Pro, a shareware imaging program. Schedule information is displayed using a Microsoft Visual FoxPro form, and all CAD files and mapping information are displayed using the MapInfo mapping engine. Figure 4-3 is a flow chart which illustrates the hot link process.

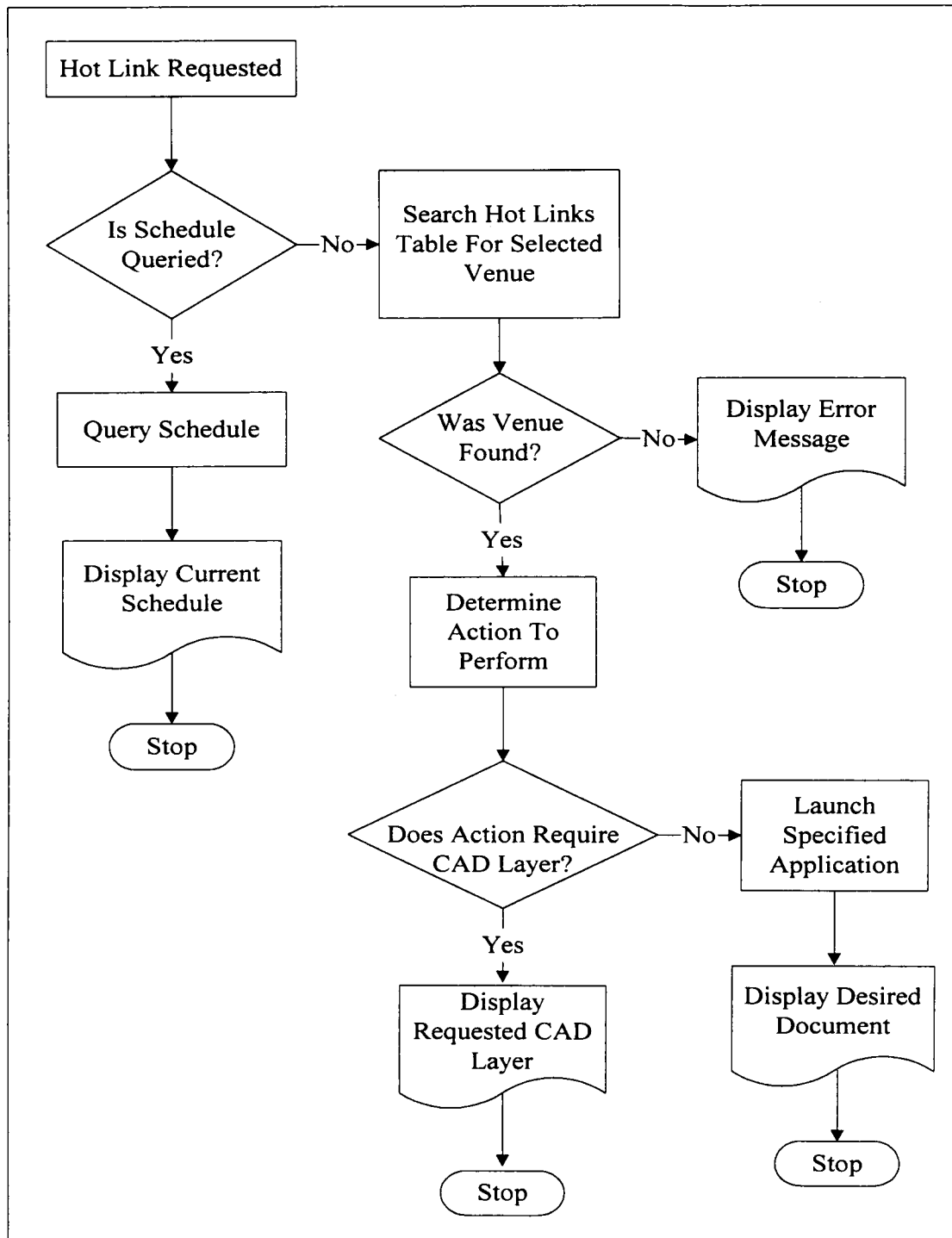


Figure 4-3. The decision process for determining a hot link.

Data requirements for the Mapping Module can be in excess of 400 Mb. To deal with the problem of huge amounts of data, the mapping engine in the Mapping Module is entirely data driven. All data that are displayed on the map are located on the user's hard disk drive. Information about each data layer and its associated display properties are stored in the Loader Table which is read upon startup of the system. As each record is read, the mapping engine determines if the layer is valid, sets its display properties and adds the layer to the map. Table 4-1 illustrates an example Loader Table.

The MapInfo mapping engine allows the Mapping Module to implement a "zoom layering" map display. In zoom layering, certain data layers are only visible when the map is displayed within specified scale ranges. For example, the *Police Command and Control System* contained information for both centerline and non-centerline streets. When the map is displayed at a small scale only the centerline streets are displayed, and conversely, only the non-centerline streets are visible when the map is displayed at a large scale. As the data are loaded from the Loader Table, these scale ranges are set.

MapInfo only allows legends to be displayed when layers are displayed thematically. However, since a large number of map layers are displayed, a legend is necessary to eliminate confusion of the map layers. The solution to this problem was developed using a combination of MapInfo and *Visual FoxPro*. An interactive legend capability was developed which allows the user to set the display properties for individual layers. This

Table 4-1. A sample Loader Table

Layer Name	Layer Path	Default Color	Minimum Zoom (ft.)	Maximum Zoom (ft.)	Selectable	Label Field
Police Officers	c:\data\dayroll.tab	Blue	0	15,000	True	Oname
Non-Centerline Roads	c:\data\roads.tab	Red	10,000	100,000	True	Name
Athletic Venues	c:\data\venues.tab	Cyan	0	100,000	True	VName
Centerline Roads	c:\data\croads.tab	Red	0	10,000	False	
Other Buildings	c:\data\bldgs.tab	Magenta	0	15,000	False	

legend is a MapInfo Layout Window re-parented into a *Visual FoxPro* form. The individual layers on the map are indicated using graphics primitives to display colors and names for the map layers. The legend is dynamic – that is, as the map scale changes, the legend also updates to reflect only those layers which are visible on the map. This process is performed by checking each layer against the current map scale and displaying only the visible layers in the legend.

Situation Simulation

The Event Manager Module and the Simulation Tool are provided to allow the police the opportunity to simulate an expected series of events, such as the Olympic Games.

The Event Manager Module, illustrated in Figure 4-4, is designed to give the police commander a planning tool by which he or she can enter a number of events, when and where they occur, and how many people are expected to attend. The use of this module is described in the *Central Manager User's Guide*. By using the Event Manager in conjunction with the Simulation Tool, the user can view the interaction between a variety of events and help determine the schedule requirements for a particular area. Its use was a valuable tool in planning for the Olympic Games in Atlanta. Each Olympic event was entered into the Event Manager, and the Simulation Tool was used to visually identify areas in the city which would require a high level of police presence.

Event Manager		Event Viewer		Edit Events	
Category	Location	Olympic	Cultural	Start	End
Cultural	Woodruff Arts Center		SITI Short Stories	07/12/96 00:00:00 PM	07/12/96 10:00:00 PM
Cultural	Woodruff Arts Center		Royal National Theater	07/12/96 08:00:00 PM	07/12/96 10:00:00 PM
Cultural	Center for Puppetry Arts Second Stage		Frankenstein by Jon Ludwig	07/12/96 00:00:00 PM	07/12/96 10:00:00 PM
Cultural	The Olympic Amphitheater		Music TBA	07/12/96 09:00:00 PM	07/12/96 11:00:00 PM
Cultural	Center for Puppetry Arts Mainstage		Toppy - Turvy World	07/13/96 11:00:00 AM	07/13/96 01:00:00 PM
Cultural	Center for Puppetry Arts Mainstage		Toppy - Turvy World	07/13/96 03:00:00 PM	07/13/96 05:00:00 PM
Cultural	14th Street - Second		Actin's Express: The Harvey Milk Show	07/13/96 03:00:00 PM	07/13/96 05:00:00 PM
Cultural	Woodruff Arts Center		Royal National Theater	07/13/96 03:00:00 PM	07/13/96 05:00:00 PM
Cultural	14th Street - Main		The Alabama Shakespeare Festival: Lizard by Dennis Covi	07/13/96 00:00:00 PM	07/13/96 10:00:00 PM
Cultural	Woodruff Arts Center		SITI - Short Stories	07/13/96 00:00:00 PM	07/13/96 10:00:00 PM
Cultural	Woodruff Arts Center		Royal National Theater	07/13/96 00:00:00 PM	07/13/96 10:00:00 PM
Cultural	Atlanta Civic Center		Miami City Ballet	07/13/96 08:00:00 PM	07/13/96 10:00:00 PM
Cultural	Center for Puppetry Arts Second Stage		Frankenstein	07/13/96 08:00:00 PM	07/13/96 10:00:00 PM
Cultural	The Olympic Amphitheater		Music TBA	07/13/96 09:00:00 PM	07/13/96 11:00:00 PM
Cultural	14th Street - Second		Actin's Express: The Harvey Milk Show	07/14/96 03:00:00 PM	07/14/96 05:00:00 PM
Cultural	Woodruff Arts Center		Royal National Theater	07/14/96 03:00:00 PM	07/14/96 05:00:00 PM
Cultural	14th Street - Main		The Alabama Shakespeare Festival: Lizard	07/14/96 08:00:00 PM	07/14/96 10:00:00 PM
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Cultural	The Olympic Amphitheater		Music TBA	07/14/96 09:00:00 PM	07/14/96 11:00:00 PM
Cultural	Center for Puppetry Arts Mainstage		Kudzu Jack and the Giant	07/15/96 11:00:00 AM	07/15/96 01:00:00 PM
Cultural	Center for Puppetry Arts Mainstage		Kudzu Jack and the Giant	07/15/96 03:00:00 PM	07/15/96 05:00:00 PM
Cultural	14th Street - Main		Alabama Shakespeare Festival: Lizard	07/15/96 03:00:00 PM	07/15/96 05:00:00 PM
Cultural	Atlanta Civic Center		Miami City Ballet	07/15/96 03:00:00 PM	07/15/96 05:00:00 PM
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Cultural	The Olympic Amphitheater		Music TBA	07/15/96 09:00:00 PM	07/15/96 11:00:00 PM
Cultural	Center for Puppetry Arts Mainstage		Kudzu Jack and the Giant	07/16/96 11:00:00 AM	07/16/96 01:00:00 PM
Cultural	Center for Puppetry Arts Mainstage		Kudzu Jack and the Giant	07/16/96 03:00:00 PM	07/16/96 05:00:00 PM
Cultural	14th Street - Second		Actin's Express: The Harvey Milk Show	07/16/96 03:00:00 PM	07/16/96 05:00:00 PM
Cultural	14th Street - Main		The Alabama Shakespeare Festival: Lizard	07/16/96 08:00:00 PM	07/16/96 10:00:00 PM

