Bridge Business Process:
Principles of Asset Management

presented to
AASHTO Subcommittee on Maintenance
Bridge Technical Working Group

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Overview

• Transportation Asset Management Efforts
• Map Current Practices
• Themes
   Principles of Asset Management
   Standardization (Practices and Materials)
   Funding Streams
• Bridge Management Diagrams
Context

- MAP-21 Rulemaking

- NPRM for bridges and pavements defines the procedures for performance measurement and target setting

- NPRM for Transportation Asset Management Plans (TAMP) calls for
  - Use of a bridge management system to assess life cycle costs, investment strategies, and performance gaps
  - Integrated risk management and analysis
MassDOT TAM Strategic Plan

• TAM Strategic Plan assessed current...
  - Business practice
  - System functionality
  - Data governance
  - Technical architecture

• Strategic Plan is high level, and focuses on agency wide perspectives

• Bridge Process Add-On = Drill down to District Level
  - Understand varied practices and challenges
What We Did

• Interviews with Boston
• Interviews with each District
• Review of District organization charts and other materials
• Review of bridge condition data
• Review of data systems and software (Maximo)
• Review of practices in other states
Map Business Practices

Map Business Practices

- Forward reports to Boston
- Enter inspection data
- Collect latitude/longitude data
- Bridge Inspectors
- Office of Transportation Planning
- GIS System (Roadway Inventory File)
- Maximo
- Calculate bridge condition metrics
- Query bridge data
- Update master database
- Q/A master database
- Prioritize bridge projects
- Generate work orders for high priority issues
- District Offices
- Bridge Section
Principles of best practice asset management are not well understood throughout the organization

Structures maintenance needs support and standardization

Clarity needed about funding streams
PRINCIPLES OF ASSET MANAGEMENT

PLAN PHASE
Plan Business Needs

Inventory & Condition
- Have complete, accurate, current inventory of NHS bridges and pavement
- Have historic condition information at network and asset levels

TAM Objectives and Measures
- Document objectives
- Understand of public’s expectations
- Define performance measures

Performance Gap Identification
- Have current and future traffic volumes
- Model future asset condition
- Short and long term condition targets
Plan Business Needs

Life Cycle Cost
- Incorporate life cycle cost when modeling future condition
- Note life cycle cost in project selection
- Define key work activities with unit cost
- Consider cost implications of new assets

Risk Management
- Identify asset, program, and agency-level risks
- Evaluate risks for likelihood and impact
- Develop response plans for highest-priority risks
Plan Business Needs

Financial Planning
- Have access to historic expenditures
- Project future funding
- Trade-off between capital and maintenance spending
- Allocate resources objectively

Investment Strategies
- Compile, prioritize, and communicate investment strategies

Reporting
- Make needed information available through prepared and ad hoc reports
Best Practices for Bridge Tracking

A best practice agency...

• ...maintains a database of current and historic bridge inventory data
  ❖ Element-level condition for current and prior structures
  ❖ Characteristics of current and prior structures
  ❖ NBIS inspection reports for current and prior structures
  ❖ Updated condition from work records and permits
  ❖ Granular financial records on the work item level, can be summarized for a structure over an arbitrary period

• ...provides a spatial query capability
  ❖ LRS kept updated as roads change
  ❖ Bridges related to attached/co-located structures in database
Best Practices for Bridge Prioritization

A best practice agency...

• ...has developed a unified prioritization strategy for capital and maintenance investments
  ❖ Uses condition, likelihood of failure, life cycle costs
  ❖ Projections of future condition for NBIs and BMIs
  ❖ Publicized metrics, communication with stakeholders

• ...selects projects based on lowest life-cycle cost
  ❖ Typical work items are documented with known costs and ideal timings
  ❖ Impact of typical work items on life cycle costs is known
PRINCIPLES OF ASSET MANAGEMENT

OPERATE/MAINTAIN PHASE
Maintenance Business Needs

Maintenance Life Cycle

Planning
- Define Customer Needs
- Measure Current Performance Level and Set LOS Targets
- Establish Performance Guidelines
- Determine Level of Work Effort to Achieve LOS Targets

Budgeting
- Refine LOS Targets and Associated Budget

Evaluation
- Evaluate Performance Against Established Targets and Budget
- Measure Outcomes
- Report Accomplishments and Expenditures
- Perform Work as Defined in Performance Guidelines
- Define Work Priorities and Deploy Resources

Scheduling
- Performing
- Reporting
- Evaluation
Best Practices for Bridge Work Tracking

A best practice agency...

