CHAPTER FOUR

# CURRENT STATE OF THE PRACTICE

## PURPOSE

This chapter presents the extent to which operational agencies use systems engineering processes and the processes most frequently used. This current state of the practice reviews the processes, deficiencies in available guidance, and issues of importance in the development of traffic signal systems. The processes examine four areas relating to (1) overall project processes and methodologies, (2) specifications, (3) local intersection control, and (4) operations and maintenance.

## BACKGROUND

In the initial stages of this project, a questionnaire was distributed to states, counties, and cities. In retrospect, the questions were not sufficiently detailed to provide a comprehensive picture of the state of the practice. Subsequently, a supplementary questionnaire was distributed to all of the states and 27 cities and counties. Responses were received from 26 states and 7 cities. The supplementary questionnaire, contained in Appendix A, sought to identify the extent to which agencies use methodologies and processes for traffic signal systems, and to identify the character of the processes used. For example, Figure 24 shows that the Minnesota DOT promotes technical courses for traffic professionals in systems engineering by means of its website. The questionnaire also sought to identify the areas for which additional material on processes or other tutorial material was needed. In addition, the questionnaire was structured to identify the perceived importance of various aspects of traffic system design. Because of the preponderance of state respondents, identification of the specific processes used reflects this particular group.

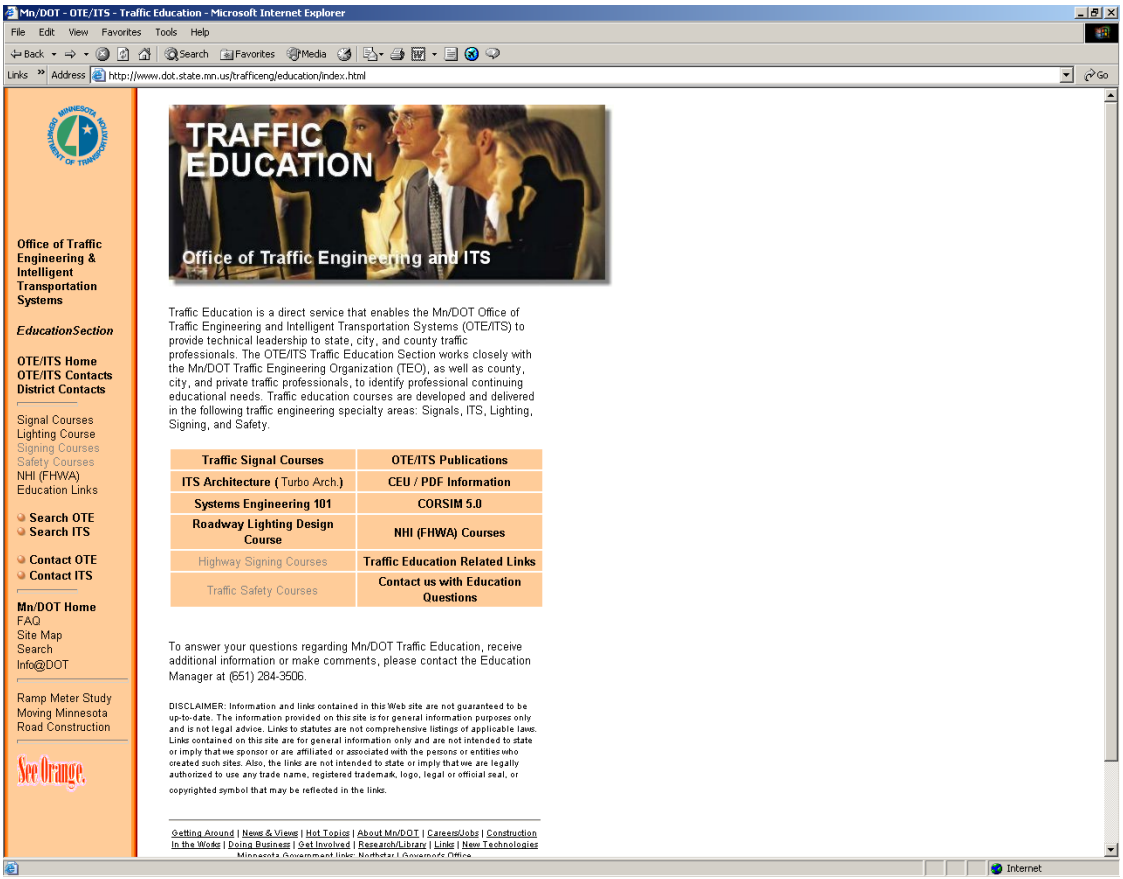


FIGURE 24 Minnesota DOT Office of Traffic Engineering and ITS website promoted a National Highway Institute course on systems engineering. (*Courtesy*: MnDOT.)

## PROCESSES

The extent to which operational agencies use systems engineering processes and the processes most frequently used are described here.

### Overall Project Processes and Methodologies

*Goals and Objectives*

Fifty percent of the respondents use a formal process for the development of goals and objectives for major upgrades. Processes mentioned included the following:

- Formal request for upgrade by traffic engineer;
- Reviews of volumes, artery characteristics, signal spacing, travel times, delay, and funding;
- Prioritization of intersection based on volume, accidents, and other characteristics;
- Project identification through concept meetings within the organization;
- Needs definition and requirements; and
- Goals based on traffic flow requirements and/or safety.

*Project Management Approach*