Sort by: Search Location:

[Return to Map Display](#)

Figure 4-4. The Event Manager module.

The Simulation Tool requires the user to enter a start and end time for the simulation period and an update interval for the display. The simulation setup screen is displayed in Figure 4-5. Once initialized, the simulation is started and the map display updates according to the simulation. Figure 4-6 illustrates the active simulation interface for the Simulation Tool. The user can choose to play the simulation forward, backward, or to pause the advance of the simulation clock. Moreover, event activity is displayed in the bottom window to give a text description of what is happening throughout the city. Color codes for venues change depending upon the status of events scheduled to occur at the venue. Events which are about to begin or have just ended are displayed by shading the venue footprint yellow, active events are displayed by shading the venue footprint orange. Incidents, such as the Centennial Olympic Park bombing, can also be input into the Event Manager and are displayed on the map by coloring the venue footprint red. In the planning stages, officer locations are not displayed on the map since they are not determined until an actual deployment.

Since all data are stored historically, the Simulation Tool can be used following a deployment to analyze the police response to a variety of situations. Since police positions are determined during a deployment, officer locations will be displayed. Using the Simulation Tool, the user can set a start time at a point during the deployment and view the activity level at venues and the police positions during the events. This tool can also be used to view what happened on a previous shift. In the aftermath of the

Start Date/Time: 07/27/96 12:00:00 AM	 Run Simulation
End Date/Time: 08/05/96 12:00:00 AM	
Frame Rate: Fast (10 second refresh) Slow (30 second refresh)	Done
Time Lapse: 15 Minutes ☒ Tabular Event Display	

Figure 4-5. The simulation set-up screen.

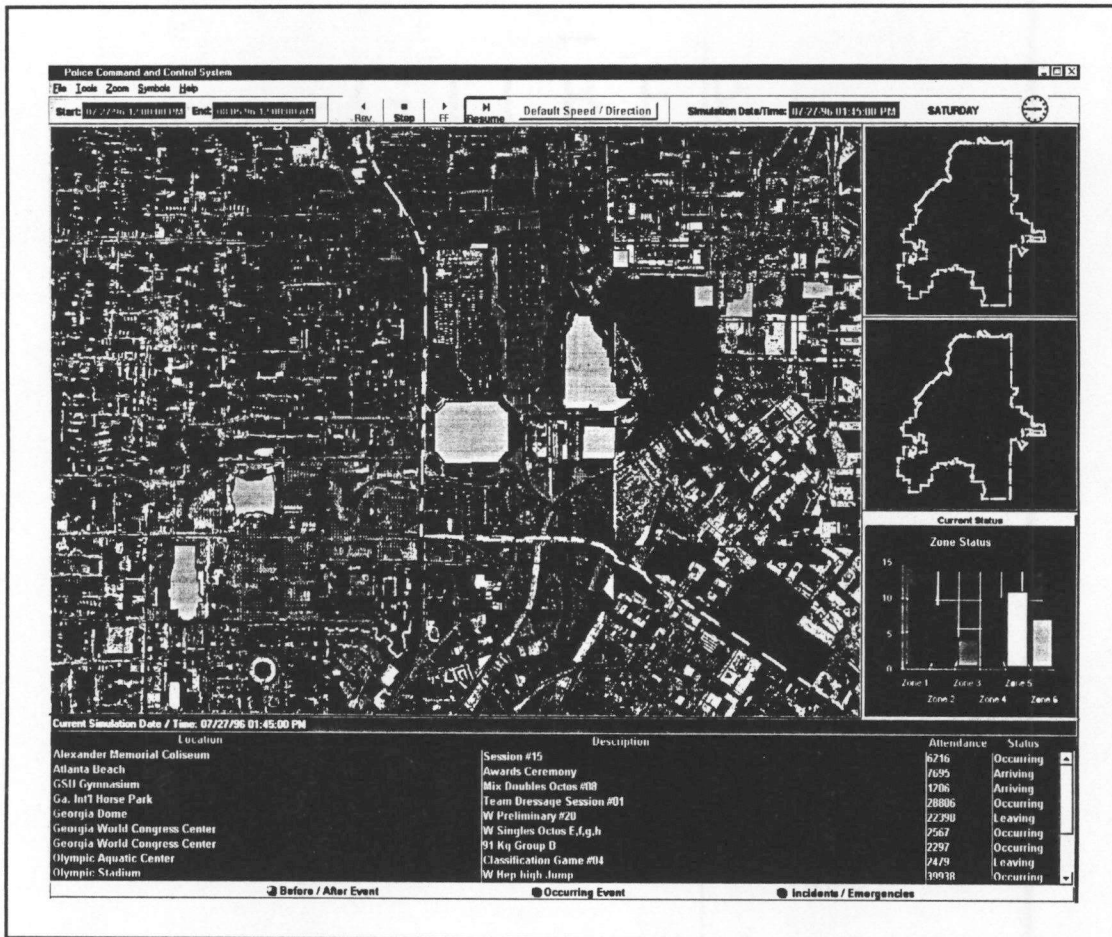


Figure 4.6. The simulation interface.

Centennial Olympic Park bombing, the Simulation tool was used by the Atlanta Police to view the police response to the bombing.

Situation Management

Situation Management differs only slightly from Situation Simulation discussed above. The major difference is the real-time aspect of its operation. During a deployment, the Event Manager contains actual events, and officer locations are displayed on the map. Moreover, actual incident and traffic restriction information is available. The map display updates every five minutes with data sent from Field Manager systems. Officer locations are displayed on the map and may be queried; however, officer positions cannot be moved on the Central Manager, rather, this operation is performed on the Field Managers. If a police commander needs changes in officer positions, the site commander is notified, gives new orders to the officer, and performs the change on the Field Manager.

As data are sent from the Field Manager systems to the Central Manager each record is time-stamped to indicate the time at which it was last updated. To alleviate a huge volume of data, Field Manager systems only update the Central Manager when major changes are necessary. At each time interval the Central Manager queries the appropriate tables and updates the map to reflect any changes. To maintain consistency venue footprint shading is identical to that used by the Simulation Tool.

Communications

The Communications Module of the Central Manager performs communication with the Field Manager systems. Files to be transferred are placed into the Communications Module, and a database table is updated indicating which Field Manager systems are to receive the specified file. A file naming convention allows the Communications Module to determine the status and type of these files. The Communications Module, written in *Visual FoxPro 3.0*, operates by periodically checking to determine if new data need to be sent to Field Manager systems. If it is determined that data are waiting to be sent to the Field Managers, the Communications Module uses a modem to dial in to the appropriate Field Manager and transfers the required files.

When data are received from Field Manager systems, a separate timer is activated which moves the files sent from the Field Managers into their appropriate locations. Most of the data files sent from the Field Manager are meant to update pre-existing tables in the Central Manager; however, others such as the incidents table and unplanned traffic restrictions replace existing tables. The update and replacement of existing tables is performed internally by the Central Manager and is beyond the scope of this work.

The Communications Module is designed to support up to four modems which can simultaneously transfer files to or from four different Field Manager systems. Conversely, the implementation of the Communications Module on Field Manager

systems only supports a single modem. The Communications Module was designed in this manner to minimize transfer time to all Field Manager systems and its design allows the Communications Module to simultaneously send and receive files on the Central Manager.

