

# *Next Generation Pavement Management Systems*

*Integration, Accountability and Engineering*

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# Outline

- Where have we been?
- What are the Issues now?
- Where are we going?
  - The Direction
  - The Information
  - The Tools
  - Long term issues

# Where have we been?

- We've been investing...

It has been estimated that we have invested **\$1.75 trillion** in our highways

(FHWA Office of Asset Mgt)



# Where have we been?

- Need to protect that investment so...
- Pavement Management Defined
  - "...the identification of optimum strategies at various management levels as well as the implementation of these strategies." [Hudson, Haas, Zaniewski 1994]
- History of Pavement Management

# PMS Developments

- From 1965-1990, PMS innovations came from research projects – FHWA, NCHRP, etc.
- However, little or no major research has been funded in PMS since 1990.
- Therefore, most of the current and future innovations in PMS software are being accomplished by commercial developers.
- Pavement and transportation asset management systems are becoming more mainstream, sophisticated, and comprehensive (all-encompassing) - similar to the ERP developments by PeopleSoft, Oracle, SAP, etc.

# What are the Issues Now?

## ● Pavement Preservation

- “In the United States, and throughout the developed countries of the world, there has been a shift from constructing new highway systems to preserving, maintaining, and maximizing the operation of what we have”  
[Madeleine Bloom, FHWA]
- “The right treatment on the right pavement at the right time” [Foundation for Pavement Preservation]

# What are the Issues now?

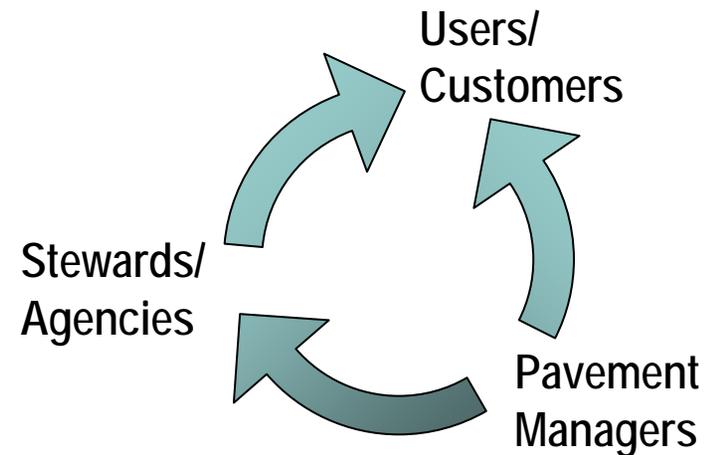
- Asset Management
  - Asset performance
  - User considerations
- “Asset management looks at all of the assets, and not solely from an engineering perspective, but from the user perspective as well”  
[Madeleine Bloom, FHWA]
- “...decision making process for allocating resources in terms of user benefits. ” [FHWA Office of Asset Management]

# Where are we going?

- The issues of the future fall in three general categories:
  - **Accountability**
  - **Integration**
  - **Engineering**

# Accountability

- Accountability to whom?
  - The Users
    - the traveling public
    - the transportation industry
  - The Stewards
    - Public Agencies (DOT, county, city, etc)
    - Privatized Toll Consortia



# The Users

- User ‘Costs’ / ‘Benefits’
  - “a good pavement should be safe and smooth”  
[Carey and Irick – original developers of the PSI from the AASHO Road Test]
- Classic ‘User Costs’:
  - Time Costs
  - Vehicle Operating Costs (VOC)
  - Accident Costs
- Other User issues:
  - Level of Service – what is that?
  - Comfort – roughness, potholes!
  - Construction Delay – frustration..



# The Stewards

- Pavement Managers are accountable to those who have been tasked with stewardship of the roads...
- Often, these agents are themselves subject to legislation:
  - ISTEA, TEA21, SAFETEA-LU
  - GASB34
    - ‘...establishes methods for governments to be more accountable to bond market analysts and underwriters...’
  - Many local variations...