• ...uses a bridge management system to develop an annual work plan
  ❖ Bridge management system develops work plans to minimize life cycle cost
    ✓ 10-year for structures
    ✓ 1-year for districts
  ❖ Work plans are forwarded to maintenance management system in Districts

• ...uses a maintenance management system to translate work plans into work orders
  ❖ Work orders are used for all work, can be open-ended
  ❖ Alerts and reminders are sent for overdue work
Best Practices for Bridge Work Evaluation

A best practice agency...

- ...has established guidelines for bridge maintenance
  - Name, number, description, circumstances of work items
  - Typical types and quantities of resources (including labor)
  - Key steps and expected daily accomplishment
- ...tracks accomplishments and expenditures
  - Real time tracking allows for mid-course adjustments
  - Long-term analysis of spending trends and comparison to accomplishments → adjustments to next year’s plan
  - Assessment of work crews, contractors, Districts
  - Ad hoc query capability
Themes

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Clarity needed about funding streams
Maintenance on Bridges

• **Majority performed on 2-year contracts**
  - Area contracts specify tasks over District or subsection
  - Ongoing pressure from Boston for site-specific contracts

• **Only two districts have in-house maintenance**
  - All Districts want in-house preventive maintenance

• **Most maintenance work is reactive to deficiencies**
  - Prioritization is typically by intuition
  - Engineers fit work to contracts and available funding
Bridge and Work Tracking

• **Condition and characteristics tracked in 4D**
  - Geospatial records for NBIs, many “BRIs”
  - Ancillary structures will be added
  - Well-used, but concerns about data detail and consistency
  - Useful information is in comment field, cannot be queried

• **Work tracking is informal**
  - Resident engineer journals lost when work is complete
  - Invoice and spending records not tied to locations

• **Summaries of spending onerous, uncommon**
Identified Five Tasks

1. Prioritization of deficiencies
   - No set way district to district
2. Select Intervention
3. Standardize contract mechanisms and scope
4. Supervise and report on work
5. Standardize materials
Task 1: Prioritize Deficiencies

• **Current State: Independent Districts**
  - Single decision-maker in some cases
  - Professional judgment
    - Evaluation on traffic volume, “chain reactions,” intuition
  - District 4 uses multiple decision-makers, collective judgment
    - Inspectors grade severity on 6-point scale
    - Inspectors use intuition
  - District 6 uses 4-year spending and condition metrics
Task 1: Prioritize Deficiencies

Opportunities for Standardization

• Standardize by... **Setting Priorities**
  - Statewide list of evaluation criteria (AADT, Functional Class)
  - Study interactions of elements to identify chain reactions

• Standardize by... **Using Grading Scale**
  - Recommended by FHWA
  - Can incorporate priorities from above
  - Likely different for every element/type of deficiency
  - Strenuous and time consuming development process
Task 1: Prioritize Deficiencies
Opportunities for Standardization

- Standardize by... **Using Management System**
  - System selects solutions for lowest life cycle cost
  - 20-year work plan for each structure
  - Annual work plan for District
  - Goal is to minimize life cycle cost across the network
  - Removes decision-making from District Structural Maintenance Engineer
  - Heavy lift to find and implement software
Task 2: Select an Intervention and Build a Scope

Description and Current State

• **Goal:** Select remediation, scope and design project
  - Remediation must fully resolve deficiency
  - Projects require scope, schedule, budget, delivery method, design, materials
  - In many cases, selection between commercial options

• **Current State: Independent Districts**
  - Engineers choose interventions that are familiar
  - Districts scope for contractors, who perform most design
  - Materials selected from Standard Materials List
  - Budgeting and scheduling are informal
Task 2: Select an Intervention and Build a Scope

Opportunities for Standardization

• Standardize by... **Writing a Repair Manual**
  - Statewide list of responses to different deficiencies
  - Include drawings and specifications for common work
  - Recommended resource and labor requirements
  - Evaluate alternative solutions by impact on life cycle cost

• Standardize by... **Using a Budgeting and Scheduling Tool**
  - List all available labor, equipment, materials, funding
  - Slot projects into contracts, funding sources
  - Synchronize availability of crews, equipment across Districts
Task 3: Administrate Contracts, Assign Work

Description and Current State

• **Goal**: Select contractors and manage spending, assign work to both contractors and in-house crews
  - By law, all contracts are low-bid
  - Limited in-house labor for structures maintenance

• **Current State: Independent Districts**
  - Local contractors bid on multiple contracts
  - Varying levels of site-specificity
  - DSMEs experiment with contract scale, terms
  - Work assigned to stay ahead of budget constraints
Task 3: Administrate Contracts, Assign Work

Opportunities for Standardization

- **Standardize by... Providing Guidance on Contract Terms**
  - Encourage communication between Districts
  - Construct recommended language for contract types
  - Evaluate ideal scale of contracts (deck & joint vs. deck)
  - Require balanced bids for maintenance contracts

