Introduction

This is the first of three White Papers prepared for the NOCoE Workforce Development Summit on June 22-23, 2016. It is designed to provide general background and context regarding TSM&O as a program activity and TSM&O staffing within transportation agencies and the private sector. The second paper will describe specific TSM&O workforce capabilities needed and existing education/training resources and gaps. The third White Paper will focus on strategies and actions for TSM&O Workforce development – providing an agenda for Summit activities.

Background: The Challenges of Transportation Systems Operations and Management (TSM&O)

Congestion and fatalities continue to increase on much of the nation’s highway systems. However, improvements in mobility thru new capacity are highly constrained by funding, long development cycles and negative impacts. At the same time, it is increasing recognized that about one-half of system delay, most unreliability and many safety issues reflect “non-recurring congestion” causes -- such as crashes, weather, construction work zones, and special events, that are not substantially addressed by added capacity – but can be minimized through operational managements.

In response, transportation agencies are increasingly turning to operational management strategies that minimize the impact of each cause of non-recurring congestion -- thereby increasing the effectiveness of the capacity already in place. Known as “Transportation Systems Management and Operations (TSM&O)”, these strategies combine advanced Intelligent Transportation Systems technology (ITS) with a set of real-time procedures, custom-tailored to each cause. These strategies are typically low cost, non-disruptive, quick turnaround – and can substantially improve mobility. Advanced technologies –such as the development of Connected Vehicle infrastructure – represent the current frontier of these strategies.

However, TSM&O requires a new and different set of program, organization and workforce capabilities to support operational management – not easily accommodated within traditional transportation agency culture, organization, and processes. TSM&O requires special systems engineering for communications information and control systems -- responding to rapidly changing technologies-- and impose requirements for 24 X 7 situational awareness, with related real-time event responses using procedures and protocols developed in close collaboration with external partners.

Acquiring these capabilities is especially dependent on developing a staff with specific technical and management capacities – relating to advanced technology planning and engineering, performance management and big data usage, real-time operational procedures, and new forms of collaboration – both public and private.

Key Findings of the Capability Maturity Workshops and Regional Operations Forums

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1 This White Paper has been prepared by Steve Lockwood and Gary Euler on behalf of the National Operations Center of Excellence
Over the last several years, research conducted by the National Cooperative Highway Research Program (NCHRP) and the Transportation Research Board’s Strategic Highway Research Program (SHRP2) program -- together with a set of state DOT “Capability Maturity” workshops and forums sponsored by FHWA and knowledge transfer activities of the National Operations Center of Excellence (NOCeE) -- have developed a heightened awareness of the challenges facing the evolution of more effective TSM&O. In more than 50 state workshops and 7 Regional Operations Forums, key state DOT TSM&O managers and staff (and often their Public Safety Agency and Metropolitan Planning Organization partners) evaluated their state’s or region’s current capabilities related to business and technical processes and institutional readiness – including the organization and staffing dimensions. This evaluation has established a clear picture of the state-of-the-practice within state DOTs and partner agencies regarding capabilities for continuous improvement of effective TSM&O. (For a summary see: http://ops.fhwa.dot.gov/docs/cmmexesum/cmmexsum.pdf).

A key issue has been the dependence of continuous improvement in TSM&O on developing the necessary workforce capabilities – both technical and managerial – both in the public and private sectors. The self-evaluations (level 2 on a 4-level scale from “Start-up” to “Managed”) indicate that while agencies have recognized the challenges associated with staff levels and workforce development, they have just begun to focus on key steps to improve workforce capability -- including identifying core capacities needed, development of position descriptions, new approaches to recruitment and retention and career development. The synergy between workforce and other dimensions of capability was widely recognized:

“Since TSM&O is not yet a formal “discipline” with a distinct educational and training focus, TSM&O staff typically come from other backgrounds from within DOTs, such as planning, maintenance, and traffic engineering and learn by on-the-job training and informal mentoring. Workshop participants indicated that minimal program expansion, largely static staffing, and the absence of strategic planning for TSM&O have provided little impetus or resources for formal training activities beyond those sponsored by FHWA.”

The remainder of this White Paper outlines the challenges facing TSM&O Workforce Development – using a series of bulleted points for maximum clarity. It should be noted that the points made are necessarily generalizations of the workshop experience-- recognizing that in each case there are unique exceptions that help establish capability improvement targets.

The Institutional Context for TSM&O workforce development

Transportation agencies and related professions have been historically focused on the mission of infrastructure capacity development and maintenance – with a strong civil engineering orientation. The Capability Maturity Workshops and Regional Operations Forums noted above indicate the challenges faced by TSM&O in this context, including:

- Capacity Development and Maintenance Culture -- The legacy policy focus, program, organizational structure, and staffing backgrounds have evolved to support a capacity
development mission. This is reflected in lack of clear position of TSM&O in agency policy, planning, and programs) – and in the lack of attention to effective organization for TSM&O and related staffing needs.

- **Absence of TSM&O Business Case:** Within the legacy transportation agency culture, the “business case” for developing and supporting TSM&O as a significant and formal agency focus is not well understood at both the executive and professional level, undercutting its rationale in the competition for staffing and budget.

- **Event-Dependent** – A focus on TSM&O has rarely been stimulated by top-down policy or program leadership – but rather by the need to respond to a specific traffic catastrophe – whether, emergency, crash or special event. In addition, evolution in new technologies, such as automated and connected vehicles, is stimulating a recognition of the need for improved technical capacity.