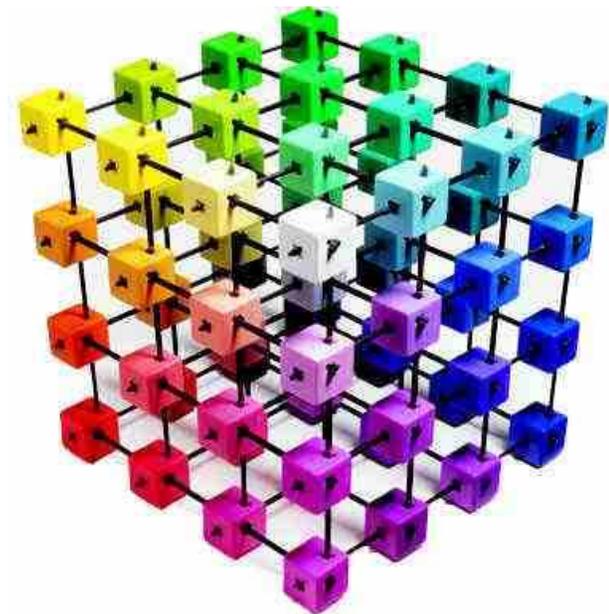
## The Stewards (cont.)

- In some cases the ‘stewards’ may be private toll consortiums, or contractors
- Often, they are under “Performance Based Specifications”
- In all cases, the stewards have been charged with balancing costs and benefits.
- This involves trade-offs... and introduces **\$Profit Motive\$**

# Integration

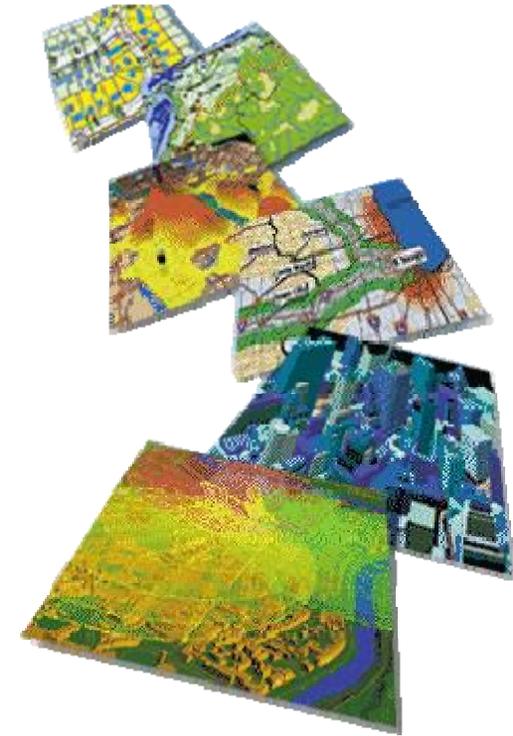
- Integration with what?

- GIS
- The field
- Maintenance (MMS)
- Design (Engineering)
- Other Agencies
- Other Management Systems
- Financial Systems
- Overall Asset Management
- Environmental
- Other Transportation Modes
- ITS



# GIS

- Linear Referencing Systems
- Coordination with other data
- Visualization/Communication



# Map Based Orientation

- GPS coordinates tied to GIS maps linked with pavement linear location referencing systems
- Seamless translation to the roadway linear network.
- Facilitates funding decisions for critical routes and specific corridors among:
  - pavements
  - bridges
  - safety
  - capacity
  - signs and signals
  - other support facilities

# Web-based PMS Software

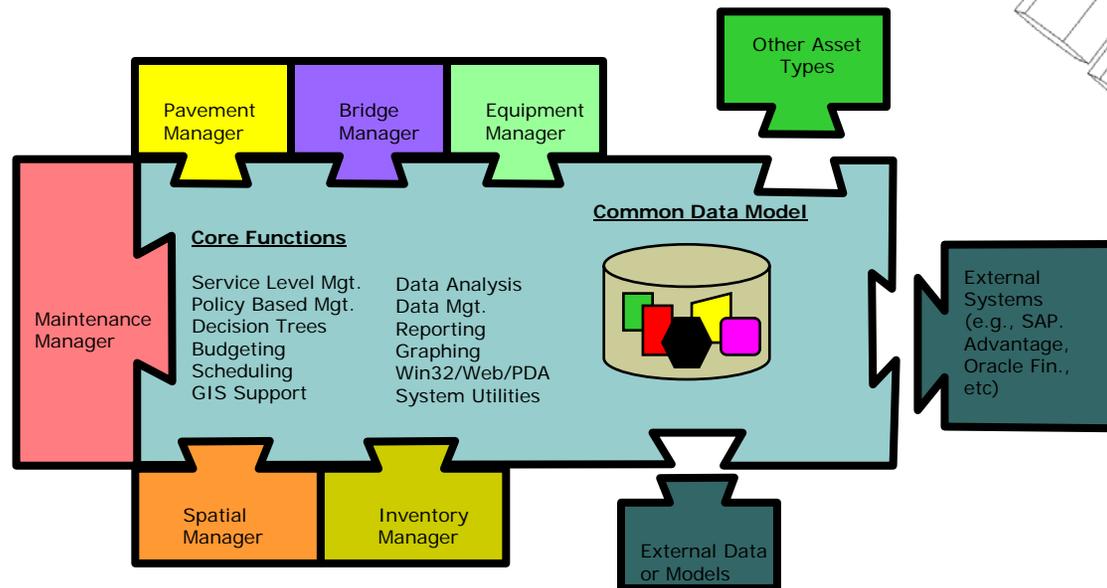
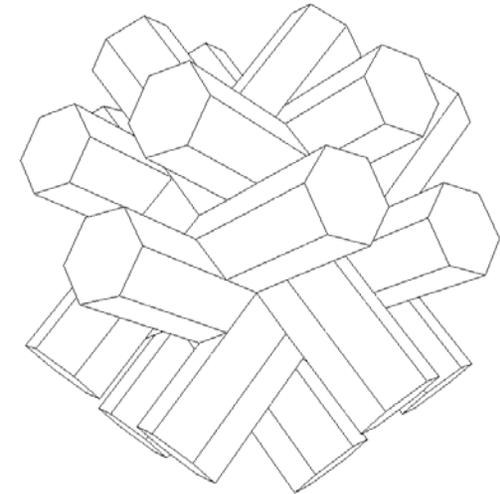
- PMS operated thru standard web browser
- Direct user interaction through the internet
- Easy access by local, district, and regional personnel in the DOT
- More information to more people to apply it
- Central application and database administration

