



Life-Cycle Cost Analysis



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Office of Asset Management

Agenda

1. Pavement Preservation
2. FHWA Updates
3. LCCA Program Status
4. State Example





Pavement Preservation

Keeping Good Roads Good



Without Pavement, We Would Be Stuck In The Mud!



Washington-Richmond road, 1919
NMAH, Archives Center, API Collection

Less Than 100 Years Ago...



We've Come a Long Way ...





Society Depends on Infrastructure

SOCIAL INTERACTIONS

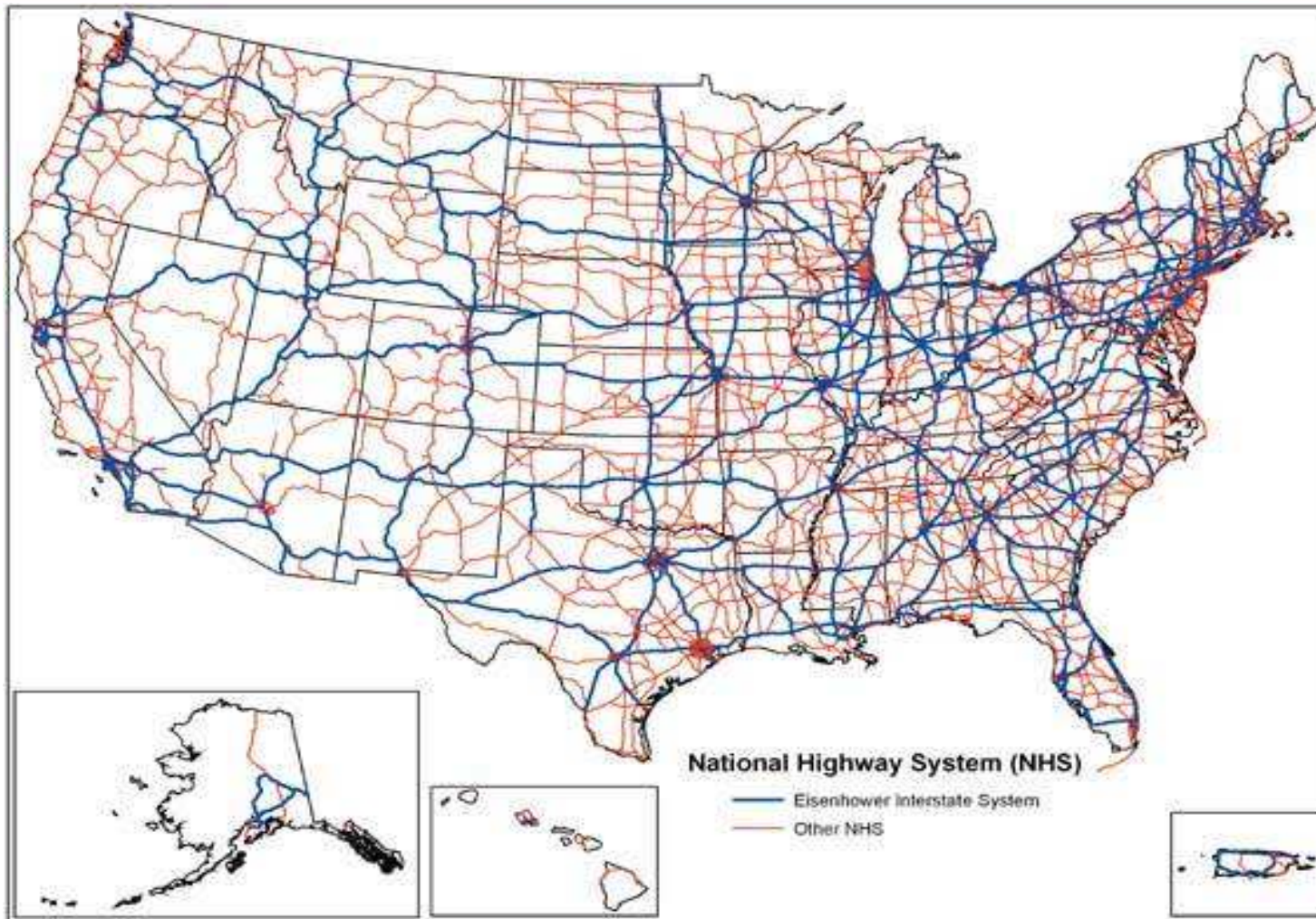
ECONOMIC TRANSACTIONS

INFRASTRUCTURE

Roads, Bridges, Airports, Water Systems, Wastewater Systems,
Gas, Electric, Telephones, Waterways, Coastal Facilities, Parks, Etc.



4 Million Miles of Roads & 600,000 Bridges





Statistics We Should Know:

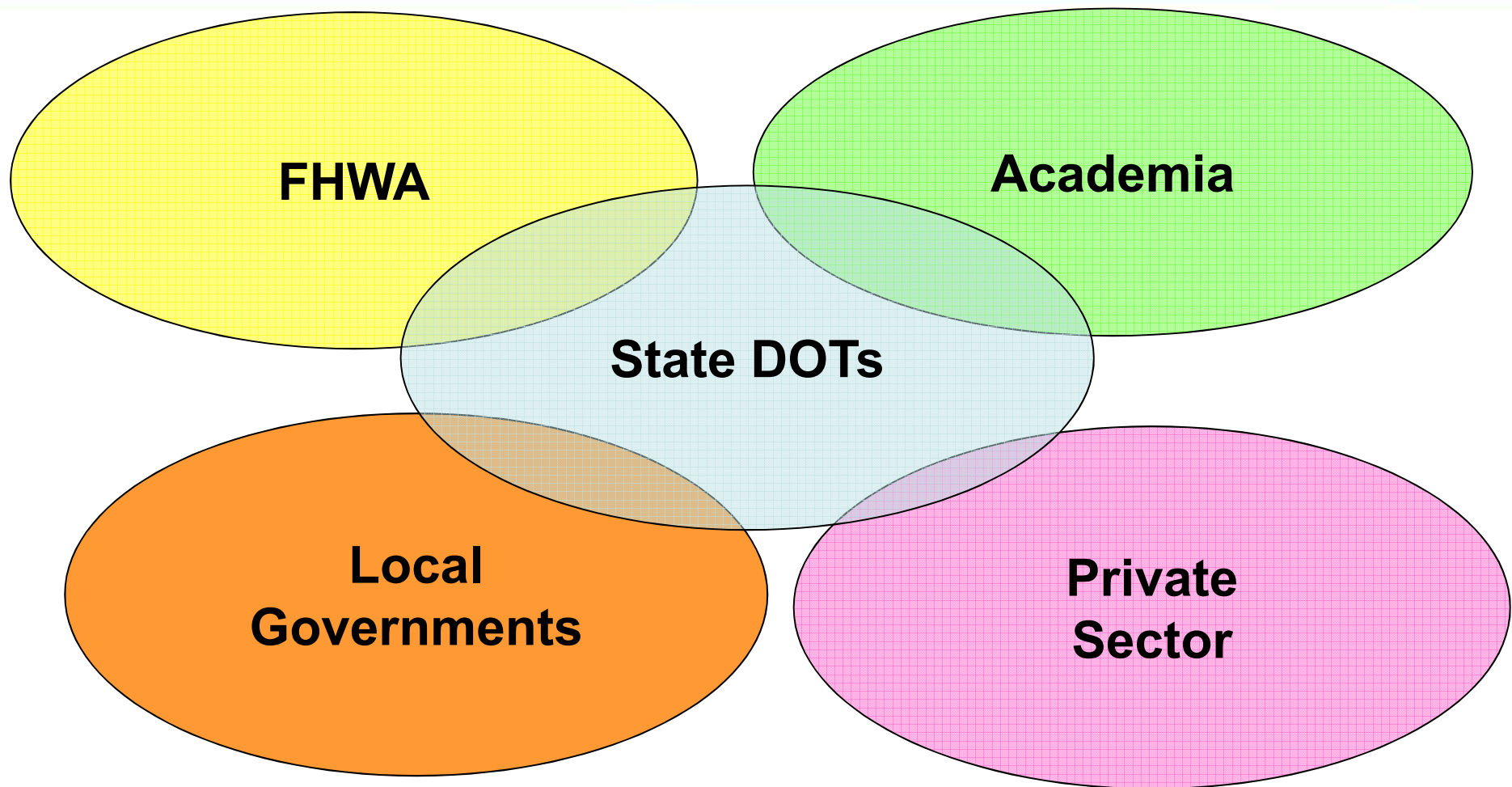
Federal	= 3%
State	= 20%
Local	= 77%

2/3 are Paved (1/3 Unpaved)

94% of Paved have an Asphalt Surface



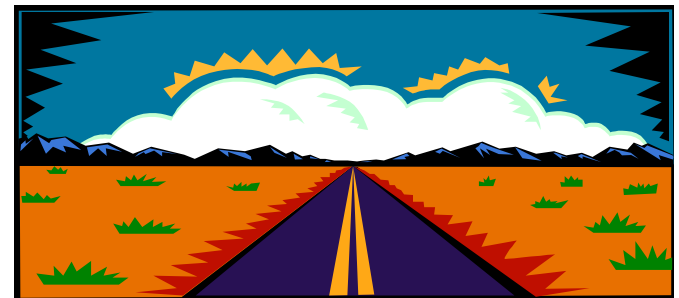
Partnerships Are Required





Pavement Preservation and Asset Management

Three FHWA Asset Management Teams:
Systems Management and Monitoring
Engineering and Economic Investment
Construction and System Preservation





Construction and System Preservation

BRYAN CAWLEY





Pavement Preservation

Doing the *right* thing...

...to the *right* pavement.

...at the *right* time...

TO KEEP THE “GOOD” ROADS GOOD!



Keeping Good Roads Good

Corridor assessment

- I-95 corridor
- What data are states using to manage “conditions” of I-95
- Common performance indicators
- Good, Fair or Poor
- MD-DE-VA
- “Evaluation of Highway Performance Measures for a Multi-Study Corridor - A Pilot Study”

<http://www.fhwa.dot.gov/asset/hif10015/>



Keeping Good Roads Good

Infrastructure Health Project

- 2 objectives
 - 1. Identify performance indicators
 - Good, fair & poor
 - Condition Data needed
 - Reported
 - 2. Identify pavement health indicators
 - What do we need to measure



Maintenance Leadership Academy

- Four-week training, blended learning
- Target audience: state and local maintenance supervisors