Eighteen percent of respondents prepare a formal document defining the management approach to be used in implementing major system improvements. Scoping studies are the most frequently used methodology. Justification studies performed by some states assess an agency's ability to operate and maintain the system. Studies also require the justification of additional cost for advanced systems. In some cases, the management approach is defined in a procedures manual.

*Alternatives Evaluation Methodology for Major System Upgrades*

Forty-three percent of the states and 50% of the cities use an alternatives evaluation methodology for major system upgrades. In addition, four of the respondents reported a benefit-to-cost ratio methodology, whereas two identified a utility methodology.

*Systems Procurement Methodology*

Seventy-seven percent of the respondents currently use a defined methodology to procure traffic systems. The overwhelming majority of these use some form of low bid process. In most cases, the process is determined by the jurisdiction's procedures. Some respondents expressed interest in moving to a design/build methodology. In addition, one respondent suggested that software should be a system integrator responsibility rather than a contractor responsibility.

*Project Evaluation Methodology*

Forty percent of the respondents perform evaluations in connection with major system improvements. Before and after studies using travel time, delay, and throughput are most commonly used. In some cases, these studies are only performed when required by funding sources. Thirty-six percent of the states and 43% of the cities conduct evaluations of traffic signal performance at periodic intervals.

### Traffic Systems Engineering and Specification

*Specifications*

The percentage of organizations using standard specifications for traffic system procurement is shown in Table 24. Approximately 55% of the agencies responding perform major specification revisions every 5 years or less and 45% from 5 to 10 years. Reasons mentioned for specification revisions were (in order of decreasing frequency)

- New technology (including new standards),
- Needs and problems,
- Statute requirements, and
- Coordination with Caltrans standards.

TABLE 24
PERCENTAGE OF ORGANIZATIONS USING STANDARD SPECIFICATIONS

| Component | States (%) | Cities (%) |
|---|---|---|
| Central control systems and field masters | 89 | 86 |
| Communications to the field | 64 | 83 |
| Field equipment (controllers and detectors) | 100 | 100 |

*Engineering Processes for Design of Central Traffic Controls*

Thirty-nine percent of the states and 43% of the cities use a formal engineering process in the development of specifications for the type of traffic control system used. The processes mentioned include the following by states:

- Standard specifications (all systems implemented by the agency are of the same type).
- Traffic needs analysis.

and by cities:

- Evaluation of existing system, technology analysis, and best-fit review;
- Problem identification, functional analysis, and resource constraints; and
- Concept study.

