Next-Generation Pavement Performance Measures

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"Engineers are not entertaining. That's not a thing the last time I checked."

– Tracy Nowaczyk

Let's prove her wrong over the next two days!

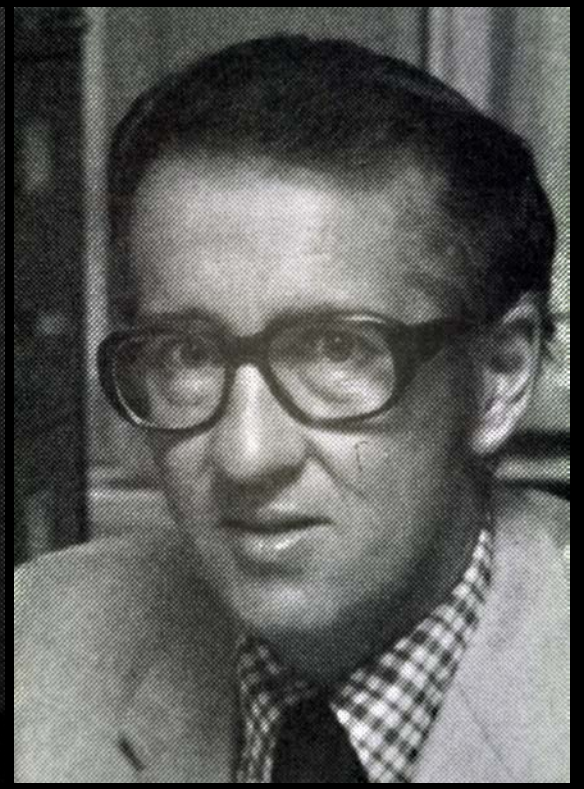
(or may be not)

