Focusing Analysis on Appropriate Management Levels

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Pavement Management

- A Structured Decision Making Process
  - Application of systems engineering concepts

- Operates:
  - In organizations
  - At management levels

In Concept Pavement Management Includes

- Planning
- Programming
- Analysis
- Design
- Construction
- Operation
- Research

As Implemented

- Most Pavement Management Systems Address
  - Programmed (Preventive) Maintenance
  - Rehabilitation
  - Reconstruction
- ***Of Existing Facilities***
- New Pavements, Research, etc. Come out of Other Systems or Planning

Transportation Asset Management

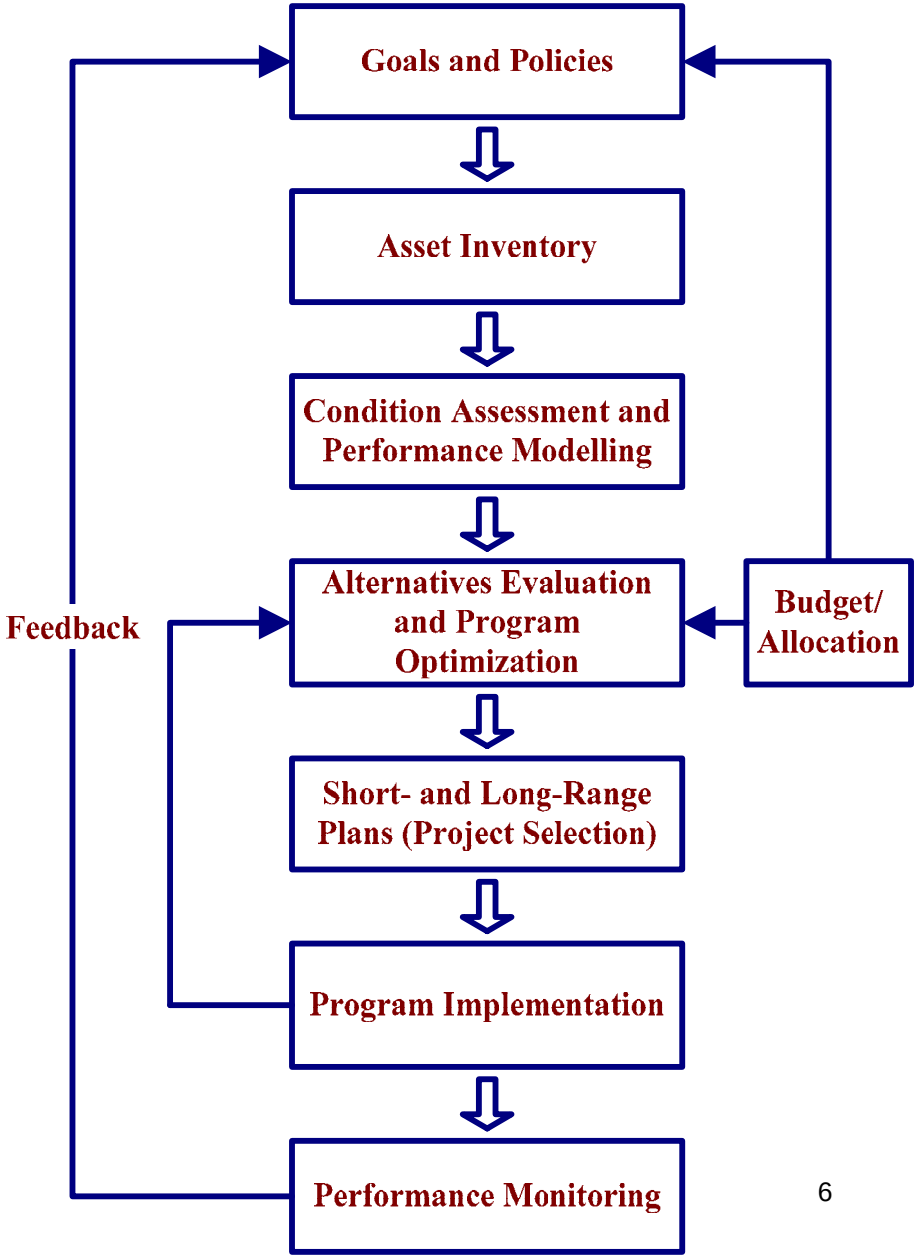
- Policy driven
- Data supported

- Investment analysis
- Strategic focus

- Impacts all management levels

Asset Management Framework

Not Much Different from Pavement Management Framework



Transportation Asset Management

- Emphasizes strategic view in infrastructure decision making
  - Investment analysis
  - Policy driven
  - Data supported
- Cross through all types of infrastructure assets
  - Gets rid of “stove pipe” management
- AASHTO & FHWA Studies

