GIS As a Tool for Pavement Management

By Carlos Chang
Outline

- Objectives
- Conceptual Approach
- Methodology
- Application, results and discussion
- Conclusions and Recommendations
Objectives

• Explore GIS capabilities as a Tool for Pavement Management

• Show the application of GIS in the framework of a GIS-Pavement Management System
CONCEPTUAL APPROACH
Pavement Management Systems

Federal Highway Administration definition

“A set of tools or methods to assist decision makers in finding cost-effective strategies for providing, evaluating and maintaining pavements in serviceable condition”
Management Levels

**PROJECT MANAGEMENT LEVEL**
Decisions on a specific pavement section

- **Technical Level** (Engineers and Technicians)
  - Preliminary Design
  - Final Design
  - Construction
  - Supervision

- **Strategic Level** (Senior Managers and Funding Authorities)
  - Planning
  - M&R Policies
  - Fund Allocation Policies
  - Budget Approval

**NETWORK MANAGEMENT LEVEL**
Decisions on the entire set of pavement sections

- **Programming Level** (Public Work Officials)
  - M&R Pavement Program
  - Budget Formulation

Feedback

Interface
Purpose of Implementing a PMS

- Assist agencies in making decisions about What, Where and When a treatment is needed.
- Analyze the impact of pavement management strategies in pavement future condition and budget needs.
- Assist to obtain the best return of allocated funds.
Framework for Management Systems
Why PMS and GIS as an Integrated System?

**PMS**
- Information must be stored in a database
- Data is retrieved from the database according to the user’s needs
- PMS must be able to answer what if questions

**GIS**
- Information in the database can be stored using location and attribute.
- GIS can show the information visually generating maps that answer what if questions
METHODOLOGY
Overview

1. Integrate Data Gathered From Different Sources
2. Show Current Street Network Data in Theme Maps
3. Identify Treatment and Budget Needs
4. Analyze the Impact of M&R Strategies on Pavement Condition
5. Visualize the Impact of M&R Strategies in Theme Maps
6. Explore New Approaches to Visualize the Data using GIS capabilities
Database Inventory

- Section ID
- Name
- Functional Class
- Surface Type
- Length
- Year Constructed
- Area
- Traffic

- Database Structure with road network information available in vector data format California Coordinate System (CCS) Zone 3, NAD83
- Information in Database created in Access, Fox or Excel
Source Data (1/2)
Source Data (2/2)
How to visualize the current data?
Hayward’s PMS/GIS Extension
APPLICATION RESULTS AND DISCUSSION
Functional Classification
Functional Classification

Total Street Miles: 596
Replacement Cost: $290 Million

Network Classification
Art        Collector        Residential
-------------------------------------
25.9 %     17.1 %        56.9 %
Street Network by Year of Construction
# Typical Pavement Condition Categories

<table>
<thead>
<tr>
<th>Type</th>
<th>Condition</th>
<th>Score</th>
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<tbody>
<tr>
<td>I</td>
<td>Excellent</td>
<td>100</td>
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<tr>
<td>II</td>
<td>Very Good</td>
<td>85</td>
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<td>III</td>
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<td>IV</td>
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<td>VI</td>
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<td>IX</td>
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Pavement Condition Index

Average PCI = 65

<table>
<thead>
<tr>
<th>Condition</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>I</td>
<td>54.4</td>
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<tr>
<td>II/III</td>
<td>20.7</td>
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<tr>
<td>IV</td>
<td>16.1</td>
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<tr>
<td>V</td>
<td>8.8</td>
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What if questions
Pavement Deterioration Model

Relationship between Pavement Condition, Treatment Selection and M&R Costs
Budget Analysis

- Fund Needs are determined based on the selected pavement management strategy.
- Impact analysis can be done for different funding scenarios.
- Results from impact analysis can be shown in Access Reports or using GIS.
Prioritization

- If funds are constrained, prioritization is done by ranking the pavements using cost-effectiveness analysis.
- PMP 8.0 is used to make the calculations.
- Results can be shown in GIS.
Summary Statistics for Scenario Analysis
# Reports for Scenario Analysis

**CITY OF HAYWARD - SCENARIO 5b - 40%**

**Scenarios - Network Condition Summary**

<table>
<thead>
<tr>
<th>Year</th>
<th>Budget</th>
<th>PM Amt</th>
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<td>$1,035,690</td>
<td>0%</td>
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<td>2006</td>
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<td>0%</td>
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<tr>
<td>2021</td>
<td>$1,035,690</td>
<td>0%</td>
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<table>
<thead>
<tr>
<th>Year</th>
<th>Budget</th>
<th>PM Amt</th>
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<td>0%</td>
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<tr>
<td>2022</td>
<td>$1,035,690</td>
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**Projected Network Average PCI by year**

<table>
<thead>
<tr>
<th>Year</th>
<th>Never Treated</th>
<th>With Selected Treatment</th>
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<td>52</td>
</tr>
<tr>
<td>2019</td>
<td>34</td>
<td>51</td>
</tr>
</tbody>
</table>

**Interest:** 4.00%  
**Inflation:** 4.00%  
**Scenario:** Scenario 5b - 40% FUNDING - No PM  
**Date Printed:** 4/14/2003  
**PMS1035**
M&R treatments in the next 3 years
Budget Needs over a 20 year period
Scenario 1: Unlimited Funds
M&R treatments in the next 20 years
Scenario 2: No funds
Streets in Poor Condition
Scenario 3: 80% of Funding Streets in Good Condition
Scenario 4: 60% of Funding Streets in Good Condition
Scenario 5: 40% of Funding Streets in Good Condition
Scenario Analysis – Network Condition

PCI over time

Year

PCI

100%  0%  80%  60%  40%
Average PCI GRID
Minimum PCI GRID
Overlapping PCI Grid- Network Line Feature Theme
Surface PCI Slope?
CONCLUSIONS
AND
RECOMMENDATIONS
Benefits of implementing an Integrated GIS-PMS

- Funds can be expended more effectively by using an Integrated GIS-PMS in the analysis.
- Facilitates the communication of budget needs with funding authorities.
- Provides alternative options for a better justification of the funds requested by showing in theme maps the consequence of an inefficient strategy or insufficient allocation of funds.
Recommendation …

Use GIS as Global Tool !!!

Implementation of PMS with other facility systems using GIS as the heart of the central database will allow to share and contrast information more easily.

– Avoiding conflicts among projects.
– Saving money
– Getting the maximum economical and social benefits from the invested funds