Transportation Asset Management Systems and Pavement Preservation

Southeast Pavement Preservation Partnership
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Today’s Discussion Topics

• Asset Management Systems Overview
• MAP-21 Influence
• Getting Better Results through Integration
• Pavement Preservation within an AMS Framework
• Improving Analysis through Research
• Taking AMS to the Next Level with Trade-off Analysis
Evolution of Asset Management Systems

• 1970’s-80’s
  – Mainframe systems
  – Primarily developed for financial purposes, e.g. cost accounting
  – Genesis of Pavement and Bridge Management Systems
  – Creation of Road Inventory Systems for Planning & Reporting

• 1990’s
  – Federal legislation requires Pavement and Bridge Systems
  – Typically stand-alone systems
  – Transition to PC’s, Windows and Client-Server Systems

• 2000’s
  – Promotion of “Asset Management”
  – Expansion of systems within disciplines
  – Web-based platforms
  – GIS/LRS Advancements
  – Enterprise systems
Common SHA Asset Management Systems

- Pavement
- Bridge
- Maintenance
- Safety
- Traffic-Signs, Signals, ITS etc
- Road Inventory
- Fleet & Equipment
- Facilities
- Asset Inventory databases & spreadsheets
Common AMS Data Dependencies

- Financial
- Project Planning and Scheduling
- Construction
- Inventory
- Legacy
- DMV
Asset Management Systems Today

- Perception that Pavement and Bridge Management are mature
- Lots of Data, quality remains an issue
- Increasing Asset Inventories, Asset types
- Assessment Methodologies continue to advance
- Advancement of Analytics
- Disparate systems are still commonplace
- Enterprise approach gaining favor among agencies
- Multiple platforms and databases challenging to support
- MAP 21 is driving the need for integrated systems
MAP-21 Influence

- Required Asset & Performance Management Plans
- Required Agency Performance Measures and Targets
- Agencies must improve or preserve asset conditions and performance
- National Performance Goals, e.g. “State of Good Repair”
- National Highway Performance Program
- New minimum pavement condition requirements for Interstate system
- Recognition of ‘Preservation”
- Long Range Plans must reflect agency Performance Plans
- STIP must align with agency Performance Goals
- Trade-Off analytical tools desirable
MAP-21 AMS Implications for SHA’s

• Are you achieving the best or optimum performance (LOS) across the network at the current level of funding?
• Are you performing the right mix of activities, projects, strategies to achieve the best long term performance for the network?
• Can you readily determine the level of investment needed across all assets to achieve agency performance targets? Can you conduct trade-off analysis?
• Do you have the capability to perform short and long term scenario analysis?
• Can you readily meet MAP 21 reporting requirements?
Getting Better Results through Integration
Transform Data into Information
Integrated AMS: Vision

- Unified Transportation Plans and Analysis
  - Cross Asset Analysis and Portfolio Management
  - Remove Silos across people, data and strategies
  - Defined dashboards, metrics and outcomes
Big Picture Integration Example

UDOT Information Systems

Oracle DB

- UPlan
- ArcGIS
- UGate
- dTIMS
- FINET
- Online Permits
- Materials Database
- Civil Rights/Certified Payroll
- PDBS
- ePM - Right of Way
- ePM - Program Management (OTIP)
- ePM - Project Management
- ePM - Structures
- ePM - CMS
- Vertis
- TIGS
- OMS
- MS Project Server
- SharePoint
- SQL Server
- ProjectWise
- Cognos
- Dashboards
- Microstation

AGILE ASSETS
Integration across Multiple System Platforms

• Consistency of Location data
• Accurate capture of work accomplished
• Consistency of Business Rules/Processes
• Ability to share or view work plans, e.g. viewing PMS work plan in MMS for planning & scheduling
• Interface Requirements & ability to push or pull data
• IT resource requirements for multiple platforms
• Frequency and Impact of Upgrades
• Keeping pace with industry advancements
Integrated Asset Management System Example

Modular Framework

- **Pavement**
  - Core Functions: Asset Inventory, LRS/GIS, Security, User Organization, Terminology

- **Bridge**
  - Core Functions: Data Management, Reporting, Graphing, Communications, System Utilities

- **Asset Trade-Off**
  - Core Functions: Mobility

- **External Data and Models**
  - External Systems (e.g., SAP Advantage, PeopleSoft, etc)

- **Safety**
  - Core Functions: Network Data Manager, Mobile Data Collection

- **Maintenance**
  - Core Functions: Fleet, Equipment, Materials, Labor

**Common Data Model**

Integrated Asset Management System Example
Example of Integration between Modules
Integrated AMS Suite

• Data shared between system modules
• Shared data increases collaboration in achieving common organizational goals and metrics
• Similar look and feel across modules - User experience
• Data imported from external systems into “core”
• Supports more efficient decisions across organization
• Reduced level of IT support due to single platform vs. supporting multiple stand-alone applications
• Common Referencing System (LRS) & standardized handling of LRS updates
• Interfaces required for external systems
Pavement Preservation within an AMS Framework

**Diagram:**
- **Title:** Pavement Preservation is Cost Effective
- **Axes:**
  - Y-axis: Pavement Condition (Excellent, Good, Fair, Poor, Very Poor)
  - X-axis: Time (Years)
- **Line:** Typical Pavement Deterioration
  - 40% Drop in Quality
  - 75% of Life
  - 40% Drop in Quality
  - 12% of Life
- **Annotations:**
  - Spending $1 on pavement preservation before this point...
  - ...eliminates or delays spending $6 to $14 on rehabilitation or reconstruction here.