Conclusion

The Central Manager system is designed to be located in the police Agency Command Center. Its centralized data gathering and display functions allow the police commander to plan for situations and monitor them as they develop. Unlike the Field Manager discussed in Chapter 5, which gives site commanders only a localized view of the city, the Central Manager gives the main police commanders an overview of all situations in the city.

Centralized management of police forces is not performed during normal operations. However, during a “crisis” such as that presented by the 1996 Centennial Olympic Games, the Atlanta Police deemed it necessary. Given that the city was expected to experience complete traffic gridlock, centralized management was determined to be the best option for the management of police forces. Even so, the *Police Command and Control System*’s Central Manager does not allow police commanders to micro-manage police officers. Site commanders are responsible for the management of officers on Field Managers, while the police commanders are given a city-wide overview and can perform management via the site commanders.

Chapter 5

FIELD MANAGER

This chapter provides a description of the Field Manager module of the *Police Command and Control System*. The Field Manager contains most of the daily administrative and operational tools used by site commanders to manage police forces at locations. These tools include the Personnel Manager, Time Keeping, the Emergency Action Checklist, online References, a Messaging system and an electronic Pin Mapping system.

To remain useful following the Olympics, it was decided that the Field Manager would have two modes of operation. In Non-Contingency mode, the Field Manager operates independently of the Central Manager. Schedules and data are maintained for the local databases only, and not sent to the Central Manager. This mode of operation is expected to be used during normal police operations. The other operational mode, Contingency, is the focus of the rest of this chapter, since it was the mode used during the 1996 Olympic Games. In Contingency mode, the Field Manager system is very tightly knit with the functionality of the Central Manager. For individual officers to appear in the Field Manager, a current schedule is required to be sent from the Central Manager via the Communications module. This schedule automatically updates the current schedule in the Field Manager. Communications breakdowns may cause the Field Manager to lose

synchronization with the Central Manager, and in these cases the schedules may need to be hand delivered to keep the systems synchronized.

The main interface of the Field Manager system is a series of buttons which allow the user to access its functions. Figure 5-1 illustrates the main Field Manager screen. Most of this functionality is described in detail below. Of particular note, however, is the system setup button. This function allows the user to perform several tasks. From this interface, the user may select the mode of operation (Contingency or Non-contingency). Moreover, the user may elect to enable the Pin Map function and select its view. For example, the Pin Map function was not needed during the Olympics at the staging areas for the Atlanta Police. However, the venue locations and the Traffic / Public Safety Field Managers, each required different Pin Map views. This function allowed for the easy setup of each system.

Personnel Manager

Typically each shift in police work starts with Roll Call. The Field Manager system facilitates this task by printing electronic roll call sheets which may be used to check roll. In the *Police Command and Control System* data for Roll Call are taken from the current schedule. The schedule is sent from the Central Manager on an ad hoc basis as changes are made. Officers appear on the day's roll call based upon the shift selected. Figure 5-2 illustrates the Personnel Manager interface.

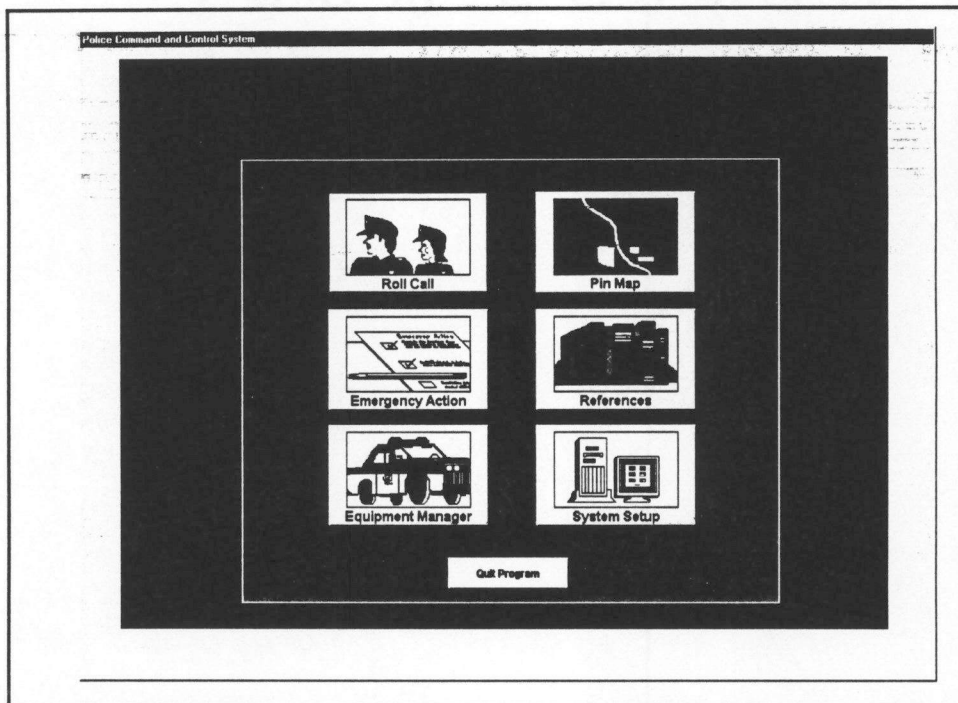


Figure 5-1. The Field Manager start-up screen.

Personnel Manager

Roll Call | Shifts | Personnel

Shifts: < all shifts > | Monday, July 29, 1996 | Reset to Present

Shift Name	Rank	Name	Unit	Duty	Absence
	Officer	Donald Rene	AHA	Public Safety / Traffic	
Atlanta University Cent	Sergeant	John Bell	Zone 1	Traffic Supervisor	
Atlanta University Cent	Sergeant	Joseph Knox	Zone 1	Traffic Supervisor	
Atlanta University Cent	Sergeant	Duyle McCall	Zone 4	Traffic Supervisor	
Atlanta University Cent	Sergeant	Carrie Mills	Zone 1	Traffic Supervisor	
Atlanta University Cent	Investigator	Robert Daniels	Narcotics	Public Safety / Traffic	
Atlanta University Cent	Investigator	Thadcaus Dansby	License & Permits	Public Safety / Traffic	
Atlanta University Cent	Investigator	John O'Brien	Auto Theft	Public Safety / Traffic	
Atlanta University Cent	Officer	Patricia Cucciolone	Zone 2	Public Safety / Traffic	
Atlanta University Cent	Officer	Micah Connor	Zone 4	Public Safety / Traffic	
Atlanta University Cent	Officer	Thomas Cox	Zone 6	Public Safety / Traffic	
Atlanta University Cent	Officer	Melissa Davis	Zone 3	Public Safety / Traffic	
Atlanta University Cent	Officer	Darin DeGraffireed	Zone 4	Public Safety / Traffic	
Atlanta University Cent	Officer	Charles Dean	Zone 5 Fair Pop	Public Safety / Traffic	
Atlanta University Cent	Officer	Robert Franks	Zone 3	Public Safety / Traffic	
Atlanta University Cent	Officer	David Freeman	Zone 1	Public Safety / Traffic	
Atlanta University Cent	Officer	Steven Frugoli	Zone 2	Public Safety / Traffic	
Atlanta University Cent	Officer	Nicole Hedley	Zone 6	Public Safety / Traffic	
Atlanta University Cent	Officer	Karena Lindley	Zone 2	Public Safety / Traffic	
Atlanta University Cent	Officer	Trent Lowe	Zone 3	Public Safety / Traffic	
Atlanta University Cent	Officer	Kevin Ofchus	Red Dog	Public Safety / Traffic	
Atlanta University Cent	Lieutenant	Darrell Ingram	Zone 2	Traffic Supervisor	
Atlanta University Cent	Sergeant	Robert Creasy	Zone 4	Traffic Supervisor	
Atlanta University Cent	Sergeant	Patricia Johnson	Zone 4	Traffic Supervisor	
Atlanta University Cent	Sergeant	Christophe Tiernan	Zone 4	Traffic Supervisor	
Atlanta University Cent	Investigator	Raymond Atwater	Larceny	Public Safety / Traffic	
Atlanta University Cent	Investigator	Adrian Parker	Auto Theft	Public Safety / Traffic	

Print Roll

Default Number of Hours to Report to Headquarters and Timekeeping: 12.00

Return to Main Menu | Send to Headquarters

Figure 5-2. The Personnel Manager screen.

On the Roll Call option screen, the user selects the desired shift and the officers scheduled to work on the shift selected appear on the computer roll call sheet. These data can be printed so that the commander may call roll normally and enter the information into the computer later. If an officer is absent, the system allows users to mark the reason for any absence. These data are automatically converted into the appropriate code used in the Time Keeping module of the Field Manager described below. If the Field Manager is operating in Contingency mode, the user presses the "Send To Headquarters" button which sends the Roll Call data to the Central Manager.

Time Keeping

The second principal administrative tool in the Field Manager system is the Time Keeping module. It is designed to speed input of individual officer's hours worked or spent on leave. To the officer on the beat, this is the most critical module of the *Police Command and Control System*. Since most officers are paid on an hourly basis, an accurate accounting of their hours is of critical importance.