*Satisfaction with Processes Used*

Respondents were generally satisfied with the processes used. Suggestions for improvement included

- Provide greater emphasis on the design/build approach,
- Improve material acceptance procedures,
- Use only proven technology,
- Shorten the planning cycle, and
- Use functional traffic system specifications and prequalify bidders.

*Traffic System Communications*

Twenty-four percent of the states and 33% of the cities used a formal planning design or engineering process for specifying traffic system communications. The processes used include

- Technology reviews,
- Communications master plan development and evaluation of equipment types,
- Review by signal standards committee concept meetings, and
- State design manual.

*Field Equipment*

Forty-three percent of the states and 29% of the cities follow a formal process in the development of designs and specifications for field equipment. Approaches mentioned include

- Use of NEMA and Caltrans specifications,
- Use of signal design manual,
- Use of qualified products lists,
- New product evaluation committee,
- Concept meetings,
- Review and test equipment using trial installations, and
- Reviews with stakeholders based on field experience.

*National ITS Architecture*

Only 11% of the respondents reported that the National ITS Architecture has significantly changed their systems engineering approach to date for the design of traffic signal systems, even though many states have developed or are developing statewide and regional architectures. Changes included the following:

- Greater emphasis on needs definition,
- Use of new technology for monitoring traffic flow, and
- Emphasis on inclusion of National ITS Architecture structure in major upgrade.

**Local Intersection Control**

*Establishment and Removal of Signals*

All but two respondents use the MUTCD warrants as the principal basis for establishing new signals or removing existing signals.

*Actuation of Isolated Intersections*

Twenty-one percent of the states and 29% of the cities use a formal process for determining whether to actuate an isolated intersection. Many agencies provide actuation for all isolated intersections as a formal or informal policy. In addition, a small number of agencies perform an engineering study to determine whether actuation is required.

*Coordination of Intersections*

Forty-two percent of responding agencies follow a formal process in deciding whether coordination should be employed at an intersection. The processes used by these agencies include

- Coordination of signals with less than 1,000 ft of separation,
- Coordination of signals with less than 1 mile of separation,
- Coordination of signals if they are within an existing or proposed system,
- Study based on use of software programs,
- Preferences and expertise of program manager,
- Cost-benefit analysis, and
- Statewide study to identify prime arterial candidates for coordination.

*Side Street Actuation in Coordinated Systems*

Thirty percent of the states and none of the cities responding use a formal process in deciding whether side street

actuation should be employed in coordinated systems. The majority of the agencies always actuate the side streets except in the central business district. Processes used include analysis of intersection requirements and judgment of the project manager.

### Operations and Maintenance

*Operations*

Thirty-two percent of the cities and states use a formal process for determining such operational parameters as hours of attended operation and operating mode. The predominant approach was the use of traffic studies. Other techniques included consensus reviews. In some cases, a formal operations staffing plan with budget constraints is proposed.

*Maintenance*

Sixty-two percent of the states and 17% of the cities responding employed processes or standards for planning and specifying maintenance and training. Traffic signal maintenance standards and preventive maintenance checklists were most commonly employed. A number of agencies specify maintenance response times and have standards for periodic or preventive maintenance.

## PERCEIVED NEEDS IN AVAILABLE GUIDANCE

A survey question addressed the need for a report or manual describing a formal engineering process in a number of areas. The percentage of respondents perceiving needs in each area is provided in Table 25. The percentage of respondents addressing the need for additional tutorial material is shown in Table 26.

As perceived by the respondents, the greatest needs for additional information or guidance lie in areas relating to

- Central traffic control systems and field masters if they are required by the system architecture,
- Communications to the field, and
- Traffic signal deployment and maintenance.