# Maintenance Management Integration

- States will integrate their MMS and PMS
- MMS will use PMS data to understand the performance of pavements being maintained
- PMS will use MMS data to understand the maintenance needs and history of pavements being managed and programmed for CIP
- This poses some organizational issues (turf battles)
- Overcome as the benefits are evaluated

# Other Management Systems

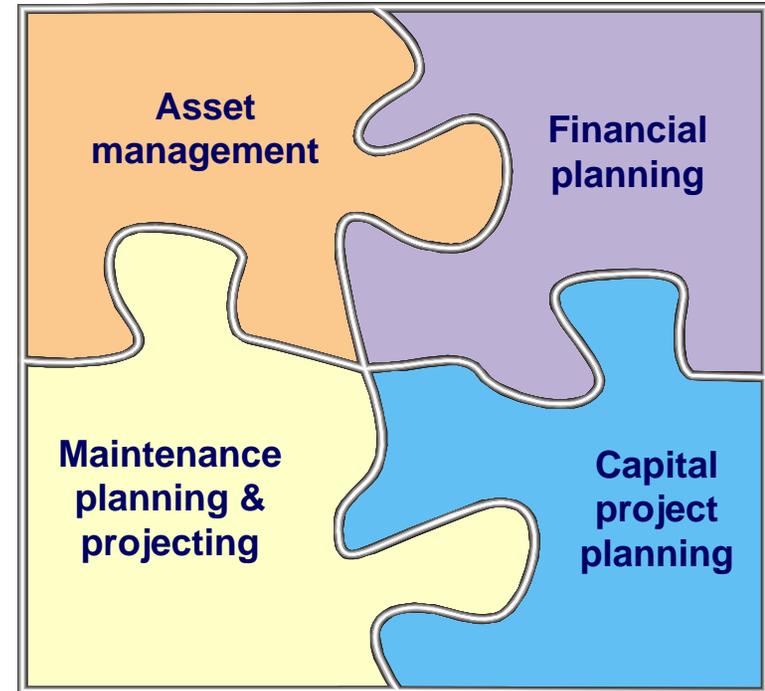
- Bridge, Signs, Equipment, etc
- Loosely coupled vs Tightly coupled