- Strong emphasis on preservation and performance improvement



Maintenance Leadership Academy

Six Modules

- ✓ Maintenance Management
- ✓ System Preservation
- ✓ Roadsides and Drainage
- ✓ Weather-related Operations
- ✓ Safety and Workzones



Life-Cycle Cost Analysis



LCCA Program Status

Distance Learning Course

Onsite RealCost LCCA Workshop

RealCost User Manual

Technical Bulletin

Bridge LCCA





Life-Cycle Cost Analysis Definition

- Life-Cycle Cost Analysis is a **process** for evaluating the total economic worth of a usable project segment by analyzing initial costs and discounted future costs, such as maintenance, user, reconstruction, rehabilitation, restoring, and resurfacing costs, over the life of the project segment.

Source: Transportation Equity Act for the 21st Century



Pavement Preservation vs. Reconstruction

State Examples

Arizona State DOT

Washington State DOT



Pavement Preservation vs. Reconstruction

Arizona Department of Transportation

- Continuous weakening of substructure material
- Cost & performance
- Sponsored a Study - *Cost-Benefit Analysis of Continuous Pavement Preservation Design Strategies Versus Reconstruction Final Report 491*

Prepared by: K.L. Smith, L. Titus-Glover, M.I. Darter, H.L. Von Quintus, R.N. Stubstad, and J.P. Hallin

