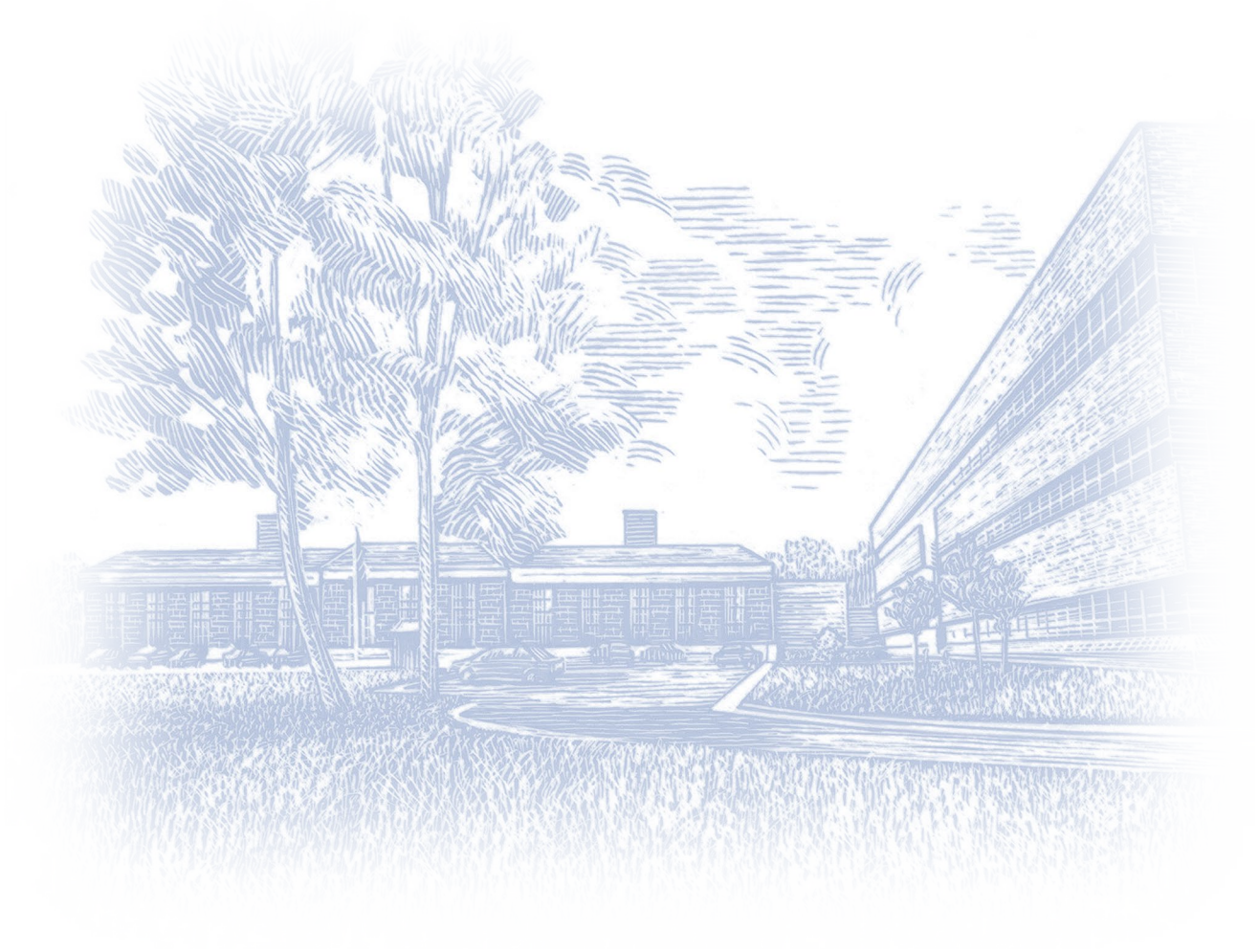
Human Factors in Advanced Traffic Management Systems (ATMS)- Progress to Date

Publication No.: ATMS Report **July 1996**



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Introduction

Traffic management centers (TMC) are expanding their efforts and resources to maintain efficient traffic flow and reduce congestion. More automation in the traffic control center is sought for processing traffic flow information from a variety of traffic sensing systems, for activation of traffic control systems such as ramp metering, and for communication of current traffic information through the use of variable message signs (VMS's). As a result the TMC operator is responsible for more monitoring, interpretation, and decision making. The expansion of these tasks increases the probability of operator error, incorrect decisions, the absence of needed decisions/actions, or an unacceptable amount of time in responding to traffic events.

In May of 1992 the Federal Highway Administration initiated a contract "Human Factors in Advanced Traffic Management Systems Design Evolution" to optimize the TMC operator interface with these systems and minimize human factors concerns. Since that time significant work has been completed, however, all of the planned research is still ongoing. The contract is scheduled for completion in the spring of 1977.