- **Standardize by... Using Bid Evaluation Software**
  - Encourage Districts to utilize CPE and WABA
  - Require all maintenance contracts to be submitted in BidX
  - Regularly evaluate estimates vs. historical data for individual bid items
Task 4: Supervise and Report on Work

Description and Current State

• **Goal:** Ensure completion of work to scope, record accomplishments, spending, resource consumption
  - Unit accomplishments ("square feet of deck replaced")
  - Many possible degrees of detail (which resources to record)

• **Current State: Independent Districts**
  - Resident engineers keep logs on paper
  - Districts store some paper logs, others lost
  - Electronic invoice records lost when project is complete
  - Accomplishments are recorded in next inspection, occasional special inspection
Task 4: Supervise and Report on Work

Opportunities for Standardization

- **Standardize by... Improving Work Records**
  - Digitize all work logs and diaries
  - Revise pay items list and include clear common definitions
  - Associate all work with geographic location and asset
  - Log resources consumed to consistent level of detail
  - Districts should be able to summarize work on a bridge

- **Standardize by... Using Maintenance Management System**
  - Establish standard fields in CMS and Maximo
  - Ensure that both CMS and Maximo track unit accomplishments
Task 5: Select Materials for Structural Work

Description and Current State

• **Goal:** Identify acceptable materials, publicize new alternatives, match materials to projects
  - Acceptable materials on Standard Materials List
  - Standard Materials List built through testing

• **Current State: Steel and Concrete Separate**
  - Steel testing managed by Boston Bridge Section
  - Concrete testing managed by Research and Materials Section
  - Districts have no easy access to concrete test results and logs
  - Districts experiment independently with new materials
  - New materials or processes are not readily available
Task 5: Select Materials for Structural Work

Opportunities for Standardization

• Standardize by... **Unifying Materials Testing**
  - Steel and concrete are evaluated in a single lab
  - Suggestions of tests on new materials possible and simple

• Standardize by... **Improving Access to Test Data**
  - Implement a new Lab Information Management System
  - Publish all test results in electronic form and archive them
  - Provide Districts with access to test result database
  - **Designs should be informed by up-to-date information**
Themes

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Funding for Bridge Maintenance

Diagram showing the structure of funding and positions related to bridge maintenance, including roles such as Chief Engineer, State Bridge Engineer, District Highway Director, District Bridge Engineer, and District Maintenance Engineer. The diagram also indicates funding streams, Boston positions, and district positions.
Capital Investment in Bridges

• Projects selected, planned, supervised centrally
  ❖ Bridges are prioritized as whole structures
  ❖ Deterioration modeled in Pontis
  ❖ Prioritization by in-house algorithm, spreadsheet

• Selection by Project Review Committee (PRC)
  ❖ Districts can suggest projects, not all do
  ❖ Districts offer feedback on draft work plans

• Central designs projects (usually) or selects contractors
MANAGEMENT DIAGRAMS
**Bridge Section Processes - Bridges**

### Prioritization
- Select capital alternatives to address greatest needs
- Calculate condition loss (CL) and HEF, use with HI to rank bridges
- Project future condition, calculate % change in HI
- Calculate HI
- Assign SD designations based on raw inspection results

### Inspections
- Identify structures in need of inspection
- Schedule inspections and assign to contractors
- Perform inspections and identify any emergency damage
- File inspection report in 4D Inspector Version
- Perform QA/QC on inspection report, merge into 4D Boston
- Assign work and provide resources
- Perform and report on work

### Intervention
- Receive notification that damage has been observed
- Secure area and assess the severity of the damage
- Select an intervention, build a scope and schedule
- Assign work and provide resources
- Perform and report on work

**Tools and Systems**
- 4D Boston
- 4D District
- Pontis
- Maximo
- AE
Bridge Life Cycle Workflow

**Boston**
- Select and design projects, sent to Construction Section
- Calculate condition loss (CL) and HEF, use with HI to rank bridges
- Project future condition, calculate % change in HI
- Calculate HI
- Assign SD designations based on raw inspection results

**Districts**
- Receive notification that damage has been observed
- Prioritize deficiencies by severity (and other metrics)
- Select an intervention, build a scope, schedule
- Assign work and provide resources
- Perform and report on work

**Capital**
- Perform QA/QC on inspection report, sign off on results

**Inspection**
- Identify structures in need of inspection and assign to inspectors
- Perform inspections and identify any emergency damage
- File inspection report in 4D Inspector Version
- Perform QA/QC on inspection report, sign off on results

**Maintenance**
Next Steps

• Implementation of Strategic Asset Management Plan
• Review staffing and job descriptions
• Identify opportunities for improvement
ARE THERE ANY QUESTIONS?