Arizona Department of Transportation

- Break-even
- Continuous preservation
- Rehabilitation treatments



Arizona Department of Transportation

Life-Cycle cost Analysis (LCCA)

- Probabilistic approach
- FHWA's LCCA spreadsheet program
- RealCost, Version 2.1 (FHWA, 2004)





Input Analysis

- ✓ Pavement performance
- ✓ Service life estimates
- ✓ Best estimates of unit costs
- ✓ Work zone-related user cost
- ✓ Discount rates
- ✓ Analysis period





Alternative Strategies

- Life Cycle Cost
 - 4 strategies
 - 15 commonly occurring pavement scenarios



Traffic Info Used in LCCA

Project ID	AADT, veh/day ^a	Cars as Percentage of AADT, %	Percent Single Trucks ^b	Percent Combo Unit Trucks ^b	Annual Growth of Traffic, %	Speed Limit, mi/hr	Lanes Open ^c	Free Flow Capacity, vphpl	Rural or Urban? ^d	Queue Dissipation Capacity, vphpl	Maximum AADT, veh/day ^e	Maximum Queue Length, mi
Cell 1	10,000	77	13	10	2.5	70	2	2,200	Rural	1,800	100,000	4
Cell 2	18,000	72	18	10	2.5	70	2	2,200	Rural	1,800	100,000	4
Cell 3	13,000	85	5	10	2.5	55	1	2,200	Rural	1,800	100,000	4
Cell 4	6,000	84	6	10	2.5	55	2	2,200	Rural	1,800	100,000	4
Cell 5	7,500	83	7	10	2.5	55	2	2,200	Rural	1,800	100,000	4
Cell 6	17,000	66	24	10	2.5	70	2	2,200	Rural	1,800	100,000	4
Cell 7	23,000	75	15	10	2.5	70	2	2,200	Rural	1,800	100,000	4
Cell 8	9,000	79	11	10	2.5	55	2	2,200	Rural	1,800	100,000	4
Cell 9	14,000	80	10	10	2.5	55	1	2,200	Rural	1,800	100,000	4
Cell 10	1,400	83	7	10	2.5	55	1	2,200	Rural	1,800	100,000	4
Cell 11	17,000	66	24	10	2.5	70	2	2,200	Rural	1,800	100,000	4
Cell 12	80,000	85	5	10	2.5	55	3	2,200	Urban	1,800	100,000	4
Cell 13	25,000	75	15	10	2.5	70	2	2,200	Rural	1,800	100,000	4
Cell 14	240,000	81	9	10	2.5	55	5	2,200	Urban	1,800	100,000	4
Cell 15	75,000	86	4	10	2.5	55	3	2,200	Urban	1,800	100,000	4



Agency Construction Cost

Bid Item	Unit	Description Bid Item Components	Unit Price	Quantity Per Day
Asphalt Concrete Friction Course (FC)	ton	Asphalt Concrete Friction Course	\$28.13	2,000
	ton	Asphalt Cement for ACFC	\$154.03	
	ton	Mineral Admixture for ACFC	\$97.42	
Asphalt Rubber AC Friction Course (FR)	ton	Asphalt Rubber AC Friction Course	\$29.44	2,000
	ton	Asphalt Cement for AR-ACFC	\$274.99	
	ton	Mineral Admixture for AR-ACFC	\$97.42	
Asphalt Concrete (AC)	ton	Asphalt Concrete (3/4" Mix)	\$22.09	2,000
	ton	Asphalt Cement for AC (3/4" Mix)	\$154.03	
	ton	Mineral Admixture for AC (3/4" Mix)	\$97.42	
Asphalt Rubber AC (AR)	ton	Asphalt Rubber AC	\$25.65	2,000
	ton	Asphalt Cement for AR-AC	\$260.48	
	ton	Mineral Admixture for AR-AC	\$97.42	
Continued....				