Management Levels

- Strategic (Asset) – Planning, Programming & Allocation for All Systems
- Network - Planning & Programming for Entire Set of Type Facility Managed
- Project Selection - Programming a Subset
- Project - Designing a Specific Section

- Last three primary focus of traditional PMS
- Many focused on the last two

Strategic – Level

- Related to Investment Analysis & Fund Allocation
  - Total Funds Needed and Allocation of Funds for Each Type Facility
  - Show Impact of Funding Options
  - Justification of Funds
- Communicate with Funding Authorities
  - Level of service desired
  - Investment needed to provide that service
- Previously Considered Planning Activities

Network-Level

- Related to the Budget Process
  - Identify Maintenance and Rehabilitation Needs
  - Funds Needed to Complete M&R
  - Prioritized Listings of Segments Needing Work
- Allocation to
  - Sub-organizations
  - Funding Categories
- Show Impact of Funding Options
  - Preservation vs New Construction
  - Distribution Among Sub-organizations
- Communicate Within Agency

Input from Strategic-level

Project-Selection-Level

- Identify Constraints not Previously Considered
  - Physical
  - Financial
- Refine Alternative Treatments
- Improve Cost Estimates
- Select Segments for Funding & Project-Level Analysis, Design & Construction
- Show Impact of Deviation from Network-Level

Input from Network-level

Project-Level

- Develop Cost-effective Strategy for:
  - Original Construction
  - Maintenance
  - Rehabilitation
  - Reconstruction
- Within Imposed Constraints
- Complete Design

Input from Project Selection-level

Post Project-Level

- Complete Required Work
- Monitor Construction
- Monitor Performance

Strategic-Level Process

- Input from Network-Level Type Facility Systems including PMS
- Information Combined – Often Manually
  - Computerized Systems under Development
  - A Few Limited Systems in Use
- Decisions About Funding Levels, Allocation, and Policies
  - Funding authorities
  - Senior management

Network-Level Process

- IMS Software Used to Develop Recommendations
- Staff Use PMS Reports to Prepare Recommendations to Senior Management
- Decisions About Funding Levels to Districts and Work Classes
  - Senior Management
  - Department Managers
  - Sometimes District Level

Project-Selection Level Process

- Some Help From Software
  - Consider Constraints not Included in Network-level Analysis
  - Finalize Candidate Project List
  - Add & Remove Projects
  - Modify Project Limits (Combine Sections)
  - Adjust Dates
  - Improve Cost Estimates
- Responsible
  - Senior Management and/or District Managers
  - District Staff

Project-Level Process

- May be initiated by different network-level and project selection-level systems
  - Other management systems
    - Safety may require realignment
  - Planning activities resulting in new facilities
    - Additional capacity
  - Other work
    - Repair of drainage components may generate design of reconstructed pavement

Project-Level Process

- Use Available Design Procedures
  - Design to Meet Needs
    - Functional, Structural, Safety, & Reliability
  - Consider
    - Life Cycle Costs, Other Constraints & Impacts
  - Within Available Funds
- Construct
- Operate
- Work Completed by
  - Engineering group (design, construction, & operation)
  - District and central office

Differences in Those Responsible

- Project-level
  - Engineers/Technical Staff
- Project-selection Level
  - Senior Management or District Managers
  - District Staff
- Network-level
  - Senior Management
  - District & Department Managers
- Strategic-level
  - Funding authorities
  - Senior management

Those Responsible Vary

- Differences Depend on:
  - Centralized, Decentralized, Public Private Partnerships or Privatized
  - Maintenance, Rehabilitation, Reconstruction or New Construction
  - Bridges, Pavements, Intersections or Additional Capacity
  - Interstate, US, SH, or Local – Urban or Rural
  - Organizational & Historical Relationships

Differences in Data Required

- Project-level - Detailed data needed to complete design
- For those sections selected for work in funding period (very small % of network)
  - Mechanics based design models and inputs
  - Functional, structural, & safety requirements
  - Available materials, etc.
  - Material properties, construction techniques, etc.
  - Other constraints & impacts
  - Costs & available funds
  - Prior performance if M&R

Project-Selection Level

- Enough data to compare preliminary alternatives for sections considered for funding (small % of network)
  - Consider constraints not included in network-level analysis
    - Programmed work
    - Additional work
    - Funding restrictions
  - Define work limits & best time to complete work
    - More complete performance data than network-level
  - Preliminary design using limited data in full model or limited design models

Network-Level

- Data on every segment in the network
- Enough to identify:
  - Best group of candidate segments or
  - Number & type of segments that need to be addressed
  - Funding impacts of different alternatives
  - Optimization, prioritization, or simulation using empirical models that connect condition, or changes in condition, of type facility to changes to funds invested
    - Network-level condition
    - Network inventory
    - Past M&R, etc.