Pavement Management Systems: The Impetus

Fred Finn

Karl Pister

Ron Hudson



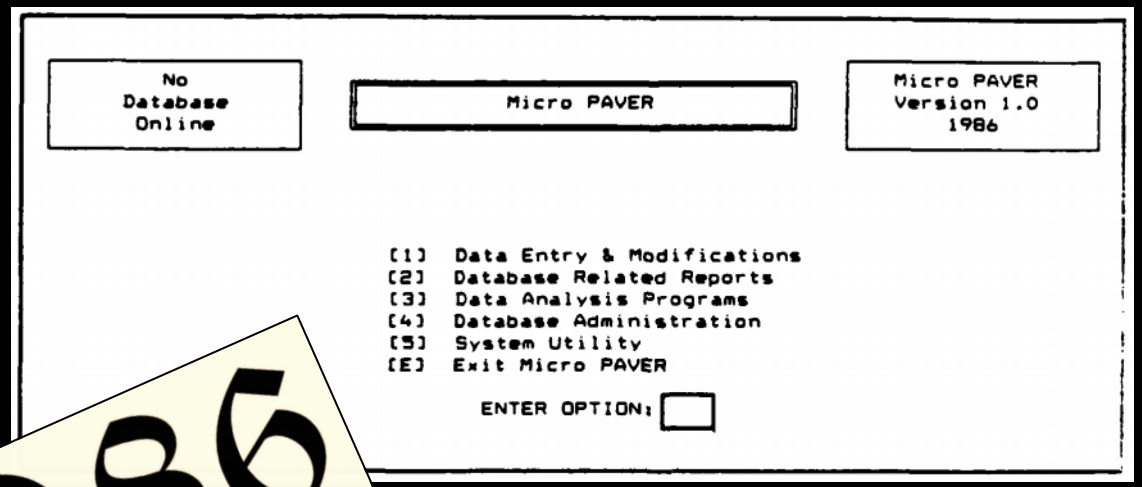
Ralph Haas

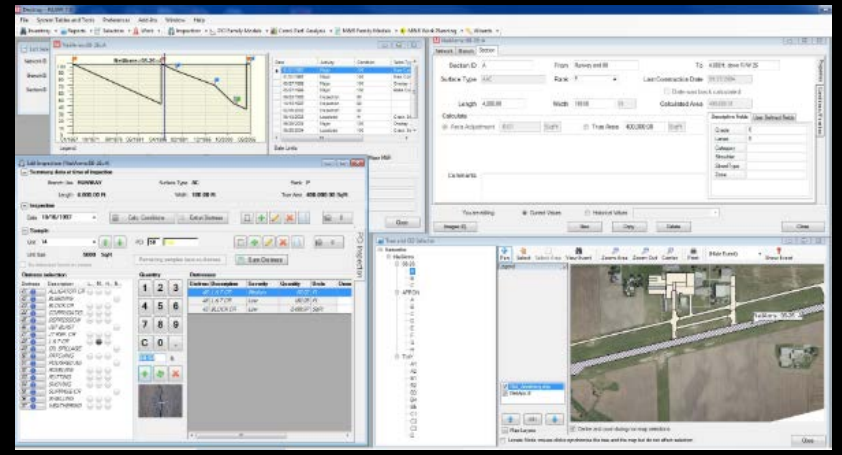
Images stolen from Dr. Carl Monismith's presentation (2011)

Humans and Pavement Management Systems

Human Being Generations	PMS Generations
Traditionalists or Silent: b. 1945 & before	1st Gen – Databases
Baby Boomers: b. 1946-1964	2nd Gen – Databases with heuristic decision tree, single period B-C analysis
Gen X: b. 1965-1976	3rd Gen – Arizona, 1982, Multi-Year optimization, decision trees, Markov models
Millenials: b. 1977- 1995	4th Gen – Web-based, enhanced optimization algorithms, GIS capabilities
Gen Z/iGen/Centennials: b. 1996-TBD	5th Gen – Cross-asset trade-off analysis capabilities

We've Come a Long Way but…
The Best is Yet to Come!





1986

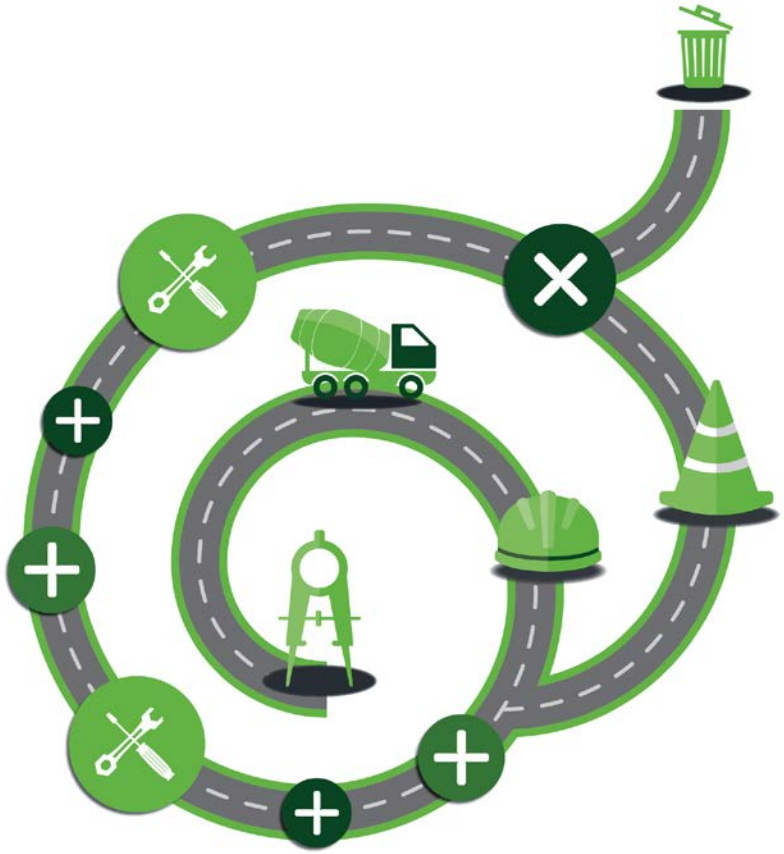
Why? What? How?