To minimize the speed of learning the Time Keeping module, its design provides a replica of the standard Atlanta Police Department time book. Time sheet printouts can be produced which are identical to those in the time book; however, each officer charged with time keeping must still generate a spreadsheet-like report of time for the unit. The Time Keeping module operates both in Contingency and Non-Contingency modes. As in

the Personnel Manager, the Time Keeping module requires a current schedule when operating in Contingency mode. Under Contingency mode conditions, time is input at staging areas and sent to the Central Manager from which unit reports may be distributed.

Emergency Action Checklist

The Emergency Action Checklist represents a powerful operational tool for managing emergency situations. The checklists are designed to facilitate decision making at the site commander level. As checklists are completed, they are time-stamped and saved for historical purposes. These saved checklists may be called up later to aid the site commander in completing incident reports, or to refresh their memory when testifying in a criminal trial. The 1996 Olympic Games presented several problems for the Atlanta Police. Uncommon situations in normal operations were expected to be much more common during the games. As a result, the Emergency Action Checklist system was developed. Figure 5-3 illustrates the Emergency Action Checklist module of the Field Manager system.

The Checklist module allows users to view the appropriate responses for a variety of anticipated potential incidents. As incidents occur, the user selects the appropriate checklist, and completes each action. The checklists are divided into response sections for the first responding officer and the Law Enforcement Venue Commander. As each item is completed, the "Completed" check box is marked and notes may be entered

Emergency Action Checklist

Run Checklist

Add/Edit

Historical Checklists

Currently Open Checklists

BARRICADED GUNMAN AND SNIPERS

Open A New Checklist

Remove Open Checklist

Checklist Items

BARRICADED GUNMAN AND SNIPERS

The Law Enforcement Venue Commander

1. Dispatch a law enforcement field supervisor to the scene to evaluate the situation.

2. Immediately notify the Tactical Specialized Management Center or the primary Tactical Response Team.

3. Immediately notify the Agency Command Center who will in turn notify the Joint Coordination Center/Joint Operations Center.

The first law enforcement officer(s) on the scene

2. Contain the suspect in the smallest area possible using the minimum amount of force necessary.

3. Inform the law enforcement Venue Commander or his/her designee of the situation and the exact location of the sniper or barricaded subject.

4. Secure an inner perimeter pending the arrival of the primary Tactical Response Team.

5. Establish an outer perimeter and provide crowd control. Provide alternate vehicular traffic routes, if needed, along with emergency vehicle ingress and egress traffic routes.

☒ Completed

Comments on Procedures:

Requested multiple backup units

Date/Time Completed:

11/15/1996 - 0600

Messages

Close Out Checklist

Return to Main Menu

Figure 5-3. The Emergency Action Checklist module interface.

regarding the response taken. A time-stamp is added to each item as it is completed. To respond to multiple situations, the user may have more than one checklist open at a time.

References

The References module is another tool included in the Field Manager for operational support. This function was developed using an internet web browser and documents formatted in Hypertext Mark-Up Language (HTML). HTML documents can reference other documents by means of embedded code specifying a hyperlink. The document appears to be a normal word processor document except that certain words are underlined and displayed in a different color (usually blue) indicating that the word is a hyperlink to another document. Implementation of the Online References module required making a call to start the web browser from Visual FoxPro.

The Online References module starts up with an master index of available documents. Most of the available documents are chapters in the Atlanta Police Law Enforcement Handbook; however, the documents also include other operations such as the inclusion of help for different modules of the Field Manager. Since the Online References module uses a separate application to display its data, it may be run simultaneously with the Field Manager.

Messaging System

Although the Atlanta Police have a city-wide radio system, it is occasionally necessary to transfer notes in writing to another officer. The messaging system is designed to assist this process. Much like an electronic mail system, the Messaging System allows users to send messages to the Central Manager and vice versa. However, the Messaging System also allows users to compose messages for local use only.

Messages may be sent to the Central Manager and all other active Field Managers, the Central Manager only, or maintained locally. Messages sent to other Field Managers are sent first to the Central Manager and then to the other Field Manager machines. The communication of messages is performed using the Communications Module described in Chapter 4. An internal timer determines if new messages are waiting, and the Messages button on the main Field Manager interface displays an animated lightning bolt indicating that a new message has arrived.

Electronic Pin Map

The Electronic Pin Map module of the Field Manager is the primary operational tool for the management of police forces. Functions in the Pin Map allow site commanders to position forces, assign them duties, manage traffic situations, and track incidents. The Pin Map is designed to be deployed for force management both inside and outside

athletic venues. Cartographic tools in the Pin Map allow users to identify features, zoom and pan on the display, save desired views and to create maps for output. Depending upon the installation, the Pin Map can require anywhere from 12 megabytes of spatial data at an athletic venue to 400 megabytes of spatial data for the Traffic and Public Safety Field Managers. Figure 5-4 illustrates the Pin Map's main interface.

Deployment of the Pin Map inside an athletic venue requires several special considerations. First, some of the functions which require the city map are disabled. These functions include the ability to restrict traffic within the city and to locate addresses. Inside an athletic venue, the mapping system displays Computer-Aided Design (CAD) drawing rather than the traditional city map. Unlike the city map, deployment within athletic venues did not support zoom layering. Rather, each CAD layer is loaded into the map at startup with only the main venue level visible. As the user selects a level to view, the system toggles off the visibility of the non-selected level and makes the selected level visible. An additional consideration is the location of police officers on various levels. To avoid having all officers appearing on every level, a "level code" was established which assigns a numeric level code to each venue level. This information is stored in the Loader Table discussed in the preceding chapter. As officers are sent to a new level, their level code is updated to reflect their current level. As levels are changed, the level code of the officer is queried to determine which officers are to

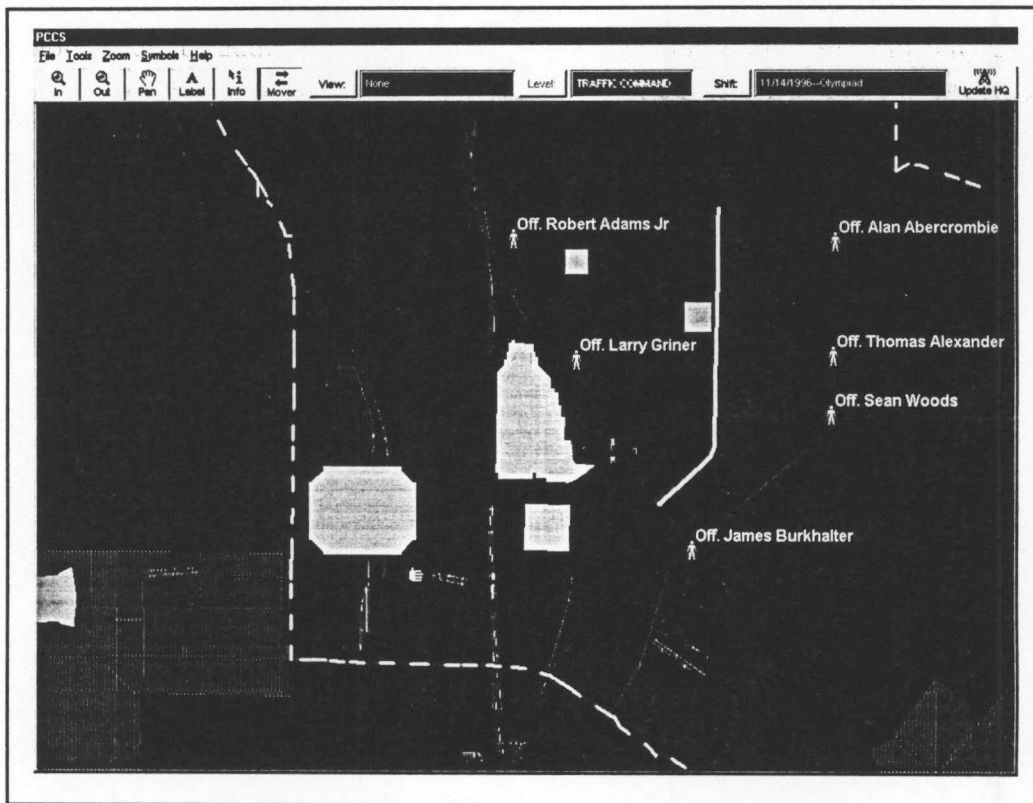


Figure 5-4. The Electronic Pin Map interface.

appear on the new level. Figure 5-5 illustrates this process. Officers outside of athletic venues are assigned a level code of zero which corresponds to the city streets. For each athletic venue, the Atlanta Police provided a CAD drawing for each level of the venue. These CAD files were located in a different coordinate space from the city map. To deal with this problem, the CAD drawings were transformed to fit into the city map's coordinate space. An additional consideration are map colors. By default the city map maintained black as a background color while the CAD drawing's background color was white.