Integration

# Integration with Financial Systems

- ERPs
- Interfaces



Integration

# Intelligent Transportation Systems (ITS)

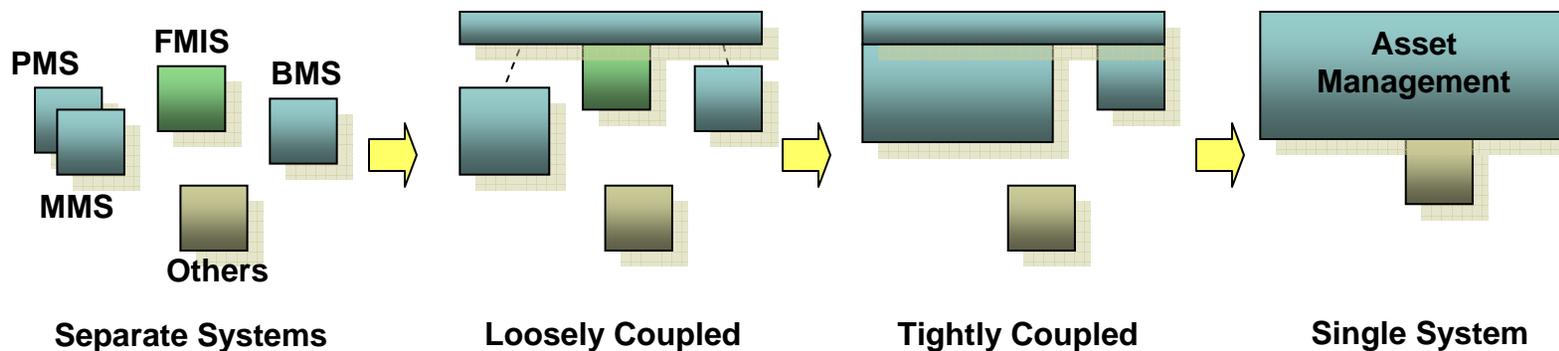
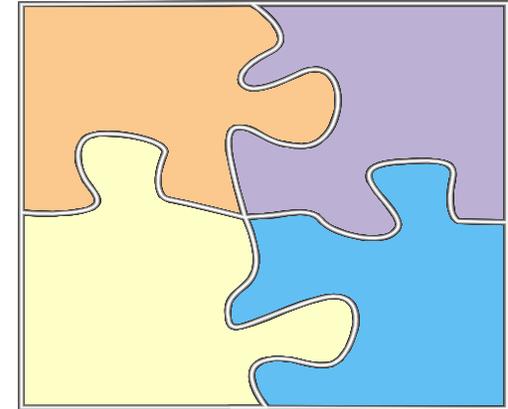
- Will take advantage of communication network being created under ITS
- Load monitored on a continuous basis
  - Traffic weights
  - Cumulative ESALs
  - Environmental Load
- Condition monitored on a continuous basis
  - Sensors built in to pavements at construction
    - Deflection
    - Strain and Stress
  - Remote Sensing
    - Roughness, Cracking



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# Integration – The Direction

- It's like a puzzle...
- It's like building blocks...
- It's an evolution...
  - Loosely Coupled
  - Tightly Coupled
  - Single System
- **ULTIMATELY PAVEMENTS ARE JUST ANOTHER ASSET**



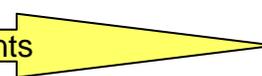
# Integration - The Information

- The sharing of information is of paramount importance
- Information Technology (IT) groups will continue to play larger and larger roles
- Engineers will have to work closely with IT

PMS



Same Basic (but evolving) Information Requirements

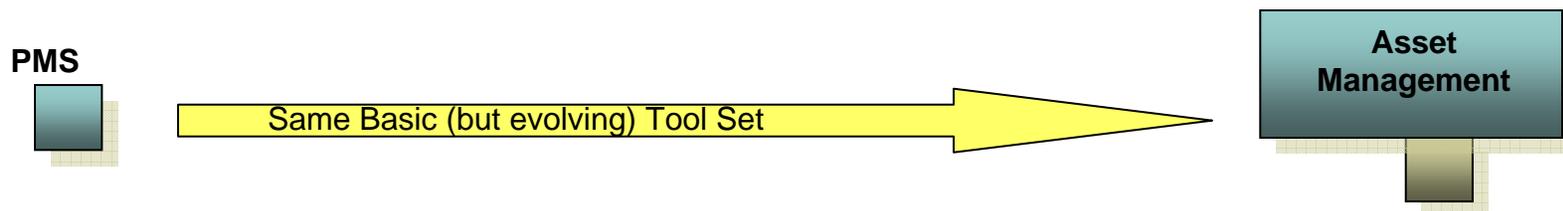


Asset  
Management



# Integration – The Tools

- At each level, trade-off analysis will be performed
- This requires continually improving
  - **prediction models** (both deterioration and restoration)
  - **analysis methods** (optimization, heuristics)
  - understanding and use of **economies of scale**
  - **risk management** (reliability)
  - understanding and use of **multiple objectives** (efficient frontiers)
  - **asset valuation** (accounting – e.g. GASB 34)
- Tool set will continue to evolve and integrate
- This in turn requires more research, education



# Internal PMS Integration

- Project level, project selection level, network level and strategic level PMS will be seamlessly integrated using the same core database
- Common definitions for PMS, at all levels, will become more widely accepted and integrated into regular use
- These forms of internal PMS integration are the basis of continued pavement engineering improvements