- **Why "cross-asset"?**
  - Cannot operate in silos anymore
- **What do you need?**
  - Data!
  - **Performance measures**
  - Financials
- **How do you do it?**
  - Mature management systems
  - Analysis tools

Performance Measures

- Forward-looking
- Action-oriented
- Intuitive
- Verifiable
- Adaptable
- Easily Implementable

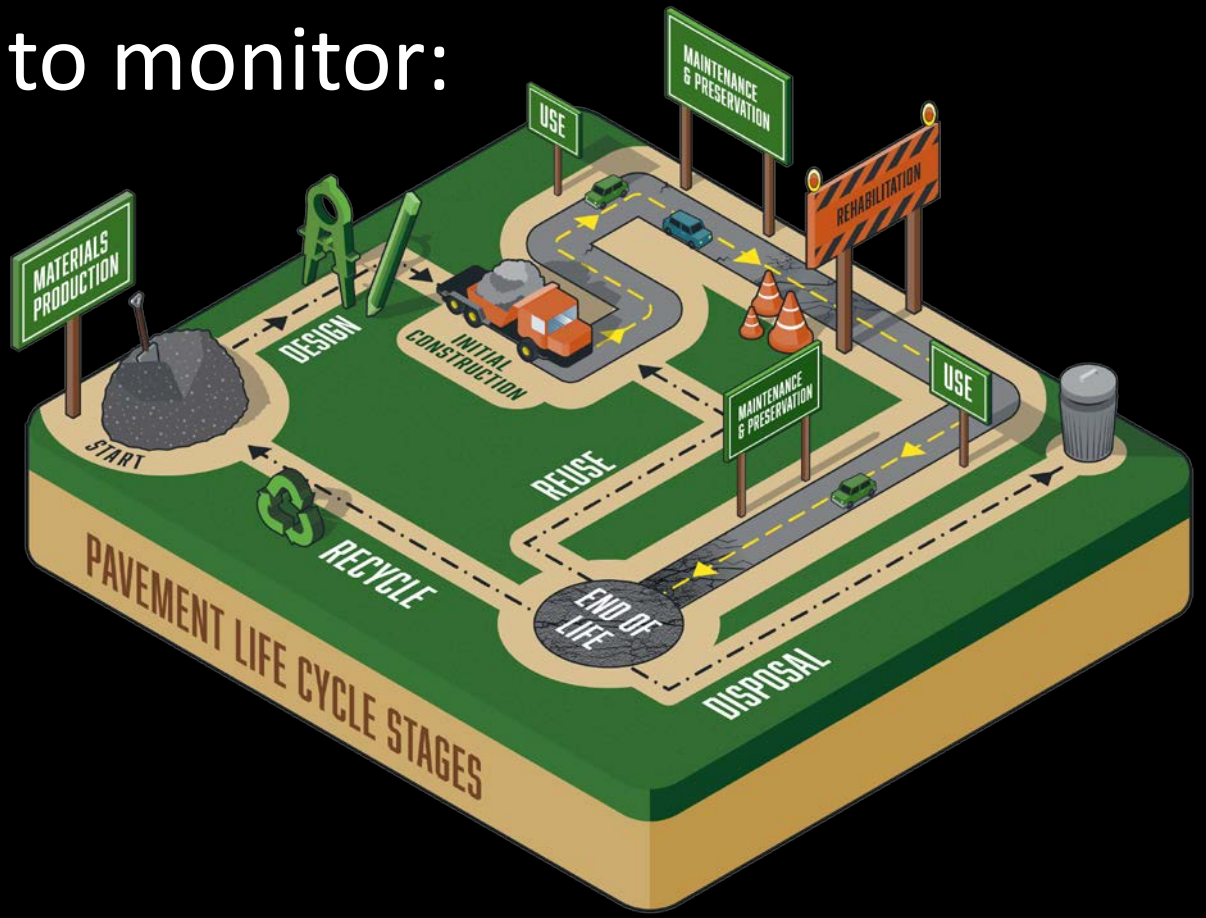
Are we making sound long-term decisions?



