

## Lecture #10:

Determine Present and Future Needs, and Priority Programming (Haas, Chap. 15-20)

### Pavement Deterioration Prediction Models

- Performance  $\Leftrightarrow$  Deterioration or Damage
- Measurement of Deterioration (e.g., PSI, PCI, IRI), Pavement Age / Accumulated Axle Loads, Past and Prediction of Future Deterioration, Establishing Criteria, Remaining Life, Rehabilitation Alternatives (Fig. 16.1)
- Types of Prediction Models  
Deterministic vs. Probabilistic Models (i.e., Survivor Curves, Markov Transition Process Models) (Table 16.1)
- “A transition probability matrix defines the probability that a pavement in an initial condition state will be in some future condition state.” (Table 16.3, 16.4)

- = F( Pavement Type, Thickness, Subgrade Type, Traffic, Environmental Effects)
- Advantages & Disadvantages
- Arizona DOT Use “Rate of Crack Change”

- Development Process: Lee's Ph.D. Thesis  
Lee, Y. H. (1993), "Development of Pavement Prediction Models," Ph.D. Thesis, University of Illinois, Urbana.

### Establishing Criteria and Determining Needs

- Examples of Measurements, Affecting Factors, Effects of Changing Criteria
- Needs Years and Action Years
- Effects of Prediction Model Errors  
"Deterioration Predictions Should be Periodically Updated."
- Need versus Type of Action Taken
- Graphical and Tabular Representation of Needs

### Rehabilitation and Maintenance Strategies

- Identification of Alternatives:  
Rehabilitation, Routine Maintenance (Preventive), Major Maintenance (Corrective) (Fig. 18.1)
- Decision Processes & Expert Systems  
Approaches to Identifying Feasible Alternatives: Simple Judgment -->

Decision Tree of Expert Systems  
Approach (can also be in Matrix Form)  
(Fig. 18.2, 18.3)

- EXPEAR Program: “Expert Systems for Pavement Evaluation and Rehabilitation” to Be Discussed in Next Semester
- KBES (Knowledge Based Expert System): Development Tool or “Shell”  
專家系統
- Deterioration Modeling of Rehabilitation & Maintenance Alternatives: Remaining Life Analysis
- Costs, Benefits, and Cost-Effectiveness:
  - (a) Costs: Actual Work, Vehicle Operating Costs, User Delays (e.g., Minnesota), Accident, Environmental Damage Costs
  - (b) Benefits: Effectiveness is the “Net Area under the Performance or Deterioration Curve” Multiplied by Section Length and Traffic (=  $AREA * Length * ADT$ )
  - (c) Cost-Effectiveness = Effectiveness / Cost  
Unit Cost, Average Annual Cost

## Priority Programming of Rehabilitation and Maintenance

- Basic Approaches: (a) Strategic Approach for Certain Future Targets; (b) Defining a Set of “Approved” R&M Alternatives; (c) Policy-Oriented Approach by Specifying a Limited Number or Type of Alternatives
- Selecting Length of Program Period (5- or 10- Year Program): Single Year by Single Year Program, or Multiyear Program
- Basic Functions of Priority Programming:  
Major Steps: Information, Identification of Needs, Priority Analysis, Output Reports  
(Fig. 19.2)
- Priority Programming Methods: (Table 19.1)
  - (a) Subjective Ranking
  - (b) Parameter Based Ranking:  
Ex: Rational Factorial Rating Method (A Priority Index  $\leq$  Expert Opinion)
  - (c) Ranking Based on B/C

(d) Near Optimization Using Marginal  
Cost-Effectiveness (邊際成本效益)

(Incremental B/C)

(e) Long-Term Optimization:

Multiyear Program, Most Complex

- Mathematical Programming: (Page 92, Mohseni's Thesis)
- Examples and Comparisons
- Budget Level Evaluation
- Funding Level Requirements for Specified Standards, Final Program Selection

Developing Combined Programs of M &  
R

## 工程經濟分析

$$S \ N \ P(1 < i)^n \ N \ P[spcaf(i, n)]$$

$$S \ N \ R \frac{(1 < i)^n > 1}{i} \ N \ R[uscaf(i, n)]$$

$$P \ N \ R \frac{(1 < i)^n > 1}{i(1 < i)^n} \ N \ R[uspwf(i, n)]$$

P = 投資現額

S, F = n期後之總額

R = 連續每期償付或收回之固定金額

i = 每期最低報酬率(Interest / Discount Rate)

n = 期數

spcaf = 一次償付複利因子(single-payment compound-amount factor)

sppwf = 一次償付現值因子(single-payment present-worth factor) = 1/spcaf

uscaf = 定額複利因子(uniform-series compound-amount factor)

sfd = 基金儲存因子(sinking-fund deposit factor) = 1/uscaf

uspwf = 定額現值因子(uniform-series present-worth factor)

crf = 資金還原因子(capital recovery factor) = 1/uspwf