Agency Construction Cost

Bid Item	Unit	Description Bid Item Components	Unit Price	Quantity Per Day
Bituminous Pavement (milling)	yd ²	Milling depth = 0.5"	\$0.54	20,000
	yd ²	Milling depth = 1.0"	\$0.76	18,000
	yd ²	Milling depth = 2.0"	\$1.10	16,000
	yd ²	Milling depth = 2.5"	\$1.25	15,000
	yd ²	Milling depth = 3.0"	\$1.35	14,000
	yd ²	Milling depth = 3.5"	\$1.40	13,500
	yd ²	Milling depth = 4.0"	\$1.50	13,000
	yd ²	Milling depth = 4.5"	\$1.60	12,500
	yd ²	Milling depth = 5.0"	\$1.70	12,000
JPC (nondoweled PCC)	yd ²	11.0-in PCC	\$27.00	2,500
	yd ²	12.0-in PCC	\$29.00	
	yd ²	12.5-in PCC	\$30.00	
	yd ²	13.0-in PCC	\$31.00	
	yd ²	13.5-in PCC	\$32.00	
Continued...				



Value of Time

Parameter	Cost
Value of Time for Passenger Cars (\$/hour)	\$3.08
Value of Time for Single Unit Trucks (\$/hour)	\$20.95
Value of Time for Combination Trucks (\$/hour)	\$25.21



Final results

- Reduction in total LCC
- Increase (from 0 to 2) in the number of rehabs between original construction and the first reconstruction events
- 9 of the 15 scenarios
- Break-even point
 - Occurs after 2 to 3 cycles of rehab



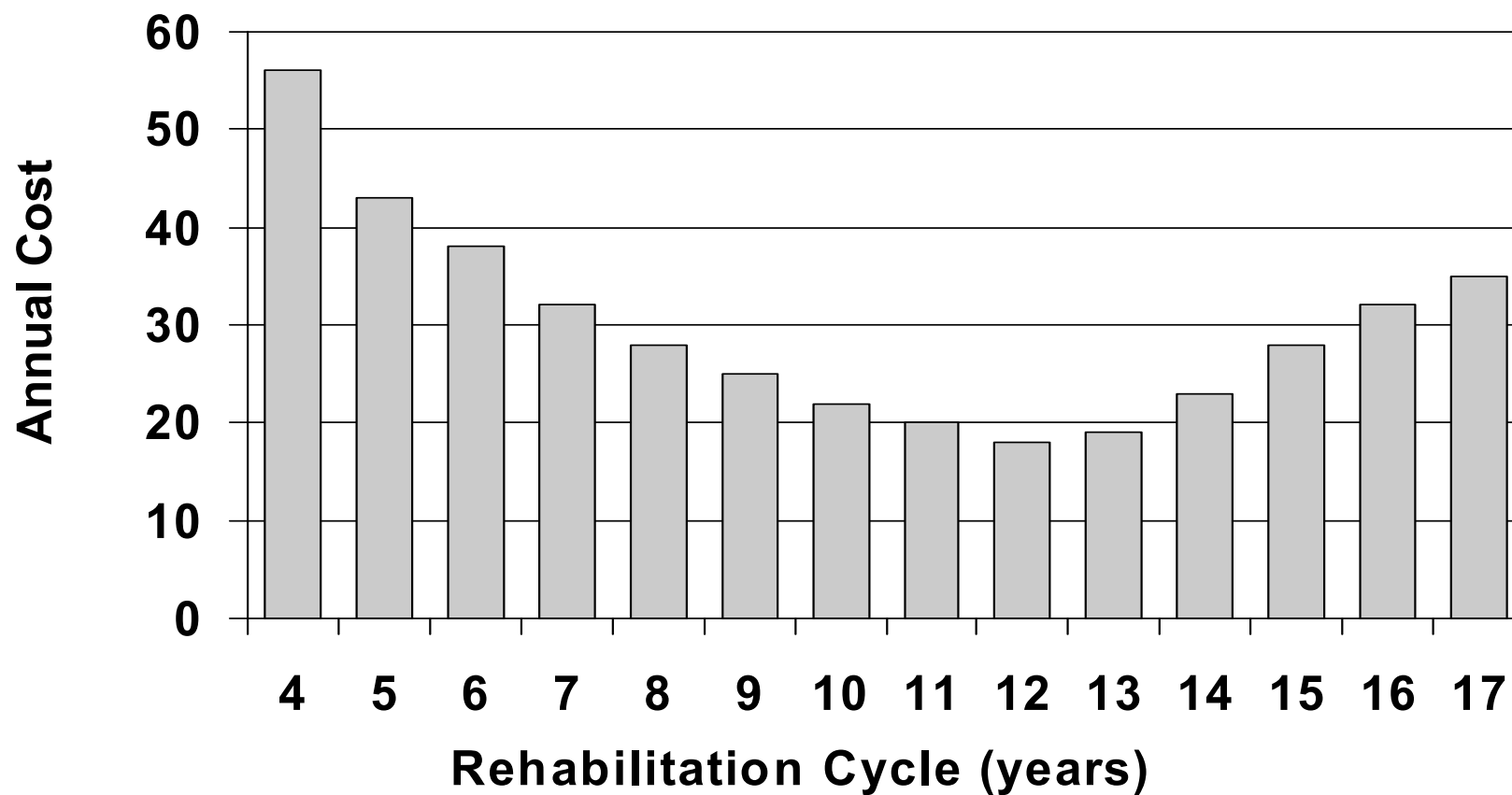
Pavement Preservation vs. Reconstruction