Upon starting the Pin Map in a venue, the user selects a shift or shifts for management. Officers for each shift are taken from the Roll Call function of the Personnel Manager module. Initially all officers appear on the venue's Main Level. Positioning of officers is performed by informing the officers of their post locations, and dragging the icons representing the officers to the corresponding map location. The Field Manager allows the operator to assign several officers to a new level at the same time. To view another venue level, the user selects the Level button from the main Pin Map interface. This action brings up a list of available levels from which the user may choose. Choosing a different level changes the view to the new level. The Level button is not available to city-wide implementations of the Pin Map.

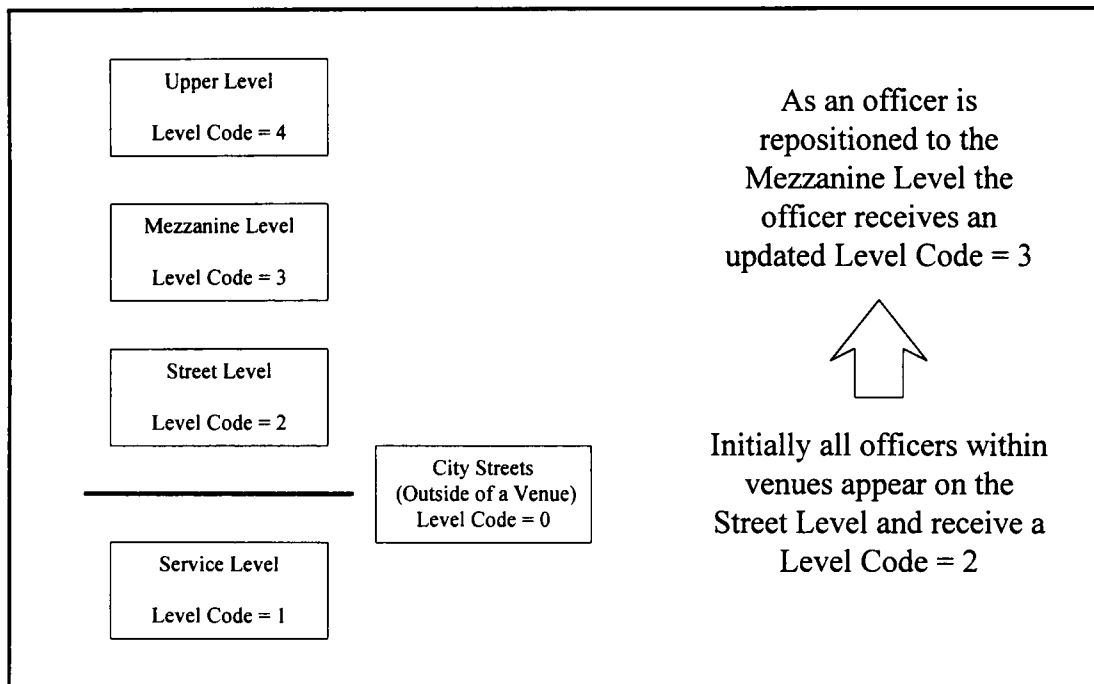


Figure 5-5. Sending officers to different levels in a venue.

Rather than displaying venue diagrams, the Traffic and Public Safety Field Manager systems displays a city map of Atlanta. Options which are unavailable inside of a sports venue are enabled on these systems. These options include the location of addresses, the traffic management tools and some of the labelling tools. Officers are positioned in the same manner as inside a venue; however, a few additional options are present. In these cases, officers may be sent to a street intersection or to an address. Several officers can be moved to a street intersection or address simultaneously using MapInfo's address geocoding functionality to return the coordinates for the prospective post location. This tool was added during the Olympic Games to facilitate the rapid redeployment of forces responding to emergency situations.

After positioning officers, the unit commander may want to remember the rationale for placing the officers at the chosen locations. To aid in this task, the user can choose to enter post orders for an officer or for groups of officers. The user can print a report of the officers along with their daily duty for the site commander. The user may also wish to print a map of the officer locations. Officer locations can be identified on the map by displaying the officer's name by the icon representing the officer. To print maps for site commanders, particularly those displays with a black background, the Pin Map automatically changes the background color, so that the map is not obscured.

During the Olympic Games, the City of Atlanta developed a traffic management plan which included several street closures, lane restrictions, and temporary direction reversals. The data for the master traffic plan were included in the Pin Map for Traffic and Public Safety Field Manager systems. However, the Atlanta Police needed to be able to add unexpected temporary traffic restrictions to respond to emergency situations. The Traffic Restriction tool was developed to deal with such potential problems. New restrictions could be added on streets between street intersections. Since the city's streets basemap did not contain topology, a heuristic approach was used to close these corridors rather than using a shortest path algorithm. The corridor is defined by selecting the street to close and its bounding intersections. The Traffic Restriction tool relies on street database accuracy to perform its task. Two circles, one originating at each bounding intersection, are created with the distance between the origins as the radius for each. All street segments which have the same name as the street to close which also lie within both circles are selected, highlighted and restricted. Figure 5-6 illustrates the street closure process. A second form allows the user to enter traffic restriction information (closed, lane restrictions, etc.). Traffic Restrictions may be edited or removed using one of the other Traffic Restriction tools.

While not intended to replace the city's Emergency 911 system, the localized incident tracking function in the Pin Map allowed site commanders to illustrate potential problem areas in the city. This tool allowed users to place an incident on the map and enter

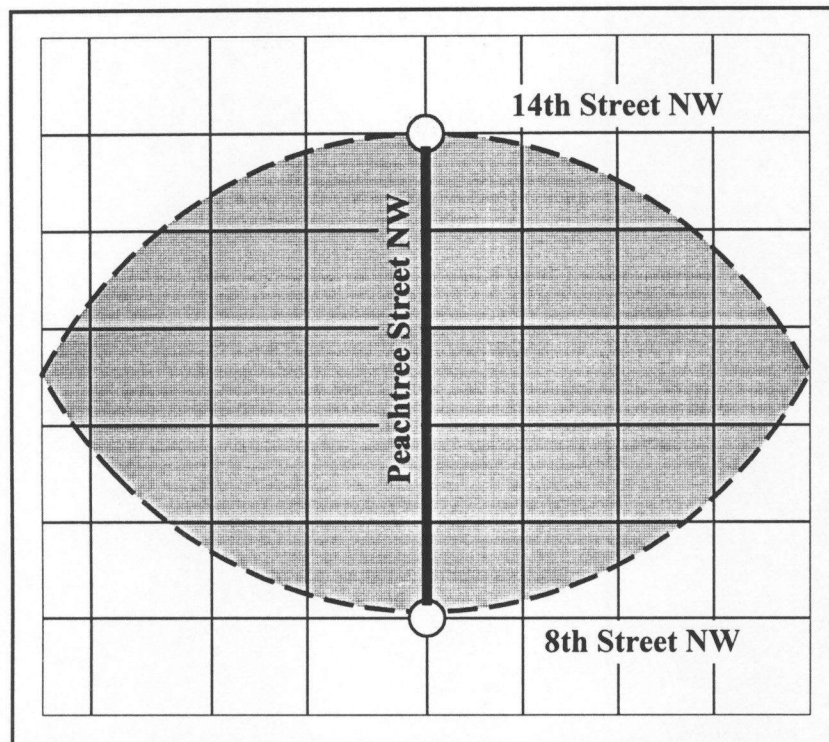


Figure 5-6. Creation of an unplanned traffic restriction. In this example, the user creates an unplanned traffic restriction on Peachtree Street NW, between 8th Street NW and 14th Street NW. The shaded area represents the intersection of two circles of equal radius, originating at the bounding intersection. All streets within the shaded area are selected; however, only those streets named Peachtree Street NW are restricted.

information about the incident into the database. Incidents can be classified using a variety of methods. The Pin Map module of the Field Manager allows three of the major types of incidents to be tracked: Crowd incidents, Traffic incidents, and Crime incidents. Each type of incident is illustrated using a different icon on the map. This option was used extensively in the aftermath of the bombing of Centennial Olympic Park. Entry of incidents requires the user to select its location on the map and to enter any pertinent information about the incident in the dialog shown in Figure 5-7.

The city map displayed on the Traffic and Public Safety Field Manager Pin Map modules is comprised of several different data layers. These layers include centerline and non-centerline versions of the street network, building footprints, athletic venue locations, parking areas, the city's traffic master plan, an aerial photo mosaic registered to the street network, and several other data layers. Like the Central Manager system discussed in Chapter 4, the Electronic Pin Map is designed to support zoom layering. Moreover, it also includes an interactive legend to alleviate confusion among the data layers.