# Improved Pavement Engineering

- Pavement design and as-built data in accessible databases
- Actual pavement performance to calibrate pavement design models
- Compatible data collection
- Sharing of performance data
- Evaluate performance of new materials and construction methods

# Pavement Design

- Improved communication with Design
- Designers will use LCCA
  - Design provides initial prediction models for PMS for
    - Seal Coats
    - Overlays
    - New Construction
  - PMS provides performance model updates for
    - Designs
    - Methods
    - Products



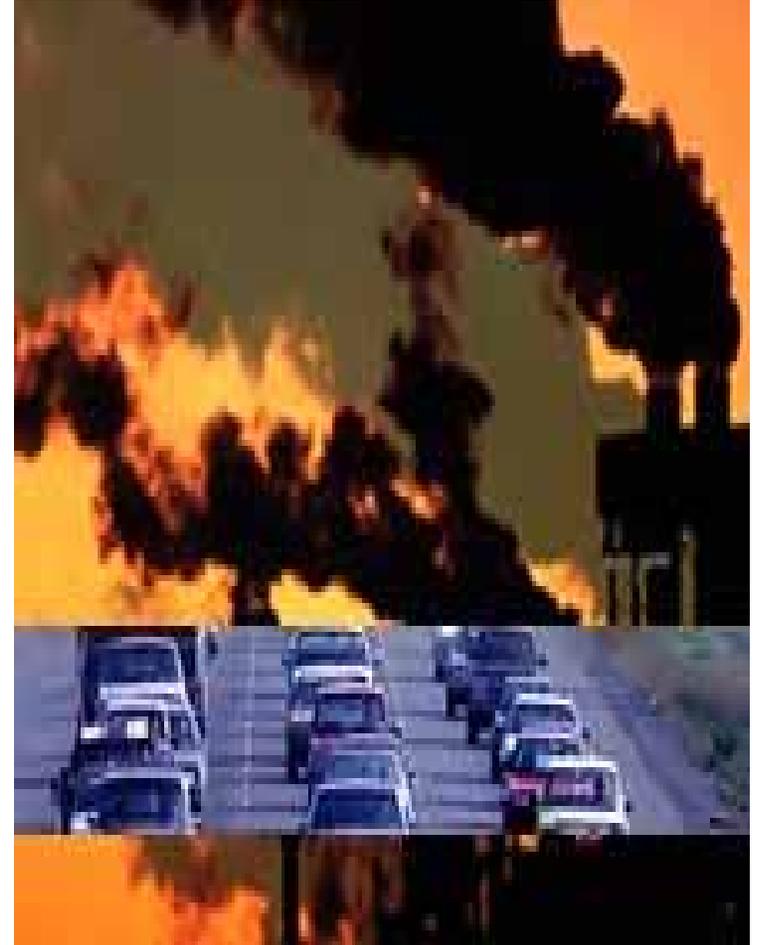
# Maintenance

- All maintenance work rigorously tracked
  - by location / exact asset
  - accurate costs
  - effects on service levels
  - effects of pavement performance
- Improved Practices
- Accurate models:
  - service levels
  - expenditures



# Environmental Stewardship

- Monitoring, Permitting and Control
  - Emissions
  - Water quality effects
  - Contaminated runoff
  - Right-of-Way expansions
- Materials used in future mix designs
- Recycling
  - Cold In-place
  - New methods



# Long Term Issues

- A century is a long time



- After the next 20 years – who knows?

# PMS After 20 Years

- Integrated
- Accountability and sustainability
- Valid, accurate data and analysis results
- Compatible performance predictions to support competing needs of
  - bridges,
  - capacity,
  - safety,
  - environment,
  - aesthetics,
  - higher maintenance levels of service
- Continual improvements in design and engineering

● Long Term Issues

# Long Term Issues

- Need to control costs within Transportation Agencies
- Increasing Environmental Responsibility
  - Restricted Materials and Methods
  - More Permits
  - More studies
- Rising Costs of Oil
  - Shifts in transportation modes
  - Increased costs of asphaltic materials

# Long Term Issues

- Different Materials
- Global Warming
  - Different environmental loads on our pavements
    - Precipitation
    - Temperature

Long Term Issues

# Conclusion

- Now
  - Preservation
  - Asset Management
- Near Future
  - Accountability
  - Integration
  - Engineering
- Long Range
  - Pervasive monitoring of pavement assets
  - Better tools to handle the PMS information and collate it with similar information from other assets