Washington State DOT

- 1993 Revised Code WA
 - Required project selection be based on the lowest life cycle cost concept
 - Optimal timing (opportunity window) 2 to 3 yrs



Washington State DOT





Washington State DOT

Network level Economic Analysis

- Design life yielded the most benefits
- Pavement Management System (PMS)
 - Pavements
 - Anticipated deterioration curves
 - Rehabilitation activity cycles
 - Anticipated costs in the year the activity would occur



Washington State DOT

- “worst first” to “a needs based approach”.
- 3 performance measures of pavement distress.
 1. Pavement Structural Condition (PSC)
 2. International Roughness Index (IRI)
 3. Rutting



Washington State DOT

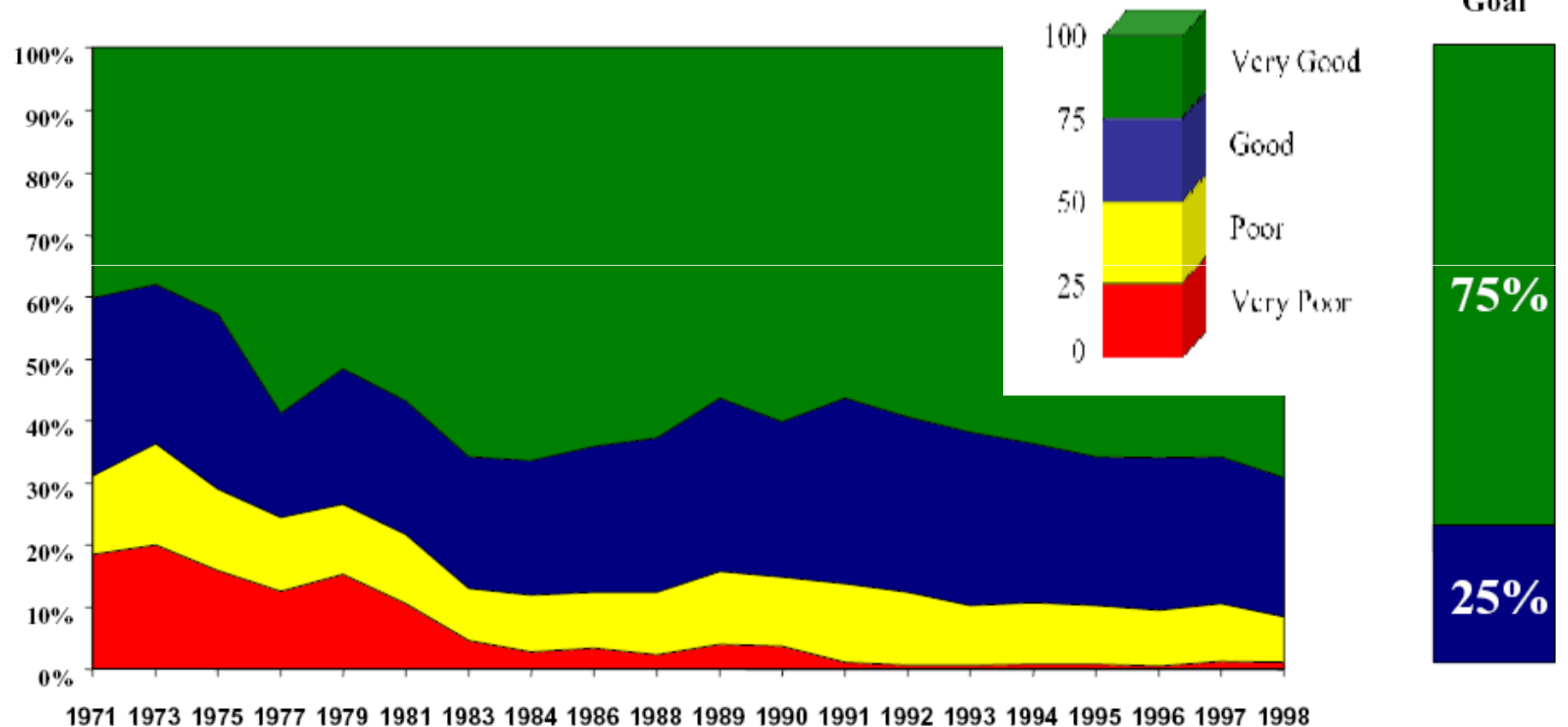
Minimum Rating

- 50 for PSC
- 220 inches/mile for IRI
- 10 mm (.4 in) for rutting
- The LCCA validation process was conducted again in 2000



Washington State DOT