- **Limited financial commitment** – annual budgets devoted to TSM&O-related activities typically range between 2-5% of total agency budget – despite its significant potential contribution to the mobility mission.

- **Not a Formal Program** – “Operating the existing system” has not yet been accorded formal program status equivalent to construction, project development, maintenance or safety – accorded its own plan, program, line-item budget and division status and staff development requirements. In most cases, TSM&O is treated organizationally as a sub-element of system development or maintenance divisions.

- **Organizational Stovepiping** – Various TSM&O-functions are often located in different agency units (ITS, operations, traffic engineering) – each involving a small staff at the middle management level in both headquarters and regions – with attendant problems of coordination and authority.

- **Lack of Accountability** – There is limited upward or outward accountability for operational performance of the network under agency jurisdiction. Operational performance in customer terms is rarely reported or used for overall agency program reorientation.

**Staffing Needs**

The lack of workforce development supporting improved systems operational management is becoming a more serious constraint to improving mobility – as recognized in TSM&O research and workshops. In addition, the demand of new technologies on staff capabilities has also been recognized in on-going professional capacity building efforts at USDOT and in some university curricula. Key findings include:

- **Static Staffing** – Staffing levels are limited – and often reduced as part of agency “right-sizing” – making it difficult to add critical staff capabilities at levels essential to improve or expand TSM&O programs. This is true both in public agencies and in private sector professional and technical services.

- **Dependence on Champions** – In the absence of a formal TSM&O program with clear lines of authority and top level reporting relationships, there is a high degree of dependence on the informal initiatives of middle management staff “champions” – who are often key players – but also vulnerable to retirement.

- **Unclear Core Staff Needs** – In both public agencies and the private sector, the needed TSM&O core staff Knowledge, Skills and Abilities (KSAs) are not well defined – both technical and managerial. Nevertheless, it is recognized that there are a range of specialized TSM&O needs not typically present in transportation agencies and supporting private sector entities – including
systems engineering, electrical engineering, IT/communications, statistics/data management/analysis, GIS, computer/software, performance quality assurance, forecasting, design and control of operations systems – as well as “non-technical” expertise such as policy, management, external communications, collaboration planning and scheduling, procurement, staffing, planning, programming, budgeting.

- **Lack of Formal Training Resources** -- There is widespread recognition that on-the-job training is crucial in a new program area such as TSM&O – in both the public and private sectors. However, formal training in core knowledge areas is also considered important to career and staff development – as well as pre-employment professional orientation. But there is little formal in-house training, and external education and training resources are limited. The coverage of the training resources of SHRP 2, FHWA, AASHTO, the Institute of Transportation Engineers, and the University of Maryland’s Center for Innovative Transportation Education (CITE) is uneven – and substantially focused on best practices in specific technical applications. Training resources are especially lacking in “non-technical” areas crucial to TSM&O program development – such as organization, management, and business and technical processes, although the National Operations Academy™ addresses important background material for TSM&O senior managers.

- **External Educational Vacuum** – Formal transportation education in universities – either pre- or post-employment – is heavily focused on traditional civil engineering skills and rarely includes an in-depth focus on TSM&O.

- **Unclear Career Track** -- State DOT careers have traditionally been built on civil engineering and project development backgrounds. These types of expertise are easily recognizable by top management, as reflected in career opportunities. For staff specializing in operations, the upward career vector is typically unclear and often constrained by lack of PE qualifications.

- **Lack of External Recruiting Pool** -- Given overall staff size limitations (both public and private sector) and difficulty in accessing the outside qualified pool of recruits, TSM&O management and technical positions are largely filled from within, via transfers from other disciplines. Most of the relevant KSAs are acquired via on-the-job training or trial-and-error. The small staff size and civil service and union constraints also inhibits mentoring and succession planning.

- **Limited Recruitment Experience** -- In transportation agencies, permanent staff recruitment from outside appears rare. Many of the needed skills (systems engineering, information technology, communications, etc.) are addressed in educational institutions with little contact with the transportation sector. In the private sector as well (vendors, consultants, engineering), the relatively small and dispersed market constrains specialized staff development.

- **Increasing Outsourcing** -- In the public sector, the combination of staffing constraints, burdensome hiring procedures, and the need for specialized technical expertise results in outsourcing key technical functions through use of consultants, contract employees or academic support – which, while convenient for agencies, does not address workforce development.

**Identifying Effective TSM&O Workforce Development Strategies**

The evolving importance of TSM&O within the transportation sector has focused increasing attention on workforce development needs. The TSM&O Capability Maturity Workshops and related professional dialogue have identified specific areas of concern for which strategies are needed to overcome Workforce Development constraints. Two main areas of concern that will be addressed in subsequent White Papers No 1 and No. 2:
White Paper No. 2 -- Identification of staff/workforce core technical and managerial capacity improvement needs and gaps in capacity development. Previous NCHRP studies have identified key staffing needs – as related to key program functional areas – such as policy and strategic considerations, program planning, systems development, project management and real-time operations and typical staff positions such as an ITS Project Manager, a Traffic Operations Engineer or an ITS Technician. This paper will identify priority needs and gaps in training and education.

White Paper No. 3 -- Strategies and actions to develop the needed work force. This paper will address key strategic issue, including:
- Pre-employment Education/Recognition of the TSM&O profession
- Recruitment and Retention
- Post-employment training
- Career Advancement opportunities and Professional development

The topics addressed in these next two White Papers will constitute the focus of the June NOCoE Workforce Summit.