The human factors TMC project has several objectives. One is to provide a top down, systems engineering analysis of system and operator needs. This analysis complemented planned empirical human factors research objectives to provide alternative designs for operator interface issues. The empirical research is being conducted on a human factors research simulator developed for this contract. The final objective is to provide a human factors handbook which contains guidelines for TMC design.

The information contained herein is a short description of the progress to date. At the end of this document are references to the project reports which describe major research findings to date.

Systems Engineering Analysis

The top–down systems engineering analysis of TMC operator needs is completed. This systematic analysis began with a high level definition of system objectives for a traffic management center based on analysis of scenarios and expert input. This analysis was executed independently and in parallel with the analysis of comparative systems and existing technology described separately below. The list of five system objectives was further elaborated upon in progressive levels of analysis to yield performance requirements, basic TMC functions, allocation of functions proportionate to operator and machine, operator tasks, and a human factors specification which addresses specific configuration items and support systems.

Analysis of Existing Control Rooms

A comparable systems analysis was performed to observe actual traffic management processes and to consider lessons learned that are not apparent in the analytical, systems engineering effort. An examination of FAA and military centers in addition to vehicle traffic centers provided descriptions of operations and functions for each facility and resulted in a general description of a control room. This analysis was further developed into a variety of lessons learned relevant to the human factors design of operator interfaces in a TMC. These findings reflect examination of several general areas important to optimal operator performance including user–system interfaces, automation, the environment, staffing and general management of the TMC. The results of human factors lessons learned emphasize early use

of computer rapid prototyping packages to design display screens to minimize human factors interface issues and the importance of keeping the operator "in the loop" when using automated systems.

Human Factors Research TMC Simulator

A high–fidelity, real–time human factors research simulator has been designed and developed to gather empirical data on operator interface issues in traffic management centers. The simulator consists of three operator workstations and one workstation for the experimenter. Each workstation has a personal computer with touch screen and other appropriate controls. Desks and chairs are ergonomically adjustable. The simulator design currently simulates a closed–circuit (CCTV) camera system to provide information about traffic conditions. The simulator provides a large screen display and a set of cathode ray tube (CRT) monitors to present first hand visual data on traffic to the TMC operators. The visual display of traffic depicts realistic movement of different kinds of vehicles on Atlanta roadways as would be seen by stationary overhead cameras. Vehicle density and motion is based on a computer model of traffic behavior. Operators are provided with appropriate CRT formats with which to respond to incidents and to clear the roadway.

A second phase of the development added work stations at which volunteer research subjects can act as drivers and view traffic conditions as though they were driving along selected corridors in Atlanta. As they travel along the designated routes, they can get information about traffic conditions from VMS's, Highway Advisory Radio (HAR), commercial traffic reports, and from their own in–vehicle Advanced Traveler Information Systems (ATIS) display. At key points, they must decide whether to divert to an alternate route. The diversion decisions made by the drivers on any one route are used as input to the diversion fractions used in the traffic model, and in turn, the traffic conditions seen by TMC operators. TMC operators can present VMS's through the provision of a driver's out–of–window view of the road as seen in a moving vehicle. These features allow researchers to study system–level human factors questions by putting both drivers and TMC operators "in the loop" at the same time. Several operator support systems are being developed (e.g., Incident Detection Location System, IDLS).

Human Factors Research on TMC Operator Issues

Ongoing research has identified some of the parameters in control room automation which interact with TMC operator performance. For instance, results support the use of an automated IDLS which yields higher incident confirmation and operator performance than manual detection. Also, when using an IDLS, operator performance is enhanced when the system provides short detection latencies and high hit rates. Simulator research has demonstrated that for CCTV cameras monitoring roadways for incidents, that cameras with preset views result in better operator performance (operators found the incidents faster) than manually selected views.

Human Factors Design Handbook

A Human Factors Handbook for Advanced Traffic Management Center Design is being developed in this project. The handbook's purpose is to provide human factors design guidance to the planners and designers of new and existing traffic management centers. There will be two editions. The first, which has been completed, is based on existing human factors experience and use of control rooms. The second edition will incorporate the results of the human factors simulator research on TMC operator performance.

The topics covered in the handbook include human error and performance, equipment design and ergonomics, principles of job design, human design for information systems, and operator task analysis.

Further Information

To obtain more information or copies of reports contact the FHWA Research and Development Reports Center (301–577–0906)
Comparable Systems Analysis: Evaluation of Ten Command Centers as Potential Sites. (FHWA–RD–93–158)
Comparable Systems Analysis: Design and Operation of Advanced Control Centers. (FHWA–RD–94–147)

First Edition: Human Factors Handbook for Advanced Traffic Management Center Design. (Published by Georgia Tech Research Institute)