Pavement Structural Condition (Statewide - All Pavements)





Washington State DOT

- Lowest LCC by conducting preservation activities
 - Early stages of deterioration to prolong their life
 - Need for major rehabilitation



Washington State DOT

- Success is measured by network condition of their pavements
- In 1971
 - 50% poor conditions
- Today
 - Less 10% are in poor condition



Resource Documentation

- **Arizona report**

*Cost-Benefit Analysis of Continuous Pavement
Preservation Design Strategies Versus Reconstruction*

<http://www.fhwa.dot.gov/infrastructure/asstmgmt/lcca.cfm>

- **FHWA Case Study**

Pavement Management Systems

The Washington State Experience

http://www.fhwa.dot.gov/pavement/pub_details.cfm?id=626



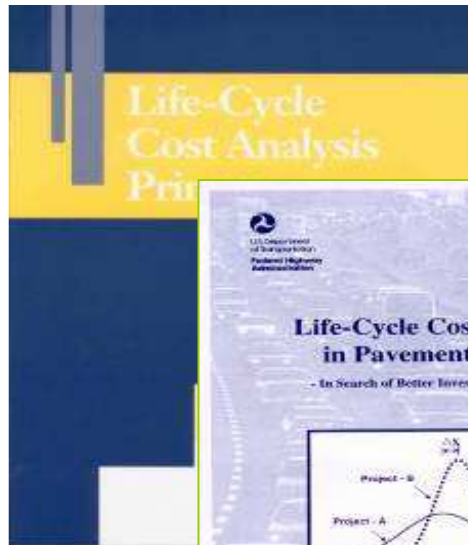
Resources

Training

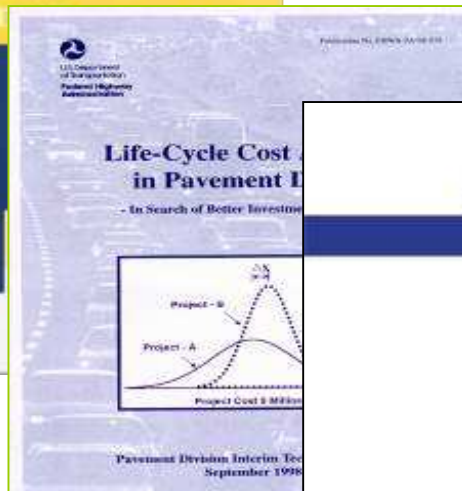
**Fundamentals of Life Cycle Cost Analysis Live
Instructor Led Distance Learning Course**