TABLE 25
RESPONDENTS PERCEIVING NEED FOR REPORT OR MANUAL DESCRIBING A FORMAL ENGINEERING PROCESS

| Area for Need | States (%) | Cities (%) |
|---|---|---|
| Specification of central control equipment and field masters | 58 | 83 |
| Design of communications to the field | 58 | 83 |
| Specification of field equipment | 58 | 33 |
| Design of traffic signal installations at intersections | 56 | 50 |
| Traffic signal system deployment and maintenance | 54 | 83 |

TABLE 26
RESPONDENTS PERCEIVING NEED FOR INCREASED QUANTITY AND/OR QUALITY OF TUTORIAL MATERIAL

| Area For Need | States (%) | Cities (%) |
|---|---|---|
| Specification of central control equipment and field masters | 67 | 86 |
| Design of communications to the field | 60 | 86 |
| Specification of field equipment | 43 | 71 |
| Design of traffic signal installations at intersections | 58 | 57 |
| Traffic signal system deployment and maintenance | 63 | 71 |

## IMPORTANT ISSUES

The questionnaire requested information on the respondents' perceptions of the importance of various issues in the development of traffic control systems. Tables 27 and

TABLE 27
IMPORTANCE OF VARIOUS ISSUES IN THE DEVELOPMENT OF TRAFFIC CONTROL SYSTEMS BY STATES

| Issue | Importance Score |
|---|---|
| Legacy issues (compatibility with existing systems, equipment) | 8.1 |
| Ease, cost, and availability of maintenance and support | 7.7 |
| Availability of new national specifications (NEMA, NTCIP, ATC, etc.) | 7.6 |
| Familiarity with technology | 7.6 |
| Performance (real-time traffic flow optimization) | 7.1 |
| Compatibility with other ITS in your jurisdiction | 7.0 |
| System cost | 6.9 |
| Plan for introducing the NTCIP protocol for communication to intersection signal controllers | 6.5 |
| National Architecture conformance | 6.5 |
| Perceived future needs | 6.1 |
| Compatibility with ITS in other jurisdictions | 5.3 |
| Availability of new system coordination technology (e.g., SCOOT, SCATS, RTTRACS, OPAC, RHODES) | 4.5 |

Notes: NEMA = National Electrical Manufacturers Association; NTCIP = National Transportation Communications of ITS Protocol; ATC = Advanced Transportation Controller; ITS = intelligent transportation system.

TABLE 28
IMPORTANCE OF VARIOUS ISSUES IN THE DEVELOPMENT OF TRAFFIC CONTROL SYSTEMS BY CITIES

| Issue | Importance Score |
|---|---|
| Legacy issues (compatibility with existing systems, equipment) | 9.0 |
| Performance (real-time traffic flow optimization) | 8.9 |
| Compatibility with other ITS in your jurisdiction | 7.8 |
| Ease, cost, and availability of maintenance and support | 7.6 |
| Perceived future needs | 7.4 |
| Plan for introducing the NTCIP protocol for communication to intersection signal controllers | 7.0 |
| National Architecture conformance | 6.9 |
| Availability of new national specifications (NEMA, NTCIP, ATC, etc.) | 6.7 |
| System cost | 6.4 |
| Familiarity with technology | 6.3 |
| Availability of new system coordination technology (e.g., SCOOT, SCATS, RTTRACS, OPAC, RHODES) | 6.3 |
| Compatibility with ITS in other jurisdictions | 5.4 |

Notes: For abbreviations see Table 27.

28 provide summaries of the responses. Importance is rated on a scale of 0 to 10, with 10 being the most important.

The relative importance of many issues for states and cities is generally similar, with legacy issues, traffic control performance, and maintainability key issues for both. States place more emphasis on the availability of national standard specifications and familiarity with technology, whereas cities place greater emphasis on equipment compatibility within the jurisdiction. Compatibility with ITS in other jurisdictions and the availability of adaptive system technology were rated relatively low by both sets of agencies.