**Source:** National Center for Pavement Preservation.
Integrated PMS Framework

- Financial Management
- Project Scheduling System
- Constr. Mgmt. System
- Recommended Project Portfolio
- Research

- PMS (models)
- Optimized Work Plan (Pvmt.)
- Asset Trade-Off Analysis

- External (RMS)
- MMS
- BMS
- Safety
- Mobility

- Mobility Assessment
- Financial Management
- Research
Key Pavement Preservation Issues

- Project /Treatment Selection Criteria
  - Decision Trees and Models
- Capturing details of completed Preservation work
  - Maintenance & Contracted work
  - Interfaces
  - Q/A-Q/C of data
  - Business Rules
  - Construction History
- Consideration of Planned Projects
  - “Hardwiring” programmed projects into analysis
- Validating the effectiveness
  - Performance monitoring
  - Determining life extension
- Timing of Treatments
  - Research
Project and Treatment Selection

- Development of Decision Trees that include preservation
Models should Incorporate Preservation Influence
Section Modeling
Getting the Right Data

• Inventory
• Location
• Condition
• Traffic
• Construction History
Construction History Data is Critical

Longitudinal Layer Data

Cross Sectional view

Work Data Table
Common Challenges with Construction Data

• Interfaces with PMS typically required
• Data Q/A required, often manually by PMS staff-difficult to automate due to differing business rules and needs
• Construction Management System project location may not align with PMS LRS
• Delay in getting project information from the field
• Pay items in Construction Management System are typically measured in units such as SY or Tons and may not provide layer thickness for Construction history
• ERP Maintenance Management Systems don’t generally provide required location data for pavement maintenance and preservation activities
• Preservation work performed by Maintenance not captured at all
Construction History – Data Entry Forms

Work History Information

Locations Information

Layers Information
Consideration of Planned Projects

• Incorporation of planned or programmed R&R Capital projects
• Requires interface between PMS and Project Scheduling System
• Projects can be “hardwired” into scenario analysis
• Challenges encountered include:
  – Pavement treatments may be only part of a broader scope and lack sufficient detail
  – Correctly locating planned projects on LRS
  – Planned Pavement Preservation activities may not specifically identify a location or treatment. (Funding Placeholder)
Determining Pavement Preservation Effectiveness

• A PMS can model preservation as one of the tools in the management toolbox

• As time progresses it is important to utilize the data collected in the PMS to refine the models
  – Use the PMS as a source for on-going research
  – Improve deterioration models
  – Better represent preservation improvements

• Investigate the effects of preservation policies and priorities by comparing scenario outputs
Example PMS Scenario Analysis Framework

- Condition Data
- Condition Indexes
- Other Pavement Data
- Predicted Condition
- Decision Trees
- Integer Solver Optimization
  - Multi-Constraint Analysis
  - Multi-Year Analysis
- Strategy Generation Engine
- Section Strategies
- Output Projected Conditions & Budgets
- Work Plan

Models
Scenarios Analysis — Concept

- Inventory
- Setup
- Engine
- Objective Constraints
- Condition
- Scenario Analysis
- Work Plan
Scenario Analysis Objectives

• **Best Set of Projects**
  - The projects meet a set of constraints
  - Maximizes or minimizes an objective
    (Maximize condition, minimize budget, etc.)

• The desired OUTPUT of the analysis is a WORKPLAN, that tells us:
  - Using which treatments to apply, (What)
  - To which sections (Where)
  - In which year (When)
Optimized Work Plans

- Work Plan lists
  - Year
  - Treatment
  - Cost
  - Location
Comparing Scenarios: Compare Analysis Methods
Validating the Impact-BMS Example

Performance Management: Evaluate impact of bridge maintenance/preservation activities on bridge element condition rating (Project/Bridge Level)

**STRUCTURE NO:** 700016

- **Predicted Condition Without Maintenance**
- **Inspected Condition (With Maintenance)**

![Graph showing maintenance work and condition ratings](image-url)
Improving Analysis through Research

• Meaningful Research results dependent on good data sets
• Accurately capturing details of completed Maintenance and Preservation work completed is critical for validating treatment effectiveness and timing
• Decision trees and models can be adjusted
• Continuous validation and updating process based on performance data
Enhancing AMS results through Trade-off Analysis

• Need to be able to analyze tradeoffs between competing objectives…
• Multi-criteria and efficient surfaces
Impact Analysis

Evaluate Impact on Bridge, Pavement and Overall System
Closing Thoughts

- MAP-21 is a Game Changer!
- The Future is about Performance
- Robust Systems are Critical for Achieving Performance Goals
- “Preservation” is actually in Law!
- Leverage AMS Analytics & Research to validate Pavement Preservation Benefits
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