Life-Cycle Performance Measures

Consider Whole Life of Assets

- Consider longer analysis periods
- Use performance measures to monitor:
  - Asset Condition
  - Life-Cycle Efficiency
  - Financial Sustainability
  - Other Factors
    - Safety
    - Mobility



Remaining Service Interval (RSI) [1/2]

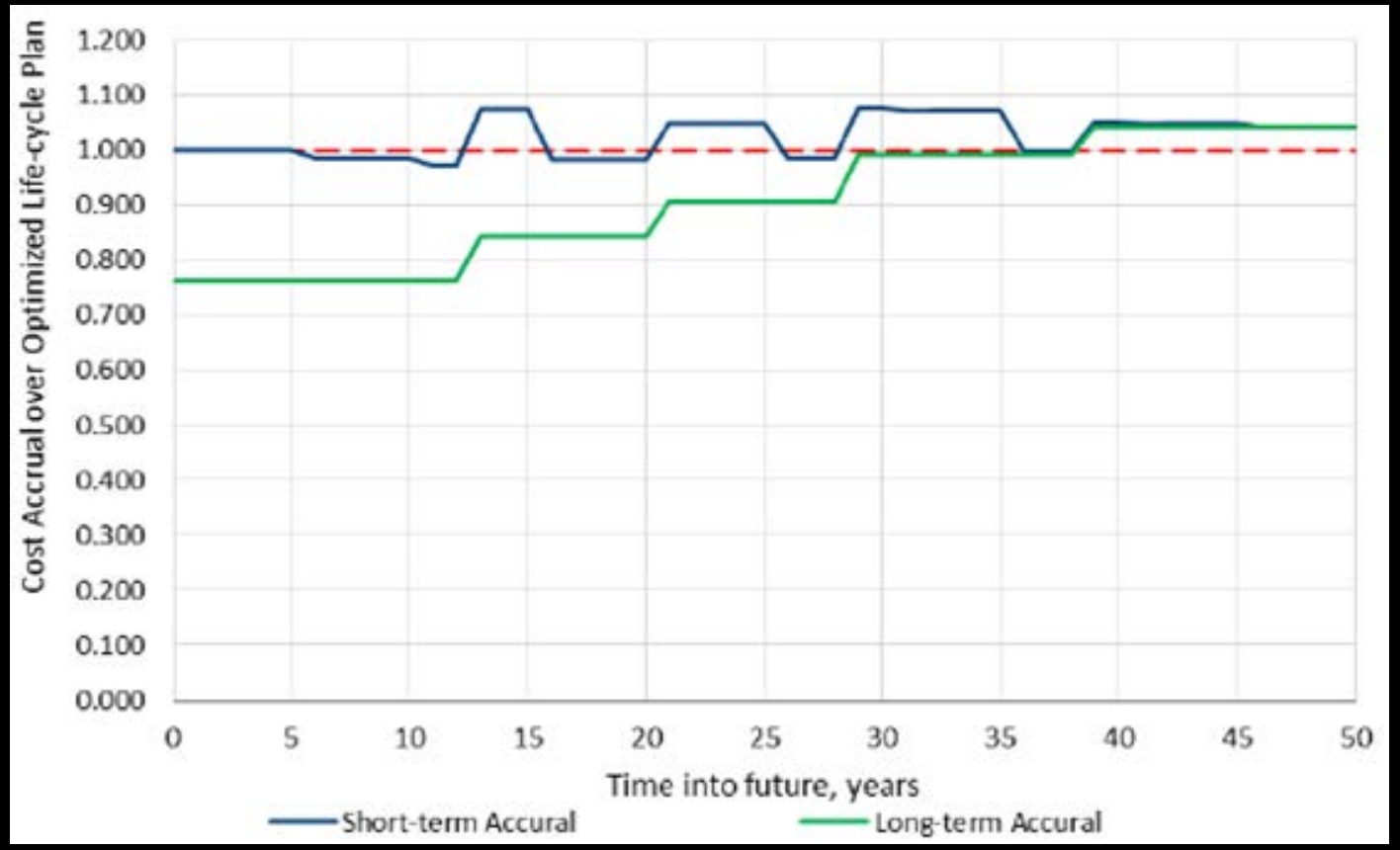
- Determine the lowest practical life-cycle cost strategy
- Traditional LCCA: treatment type/timing are **inputs**
- RSI Analysis: treatment type/timing are **outputs**