In Contingency mode, as significant changes are made to officer positions, incidents, or traffic restrictions, the user sends these data to the Central Manager. These data are transferred into the communications queue and where they await transfer to the Central Manager. The transfer process requires the electronic transfer of up to nine separate files

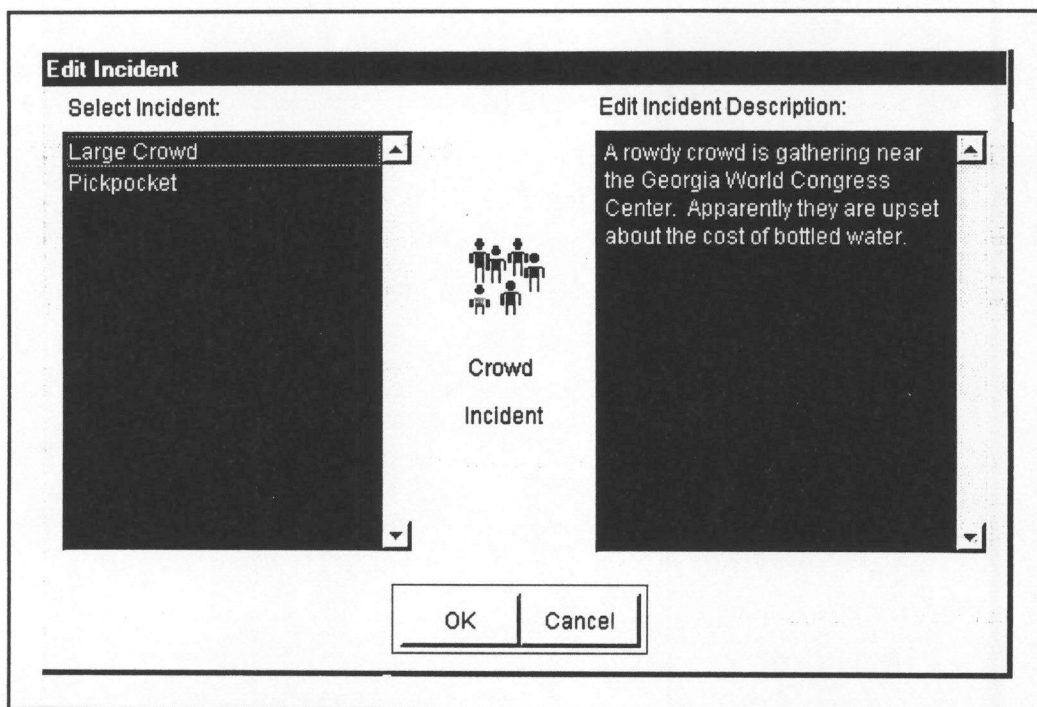


Figure 5-7. The Edit Incident dialog.

to the Central Manager which stores these files historically and integrates the data for situation monitoring.

Conclusion

Not only did the Field Manager represent a significant step forward in the technology available to the Atlanta Police, but it also aided localized force management by on-site commanders. When operating in Contingency mode, the system shares data with the Central Manager so that those higher in the command hierarchy can be kept apprised of developing situations. In Non-Contingency mode, the Field Manager assists unit commanders with the Time Keeping and Personnel Management functions which are used daily in police work. The Emergency Action Checklist provides commanders with a “paper trail” which may be used as a reference for the creation of police reports or for testifying in court. Moreover, the Pin Map can be used to track officers and incidents such as gang-related crimes or drug arrest locations. A resulting potential use is a crime analysis system to help the Atlanta Police take a proactive approach to decreasing the effects of crime in the city.

Chapter 6

MAPPING SYSTEM EVOLUTION

This chapter examines the evolution of the *Police Command and Control System* mapping system. The majority of the *PCCS* was developed using Microsoft's *Visual FoxPro 3.0*, a powerful database management and development language. The mapping system was originally written using *ArcView 2.1*; however, its limitations such as its lack of compliance with the *Windows* Application Program Interface (API) discussed below, necessitated a change of mapping applications to *MapInfo Professional 4.0*. The integration of *Visual FoxPro* and the mapping system necessitated this change. The Pin Map of the Field Manager system took a somewhat different development path. The evolution for the mapping systems is discussed below.

Discussion of *ArcView 2.1*

ArcView 2.1 is a desktop-based GIS system which allows users to map and analyze various types of data. The system, developed using Neuron Data's *Open Interface*, provides users with the same interface on multiple platforms. This cross-platform interface represents one of the program's greatest strengths; however, in the case of the *PCCS* it represented its greatest drawback.

ArcView, developed by ESRI, provides users with a project document that contains individual views, tables, graphs, map layouts, and scripts that may be treated as a single master document. Moreover, *ArcView*'s scripting language, Avenue, allows users to modify the interface to create custom applications. Avenue is an object oriented language which provides a great deal of flexibility in dealing with data and the interface. Spatial data for *ArcView* are stored in either *Arc/Info* format, as an open data structure known as a Shapefile, or as *AutoCAD* DWG files.

Views in *ArcView* are created as a collection of individual layers which may be ordered by the user. An interactive legend is present at the side of each view indicating the color codes for each layer. The interface allows users to implement zoom layering. That is, the visibility of certain layers can be toggled on or off depending upon the current map scale. Users may pan or zoom into specific areas on the map, identify, label, or select features on the map provided that the layer is selected in the legend. Such a system is quite powerful for spatial query and analysis.

Tables in *ArcView* are used to store data which may or may not be spatially referenced. Spatially referenced tables may be linked to a view containing the spatial layer. The native format for tables in *ArcView* is the DBF file. However, tables from any Open Database Connectivity (ODBC) compliant database may be included. Moreover, the system treats INFO tables as a second native format. Tables may be opened as shared

tables tightening the ability to integrate with *Visual FoxPro*, which also uses the DBF file as a native file structure.

The charting system in *ArcView* is quite powerful. The system allows the user to create a wide variety of charts in the system, each of which may be linked to data displayed in a view. This tight integration between the charts and view allows users to identify features on a map when a piece of a chart is identified. Moreover, each chart is automatically updated when data for the map are updated. The charting system is limited by the inability to fully change the chart's display characteristics using Avenue. The lack of the ability to programmatically configure charts eventually required the use of a third party graphing package to obtain the desired charts.

ArcView provides a powerful system for creating presentation graphics called layouts. Users may create layouts consisting of views, charts, and tables which can be automatically updated as the underlying document is changed. While such a system is quite powerful, its usefulness to the *PCCS* is limited. Since only views were printed by the *PCCS*, the layout document was unavailable for use.

Avenue, *ArcView*'s scripting language, allows the user to customize the user interface and to create custom applications. The language is object-oriented allowing for powerful manipulation of multiple types of documents with a single piece of code. The language

allows for communication with other applications via dynamic data exchange (DDE). However, as a result of *ArcView*'s development with *Open Interface*, Avenue does not support object linking and embedding (OLE). Data input forms may be created using C, C++ or any other language which allows users to create forms and store them in a dynamic link library (DLL).

A major consequence of the cross-platform development approach in *ArcView* 2.1 is the interface itself. The *ArcView* interface appears to be a Microsoft *Windows 3.1* system even when the system is run using *Windows 95*. Since the *PCCS* was developed using *Windows NT 3.51* with the *Windows 95* shell preview program, *ArcView* appeared out of place. Moreover, the system did not support a variety of application program interface calls which will be discussed below.

Discussion of *MapInfo Professional 4.0*

MapInfo Professional 4.0 is a desktop mapping package. The system does not support complex spatial analysis as well as *ArcView*. Nonetheless, many of the functions allow the user to perform simple spatial analysis. Like *ArcView*, *MapInfo* can create maps, tables, charts, and layouts; however, an add-on product, *MapBasic*, is required to make modifications to the interface. Unlike *ArcView*, *MapInfo* allows individual documents that are not linked to a master document.

Maps in *MapInfo* behave much like they do in the *ArcView* mapping system. Data are added as map layers which may be customized. However, unlike *ArcView*, layer display and control is handled outside of the document through a separate interface. The use of a separate interface for layer display and control, while somewhat more difficult than *ArcView*'s document-linked interface, did not pose problems to *PCCS*. The use of a dynamic legend, discussed in Chapter 5, replaced the use of both *ArcView*'s and *MapInfo*'s legend capabilities.

Several differences are apparent in the map display capabilities of *ArcView* and *MapInfo*. The most glaring difference is the presence of *MapInfo*'s Animation Layer. Since *ArcView* does not support a separate layer for animation, any change to the map required a complete screen redraw. The Animation Layer is a layer which allows for rapid updates without requiring a complete screen redraw. *ArcView*'s lack of an Animation Layer resulted in slower times for overall map display and required tricks to get the map to perform as desired. A second major difference is *MapInfo*'s inability to display *AutoCAD* DWG files. *MapInfo* requires that *AutoCAD* DWG files be converted to DXF files which may be imported into native *MapInfo* tables. The conversion to native *MapInfo* tables required a few days, but resulted in a vast improvement in display speeds, since *ArcView* performs a similar conversion each time the DWG file is loaded into memory. Moreover, *ArcView*'s display engine for DWG files resulted in the loss of the annotation for CAD files.

The project document approach in *ArcView* limited the flexibility of the system. All data needed to be pre-loaded into the system which presented problems as new data layers needed to be added. In *MapInfo*, the lack of a unified project document actually made implementation of the *PCCS* more flexible. A data-driven approach which read the data layers to be displayed on the map from a file allowed rapid changes to be made to individual layers outside the system.

The *MapInfo* charting system is somewhat more limited than *ArcView*'s. A greater variety of charts are available; however, the charts are static and may not be linked to map data. The lack of linkage between maps and charts was not an impediment to later implementations of the *PCCS*, since a third party charting package had already been chosen.