Strategic-Level

- Focus of Asset Management
- Combined Data from Network-level Systems
  - Data on every segment in every infrastructure network
- Funding needed to provide desired level of service in all facilities
  - Enough to identify:
    - Best allocation among systems
    - Funding impacts of different alternatives
    - Multi-objective optimization, prioritization, or tools using empirical models that connect performance, or changes in performance, of type facility to changes to funds invested

Differences in Data

- Project-level
  - Detailed data needed to complete design
  - For very small % of network
- Project selection-level
  - Enough data to select projects to be funded
  - For small % of network
- Network-level
  - Enough data to identify candidates & support allocation
  - For entire network
- Strategic-level
  - Data from network-level (entire network)
  - Data that funding authorities can use
  - Indicators of work performed and results achieved

Focus of Most Civil Engineering Education

- Solve problems in a specific way
  - Design a facility or system
  - Mechanics or process based
  - Materials are chemical compounds
  - Mathematics used to characterize conditions

Civil Engineering Design

- Defines problem
  - Objectives & functional requirements
- Considers constraints
  - Economical, environmental, sustainability, constructability, ethical, health & safety, social, and political
- Feasibility
  - Identifies and analyzes several feasible alternatives

Civil Engineering Design

- Design Methodology
  - Employs appropriate design models and tools to solve the engineering problem
- Selects Best Design Option(s)
  - Meets constraints
  - Least life-cycle cost or
  - Best benefit-cost ratio

Focus of Many Engineers

- Project level
- Project-selection level
- Engineers who move to management then develop focus on:
  - Network level
  - Strategic level
- Many want project-level data for entire network
  - Blame it on us educators
  - Great dream; impossible in my life-time

Analysis System Design, Development, & Selection Issues & Barriers

- System Not Matched to Agency
  - Needs
  - Resources
  - Capabilities
- Quality & Availability of Data
  - Excessive data requirements lead to abandonment
  - Focus the data needed to the decisions being supported at the management level
- Perceived Complexity
- Black Box IMS

Overcoming Organizational Issues

- Conduct Organizational Analysis of Current Management Process
  - Know your agency!!!!!!
  - What decisions need supported at what level?
  - What processes need to be changed?
  - Who controls acceptance/implementation?
  - What benefits would affect acceptance?

System Design, Development, & Selection for Success

- Compatibility
  - Form follows function
  - Select the tool needed for the problem being addressed
- Complexity
  - Provide support needed with tools agency can use and sustain
- Relative Advantage
  - Must provide something better than currently available – for least possible resources

Provide Interconnectivity Among Levels

- Same definitions of distress but different levels of accuracy, precision, and reliability
- Same approach to models
  - Performance equation parameters dependent of different levels of detail
  - Project-selection uses deterministic equations from same data that network uses for probabilistic equations
  - Best return for funds expended based on similar concepts

Analysis System Design, Development, & Selection for Success

- Compatibility
  - Provide tool that supports decisions being made
- Complexity
  - Provide support needed with tools agency can use and sustain
- Relative Advantage
  - Must provide something better than currently available at less expenditure if possible

Analysis Tools

- Project-level
  - Mechanics based design models
  - Life-cycle cost analysis & engineering decision theory
- Project selection-level
  - Preliminary design using limited data in full model or limited design models
- Network-level
  - Optimization, prioritization, etc. tools using empirical models that connect condition, or changes in condition, over time of type facility to changes to funds invested
- Strategic-level
  - Multi-objective optimization, prioritization, or tools using empirical models that connect performance measures, or changes in performance measures, over time of type facility to changes to funds invested

Focusing Analysis Tools

- Engineers Solve Problems
  - Within constraints imposed
  - Including data that is valid at that level
- Analysis Tools Must
  - Address the problem
  - At the level
  - Within constraints
  - Interconnect

Horror Stories

- Too Complex
- No Connection
- Two Points – Sophisticated Analysis
  - Monte Carlo
  - Neural Nets
  - Genetic Algorithms

Data Collection Axioms

- Collect Only the Data Needed
  Only When It Is Needed
- Corollary - Stage Data Collection
  - Update/validate only the data you need for sections being considered at the level you need it
  - And
  - Collect additional data you need only for sections being considered at the level you need it

Data Collection

- Focus data collection & upkeep
  - On data needed to support decisions at level being address
  - For sections being considered at that level
  - On what is available and can be collected at reasonable expenditures
  - Different “complete” data sets for different levels in same database

Questions?