Remaining Service Interval (RSI) [2/2]

- Optimal Strategy: Lowest-life-cycle cost
- Sub-optimal Strategies: Higher overall life-cycle costs; may have lower costs for shorter “planning periods”
  - Useful in a fiscally-constrained analysis
- How to choose the best strategy?
  - Prioritize based on “best value” for available budget
  - Combination of optimal and sub-optimal strategies, considering each segment in the network

Life-Cycle Measures

- Life-Cycle Cost
  - Net Present Value (NPV)
  - Annualized Cost per Lane-Mile
- Cost Accrual Ratio: Compare NPV of costs incurred to date/projected vs. NPV of lowest-life cycle cost strategy



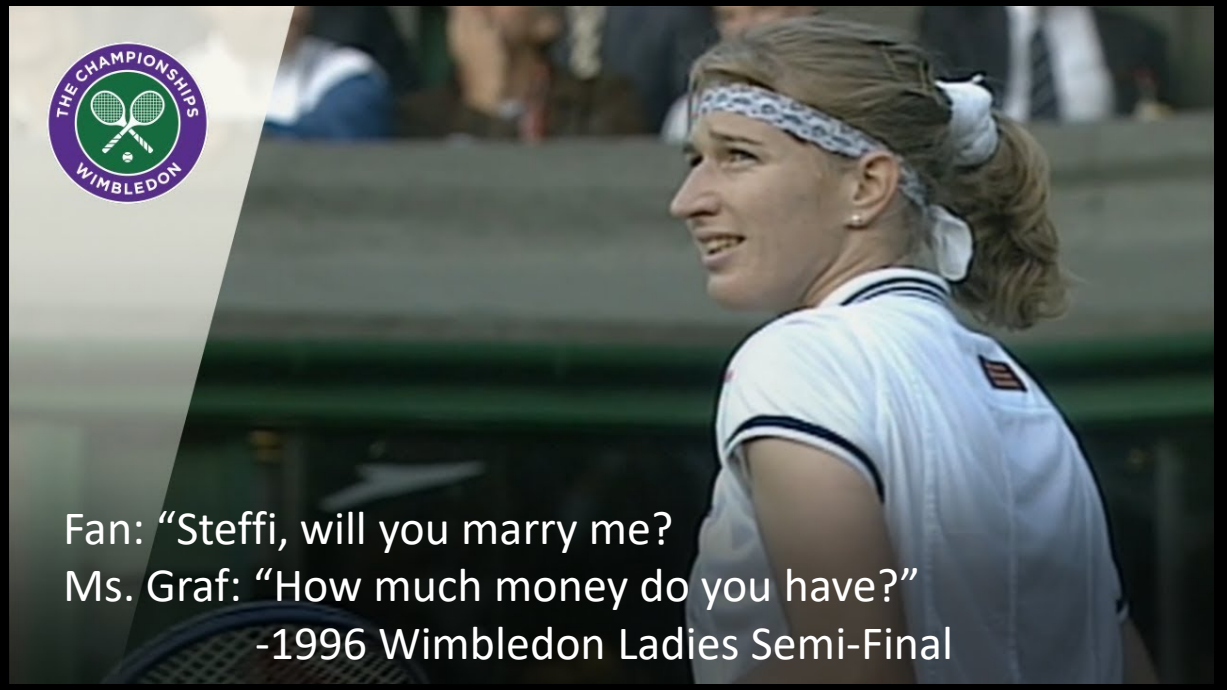
Sadasivam and Mallela (2016)

Financial Performance Measures

It’s All About the Money!