The table document type in *MapInfo* is similar to that of *ArcView*. Tables may be stored in native format or as DBF files. Moreover, ODBC tables may be incorporated. Unlike *ArcView*, however, tables are opened exclusively. This situation prevented tables from being shared simultaneously by *MapInfo* and *Visual FoxPro*. A solution to this impasse was required.

The *MapBasic* programming language is quite dissimilar to Avenue. The language is based upon BASIC rather than an object-oriented implementation. The BASIC roots for the language meant that performing operations that are quite simple in Avenue required a greater amount of code to perform the same task. Such a situation would seem to be an obvious drawback; however, *MapBasic* provides the user greater flexibility in its implementation than Avenue in that it allows the user to create custom data types and custom functions. The flexibility of *MapBasic* was of critical importance in the decision to convert from *ArcView* to *MapInfo*.

Unlike *ArcView*, *MapInfo* further allows developers to control the environment remotely using a process known as OLE Automation. This process, which is somewhat similar to DDE, is far more powerful in that controlled applications are not visible to the user. The use of this process led to a more unified interface appearance.

Windows Application Program Interface Issues

The *Windows* Application Program Interface (API) is the means by which all *Windows* programs communicate with the operating system. In addition to the *Windows 3.1* look of *ArcView* discussed above, several aspects of *ArcView* conflicted with the API during the implementation of the *PCCS*. Each conflict with the *Windows* API required a work around to be devised. These factors and the lack of support for OLE resulted in the switch from *ArcView* to *MapInfo*.

As discussed above, *ArcView*'s cross-platform development created barriers to the successful implementation of the PCCS. Individual document windows are hidden from the API by the main *ArcView* window. As a result, the user could reposition individual documents within the interface. This situation required a work-around to reset the window positions at the touch of a button. Conversely, *MapInfo* allows users virtually complete access to the API. Windows can be seen by the API and the user may manipulate them by using the document's window handle. This allows developers a high degree of flexibility and aids in creating integrated applications which act as a single application. Moreover, *MapInfo* windows can be "re-parented" to allow inclusion in other documents. For example, in the mapping interface in the final version of the PCCS, three *MapInfo* maps are re-parented into *Visual FoxPro* windows. This allows *Visual FoxPro* to specify all the display characteristics of the individual window, yet allows *MapInfo* to operate independently within the window. This re-parenting operation cannot be performed in *ArcView*.

Any mouse clicks on the *ArcView* interface brought the entire application to the front which gave the PCCS a disjointed look and feel. The solution required several API calls to keep any visible *Visual FoxPro* windows "always on top" of *ArcView* during interaction with the map. However, such an implementation prevented interaction with other programs. For example, the scheduler module of the Central Manager allowed

users to export data to Microsoft *Excel* for further analysis. When *Excel* was started, the application was obscured by several *Visual FoxPro* windows placed “always on top” of *ArcView*.

The lack of compliance with the *Windows* API required a wide variety of work-arounds to make the *PCCS* appear to perform as a single system. Another problem arose from conflicts with the use of OpenGL screensavers. When an OpenGL screensaver was activated by the operating system, *ArcView* shrank to a small size at the side of the screen, leaving several *Visual FoxPro* windows intact. The only work-around to this situation was to not use an OpenGL screensaver or to never allow it to activate during operation of the *PCCS*. This problem further contributed to the image that the *PCCS* was two separate applications working in tandem.

Electronic Pin Map Evolution

Development of the Pin Map module came late to the development of the Field Manager system. Originally conceived in December 1995, a working prototype of the Pin Map was operational by late January 1996. The prototype version of the Pin Map included some of the same functionality of the final version; however, the flexibility of the system was hampered because the system relied on bitmaps to display the map. Officer locations and incidents could be tracked in this manner, but the inclusion of venue and traffic data was not possible. Moreover, the developers experience problems with registration

accuracy of the bitmapped maps. This prototype was initially intended to be the final version of the Pin Map.

In late April 1996, a decision was made to convert the Pin Map module to a “true” interactive mapping application. By this time the conversion of the Central Manager mapping system from *ArcView* to *MapInfo* was complete. The conversion of the Pin Map was to be completed prior to the start of initial training sessions in mid-May 1996, two months prior to the system deployment date. A working prototype of the new Pin Map was completed in just under two weeks, and was made possible by the use of a common code base for both the Central Manager mapping system and the Pin Map.

Conclusion

Several factors led to the decision to change from *ArcView* to *MapInfo*. The lack of compliance with the *Windows* API in *ArcView* represents the primary rationale for the switch. *MapInfo*’s ability to be re-parented into another window allowed a greater degree of integration with *Visual FoxPro*, resulting in the look and feel of a single application rather than two application working together. Moreover, *MapInfo*’s support of OLE Automation allowed for greater stability and a nicer interface because all interface operations could be performed in one application (*Visual FoxPro*) that supported more powerful interface design capabilities. *ArcView*’s implementation required that interface design be performed in *ArcView*, reducing the flexibility for interface design.

Chapter 7

SYSTEM USAGE

This chapter examines the operational usage of the system and evaluates the success of several key components. The *Police Command and Control System* provided the Atlanta Police Department with a variety of tools to help manage their force during the Olympic Games.

Assumption Results

Many of the assumptions discussed in Chapter 2 proved to be inaccurate. As a result of planning by the Atlanta Committee for the Olympic Games (ACOG) and the city of Atlanta, many of the anticipated problems did not materialize; however, others which had not been expected became apparent. These assumptions had a significant impact on the operation of the *Police Command and Control System*.

Anticipated traffic congestion in the city was much less than expected. The majority of visitors took heed of warnings and chose not to drive to the downtown area. Most rode shuttle buses from the perimeter areas of the city or rode MARTA, whose ridership more than doubled (MARTA, 1997). Moreover, many downtown and midtown businesses allowed workers to tele-commute or to work flexible hours to relieve congestion.

Because of the use of mass transit facilities, and the lessened pressure of the downtown area workforce, traffic congestion was not as bad as anticipated.

Pedestrian traffic was quite heavy in the city particularly in and around the Olympic Ring. Moreover, pedestrian traffic was significantly worse for several days as a result of the closing of Centennial Olympic Park following the bombing. The park had initially received daily visits totalling more than 100,000 persons, and with its closing city visitors were forced into other areas of the city.

Crime in Atlanta had been expected to be significantly less than usual, and during the Olympic Games the city's rate of violent crime was reduced. With the exception of the Olympic Park bombing, most crime was restricted to petty thefts, ticket scalping, and prostitution offenses (Atlanta Police, 1996). The increased presence of security personnel appears to be a major factor in the drop in crime.

Low morale was initially expected to provide problems for the Atlanta Police during the Olympics; however, the incentives, notably relaxed overtime guidelines, alleviated most problems with morale. In fact, several officers volunteered to work on their day off to accrue more overtime pay. Shortly before the Olympics, the Atlanta Police reversed an earlier policy barring officers from wearing short pants while on duty. This reversal resulted in fewer officers suffering from heat-related illness (Gordon, 1997).

Nonetheless, a few problems did occur as an indirect result of the July heat. A handful of officers became ill due to spoilage of the box lunches they had been given. Officers who became ill needed to be replaced in the schedule used by the *Police Command and Control System*. Table 7-1 illustrates the initial assumptions and their results during the Olympics.

Advantages of the Police Command and Control System

One of the primary advantages of the *Police Command and Control System* was its use during the planning stages of for the Olympics. The system was used to develop operating plans for venues and for traffic-public safety positions. Moreover, based upon the activity level indicated by the situation simulation capabilities of the Central Manager, the system was used to refine requirements needed maintain order in the city.

The system was further used to develop a twenty-one day schedule for the Atlanta Police. As requirements were refined, the system was able to determine which officers were to be members of the Olympic Discretionary Force (ODF). Once the ODF was developed, the system was used by police planners to develop the schedule. The schedule took into account normal off-days and attempted to maintain as normal a schedule as possible given the requirements. Once a sufficient schedule was developed, individualized schedules along with mailing labels were prepared and printed by the system for each officer on the ODF.

Table 7-1. Outcomes of *Police Command and Control System* assumptions.

Assumption	Outcome
Traffic Congestion	Not as bad as expected
Heavy pedestrian traffic	Worse than expected
Not much violent crime	Valid, except for Olympic Park Bombing
Hot weather	Few heat related casualties
Six twelve hour shifts/week	Several officers volunteered on off days
Officer rotation	Fixed posts assigned
Dedicated data transmission lines	Several locations did not receive

The scheduling system of the *Police Command and Control System*, discussed in Chapter 5, provided the Atlanta Police one of its most powerful planning tools. It allowed police planners to develop schedules which held up when questioned for racial fairness – a question which had not been anticipated during the design phase of the system. Moreover, during the planning phases, multiple schedules could be run and analyzed separately to determine the most appropriate means of covering the anticipated security demands.