**Onsite RealCost Life-Cycle Cost Analysis (LCCA)
Software Workshop**

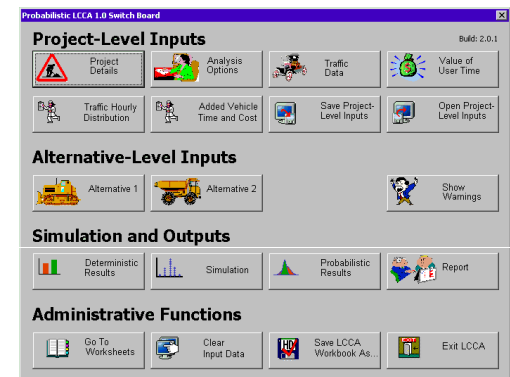
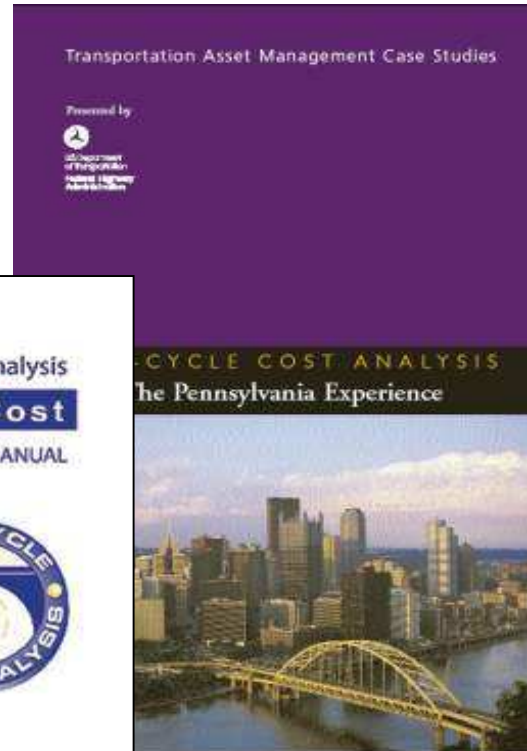
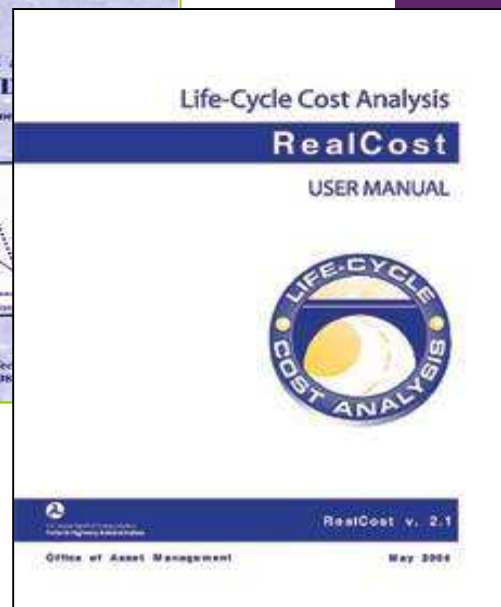
Resources



Technical Bulletin
FHWA-SA-98-079



LCCA Primer
FHWA-IF-02-047



LCCA Software
RealCost 2.5
and
User Manual



Summary and Closing Remarks

- Pavement Preservation
- Keeping Good Roads Good
- LCCA/RealCost
- State Examples

<http://www.fhwa.dot.gov/infrastructure/asstmgmt/lcca.cfm>

Thank you

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<http://www.fhwa.dot.gov/infrastructure/asstmgmt/lcca.htm>