- Are we investing adequately?
- Is our plan financially sustainable?

“Share it fairly but don’t take a slice of my pie”
-Roger Waters on funding allocation issues
b/w pavements and bridges



Asset Sustainability Index

$$Asset\ Sustainability\ Index\ (ASI) = \frac{Amount\ Budgeted}{Amount\ Needed}$$

- "Amount Budgeted" comes from agency's financial planning process
- "Amount Needed" based on lowest life-cycle cost approach

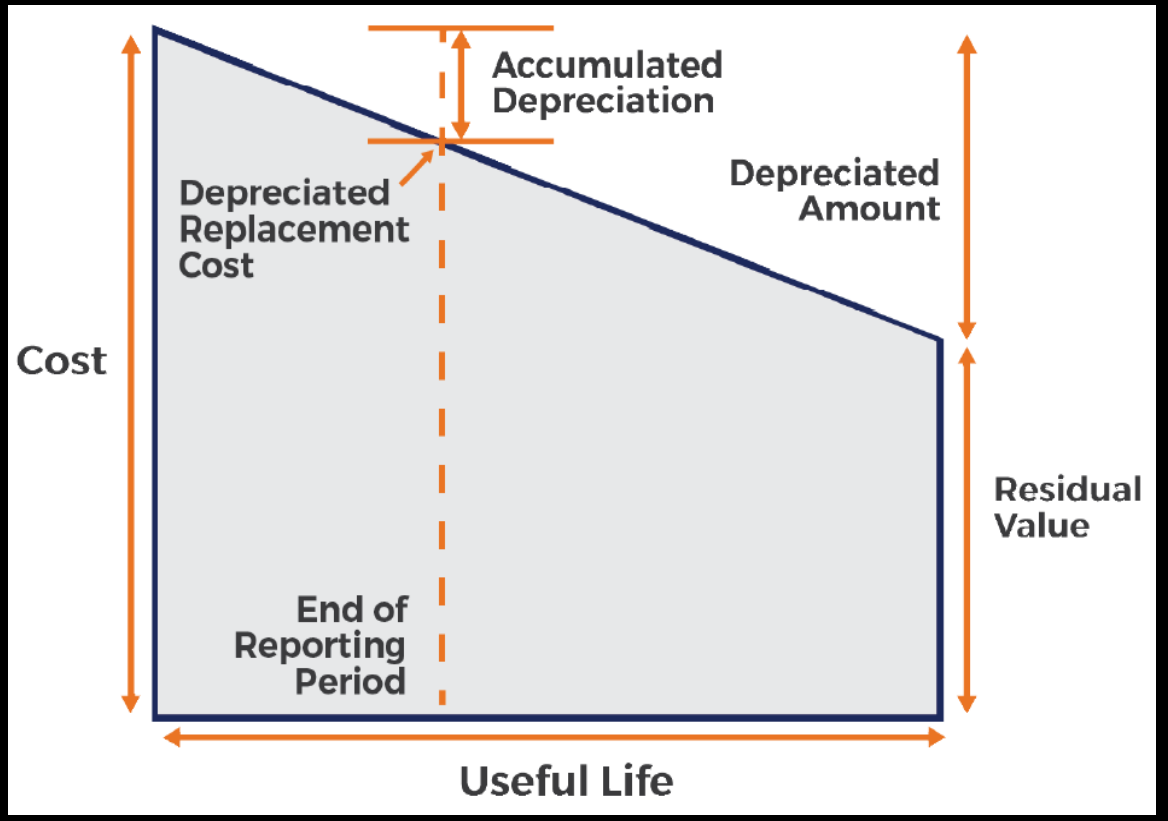
Sustainability Ratios Over Time By Asset Class Or Activity										
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Pavements	0.83	0.82	0.81	0.81	0.80	0.79	0.78	0.77	0.77	0.76
Major Routes	0.80	0.79	0.78	0.78	0.77	0.76	0.75	0.75	0.74	0.73
Arterials	1.00	0.99	0.98	0.97	0.96	0.95	0.94	0.93	0.92	0.91
Collectors	1.00	0.99	0.98	0.97	0.96	0.95	0.94	0.93	0.92	0.91
Pavement Rehabilitation/Replacement	0.40	0.40	0.39	0.39	0.38	0.38	0.38	0.37	0.37	0.37
Pavement Preventive Maintenance	1.00	0.99	0.98	0.97	0.96	0.95	0.94	0.93	0.92	0.91
Bridges	0.90	0.89	0.88	0.87	0.86	0.85	0.84	0.83	0.82	0.81
Preventive Maintenance/Preservation	0.90	0.89	0.88	0.87	0.86	0.85	0.84	0.83	0.82	0.81
Sub and Superstructures	0.87	0.86	0.85	0.84	0.84	0.83	0.82	0.81	0.80	0.79
Decks	0.89	0.88	0.88	0.87	0.86	0.85	0.84	0.83	0.82	0.82
Painting	1.00	0.99	0.98	0.97	0.96	0.95	0.94	0.93	0.92	0.91
Maintenance	0.95	0.94	0.93	0.92	0.91	0.90	0.89	0.88	0.87	0.86
Guardrail	0.95	0.94	0.93	0.92	0.91	0.90	0.89	0.88	0.87	0.86
Pavement Markings	0.95	0.94	0.93	0.92	0.91	0.90	0.89	0.88	0.87	0.86
Drainage	0.95	0.94	0.93	0.92	0.91	0.90	0.89	0.88	0.87	0.86
Signage	0.95	0.94	0.93	0.92	0.91	0.90	0.89	0.88	0.87	0.86
Vegetation/Roadside	0.95	0.94	0.93	0.92	0.91	0.90	0.89	0.88	0.87	0.86
Pavement Surfaces	0.95	0.94	0.93	0.92	0.91	0.90	0.89	0.88	0.87	0.86
Overall ASI	0.88	0.87	0.855	0.84	0.83	0.82	.81	0.79	0.77	0.75