In the aftermath of the Olympic Park bombing, the system proved to be a valuable resource. The day following the bombing, the city's E-911 dispatch system reported more than 100 bomb threats (Atlanta Police, 1996); each of which had to be taken seriously. The *Police Command and Control System* allowed the police to monitor situations as they were reported. Individual threats were entered on the Public Safety Field Manager, and sent to the Central Manager which was able to display each incident on the overhead display screen. On the morning following the bombing, the Central Manager's situation monitoring and situation simulation capabilities, discussed in Chapter 5, allowed the police to play back the bombing, threats and incidents of the previous night and helped them to better maintain public safety. Moreover, Field Manager machines were used to create maps of possible threat locations for use by force commanders.

Perhaps the most important usage of the *Police Command and Control System* was from a public relations standpoint. ACOG and other agencies each had custom systems developed to assist them in planning and operating the Olympics. The *Police Command and Control System* not only assisted the police in planning and operating the Olympics, but it allowed the Atlanta Police to prove to Federal and State authorities that they were ready.

Shortcomings of the Police Command and Control System

Several shortcomings in the *Police Command and Control System* became apparent after the system became operational. These shortcomings resulted from a number of sources including the system design and management procedures established by the Atlanta Police. Furthermore, communication problems interfered with the operational implementation of the system.

The inability to devise a concrete set of system requirements early in the development process led to a considerable number of problems. With the short development period, the prospective tools created as part of early system prototypes required substantial rewrites of the software. While these tools helped to further define the system, their cost in terms of development time meant that other aspects of the system could not be fully debugged and evaluated. Moreover, the rapid pace of changes to the software led to problems in effectively training officers to use the system. Some new functionality was

added so late in the process that users did not have enough time to become comfortable in the system usage.

The change in mapping software from *ArcView 2.1* to *MapInfo Professional 4.0* cost more than a month of development time. Since both the Field Manager and the Central Manager system relied heavily on the mapping system, this change was quite expensive in terms of development time. The mapping system developer had to develop new specifications for interacting with each system, and these changes needed to be implemented rapidly by the other system developers. This cost led to inadequate debugging time to certain areas of the software such as the Time Keeping system discussed below. Nonetheless, the system did achieve a more unified interface with the new mapping software.

Once preliminary schedules were distributed to the ODF, several changes were to be expected. A much greater volume of changes was required to be made than originally anticipated. The Central Manager's method of posting schedule changes proved to be somewhat inflexible and making all of the changes required a great deal of effort.

Additional schedule changes resulted from the command decision that *all* officers were to be made available to the scheduler. As a result, several undercover narcotics officers threatened resignation rather than be forced to wear a uniform on the streets (Gordon, 1997). These positions had to be covered with other officers from the force.

Because of the scheduling module's inflexibility, the system tended to lag behind reality. All schedule changes were supposed to be approved by the Chief of Staff of the Olympic Discretionary Force (ODF). However, in the actual operation commanders at the staging areas tended to revert to familiar management practices and adjusted the schedules on an ad hoc basis. A greater volume of schedule changes occurred than had been anticipated, and a lag in reporting these changes resulted in cascading problems from the Central Manager to the Field Manager systems. Officers would not appear on the roll call sheets or the pin map at the Field Managers because the system could not keep up with the number of schedule changes. The issue of schedule changes took several days to resolve and eventually required intervention from the ODF's Chief of Staff.

The *Police Command and Control System* Field Manager's time-keeping system was to be used by officers of the Olympic Discretionary Force. Problems in the time-keeping system proved to be a major factor in the under utilization of the software. Due to speed of development, changes were required to be made in the time-keeping system without adequate testing time. No officer's time worked was lost by the system; however, some queries would occasionally post unexpected results. Several officers lost confidence in the system solely because of the problems in the time-keeping system. To alleviate these problems, a decision was made to revert the standard means of keeping time on a spreadsheet.

Additional problems from the time-keeping system resulted from the managerial policies of the Atlanta Police. Time was to be aggregated by the Olympic duty assignment, and then sent to the officer's regular Official Time-Keeper. However, several officers did not report time as required at the staging areas; rather, the Official Time-Keeper was notified of the officer's time. Several days passed before this time could be gathered at the Atlanta Police Agency Command Center, entered into the time-keeping spreadsheet, and redistributed to the Official Time-Keepers.

Communication limitations of telephone lines proved to be a major factor. During the development phase of the PCCS, data lines were to be located at all locations receiving Field Manager systems. However, several of the data lines had not been installed when the system became operational. Moreover, the data lines at the staging areas in two area high schools had been routed through a telephone switchboard which prevented access by outside modems. These problems greatly reduced the effectiveness of the PCCS because updated schedules could not be sent to the staging areas easily. To work around this problem, a "sneaker-net" was established which required visiting the staging areas on a daily basis to install schedules and download time-keeping information.

Another problem with communications resulted from officers at Field Manager locations using the system in an unauthorized manner. Officers at some sites would use the Field

Manager systems to dial into computer bulletin boards or the internet. Doing so required changing the modem configuration which prevented the system from communicating with the Central Manager. Rarely was the modem configuration reset to the appropriate parameters for communications to be reestablished with the Central Manager.

Perhaps the greatest shortcoming of the *Police Command and Control System*, as applied to 1996 Centennial Olympic Games, was its inability to deal with non-crisis situations. As originally envisioned the system would be operational in a city suffering from total traffic gridlock. Police force movements would be impeded in such a case and centralized management of forces would be necessary. During the Olympics, however, traffic in Atlanta posed few problems and moving about the city was much easier than expected. The lack of a crisis presented by traffic gridlock allowed the Atlanta Police to manage their forces more normally than had been anticipated. The resulting schedule changes and unanticipated managerial practices led to the many of the *Police Command and Control System*'s shortcomings.

Lessons Learned

This case study of the development of the *Police Command and Control System* provides a useful guide to several of the successes and failures encountered in developing a spatial decision support system for law enforcement. The failure to determine a concrete set of system requirements early in the development process greatly hindered the final outcome

of the project. Moreover, the short development period of thirteen months and the evolutionary prototyping methodology employed during the development required a monumental effort on the part of the system's developers, of which the author was a member. The software for many of the prospective tools delivered in early versions of the *Police Command and Control System* was eliminated entirely, or required several major revisions. Most notable among these tools is the mapping engine. Furthermore, the short development time period resulted in inadequate time for testing the system. Problems which could have been easily identified via a thorough debugging effort, did not become apparent until after the system became operational.

Having a well-trained group of users is critical to the success of any software system. However, due to the shifting requirements and redesign, much of the functionality included in the system changed between training periods. Moreover, several of the officers trained to act as Field Manager operators were reassigned to other tasks prior to the Olympic deployment of the PCCS. Several officers had to be trained just prior to deployment to ensure that every Field Manager system had a qualified operator at all times. During the training sessions, it became apparent that many officers assigned to operate the Field Manager systems knew little about operating computers, and this problem slowed the progress of the training classes.

Despite the problems discussed above, the *Police Command and Control System* proved to be a valuable resource for the Atlanta Police. From both a planning and public relations standpoint, the system proved to be worthy of development. Moreover, during a crisis situation such as the aftermath of the Olympic Park bombing, the system rose to the occasion and performed quite well. However, much of the system's functionality was not required because of the lack of traffic gridlock in the city. As a result the system was under utilized.

While the problems encountered in the deployment of the *Police Command and Control System* did not prove to be catastrophic, they did result in an overall lack of confidence among its user base. Part of this lack of confidence can be traced to an inertia-like resistance to change in police operations. Other reasons for the under utilization of the system include inadequate managerial practices, incomplete information, and having too few properly trained system operators.

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APPENDIX

The Police Command and Control System Development Team

1. Robert D. Hunter, Oak Ridge National Laboratory: PCCS Project Manager, developer of Scheduler software.
2. Gary Boruff, The University of Tennessee, Knoxville: Principal Developer of Central Manager subsystem.
3. Don Hanlon, The University of Tennessee, Knoxville: Principal Developer of Field Manager subsystem.
4. Dean Miller, The University of Tennessee, Knoxville: Developer of the Central Manager mapping system. Specified much of the interaction between the Central Manager and the map. Developed the Electronic Pin Map in the Field Manager subsystem.
5. Steve Stamm, The University of Tennessee, Knoxville: Developer of the Communications module used by both the Central Manager and the Field Manager subsystems.

VITA

Dean Morgan Miller was born in Huntsville, Alabama on June 24, 1967. He moved to Mt. Juliet, Tennessee from Michigan in the autumn of 1972, where he graduated from Mt. Juliet High School in May, 1985. He entered The University of Tennessee, Knoxville in September of 1985 where in December, 1991 he received his Bachelor of Arts in Geography. While working for the Transportation Research Center at The University of Tennessee, Knoxville, he has had the opportunity to develop a variety of geographic information systems (GIS) applications. Beginning in June, 1995 and continuing until August, 1996, he was a member of the development team for the *Police Command and Control System* used by the Atlanta Police for force management during the 1996 Centennial Olympic Games. During this effort he developed the mapping interface used in both the Central Manager and Field Manager subsystems. Concurrent with his employment at The University of Tennessee, Knoxville he enrolled and took classes toward a Master of Science in Geography. He received his Master of Science degree in August, 1997.