FHWA (2012)

Asset Sustainability Ratio

$$Asset\ Sustainability\ Ratio\ (ASR) = \frac{Asset\ Renewal\ or\ Replacement\ Expenditure}{Asset\ Value\ Depreciation}$$

- Are assets being renewed or replaced at the rate at which they are deteriorating?



Australian Infrastructure Financial Management Manual (2015)

Asset Consumption Ratio

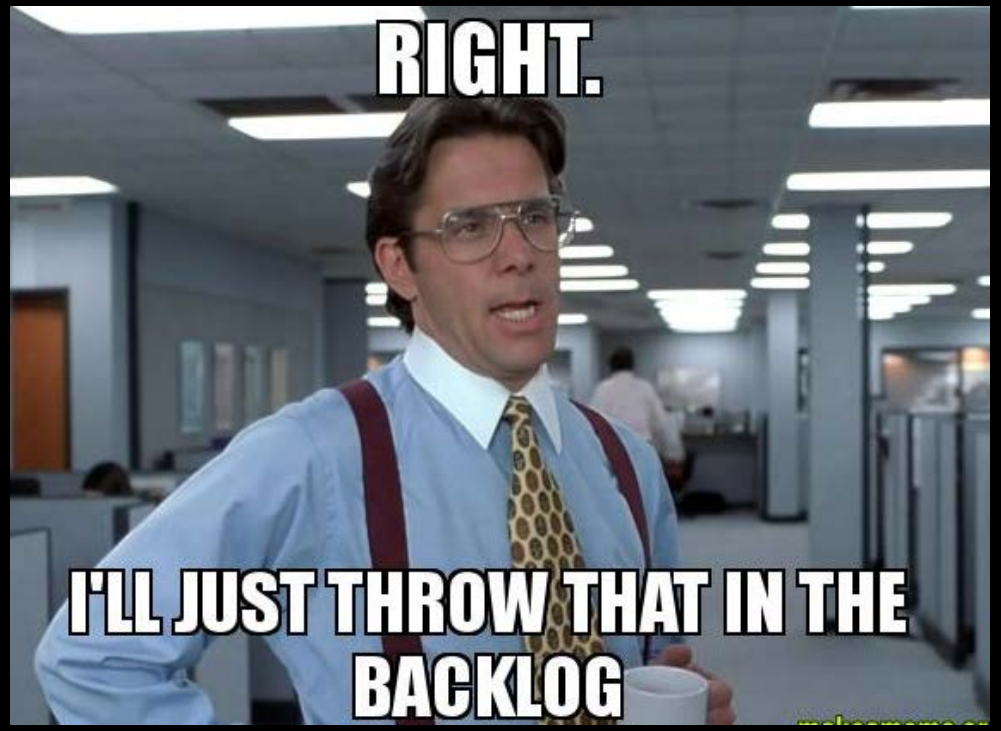
$$\textit{Asset Consumotion Ratio } (ACR) = \frac{\textit{Depreciated Replacement Cost}}{\textit{Current Replacement Cost}}$$

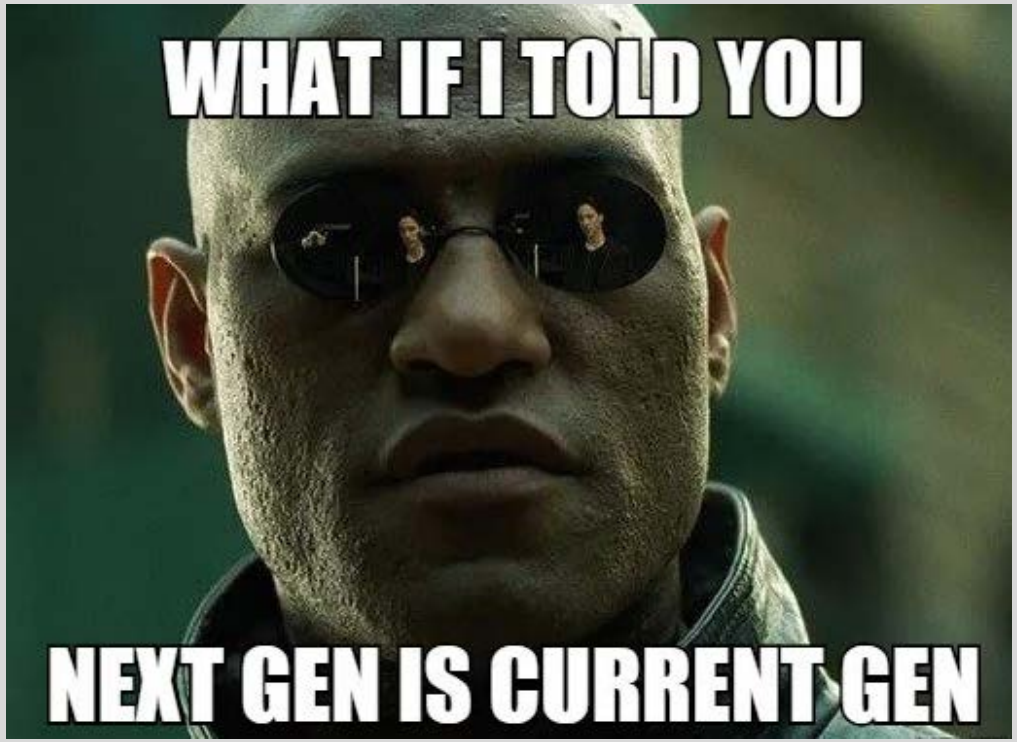
- What is the average proportion of as-built (or as new) condition left in the asset?

Australian Infrastructure Financial Management Manual (2015)

Backlog Reduction Ratio

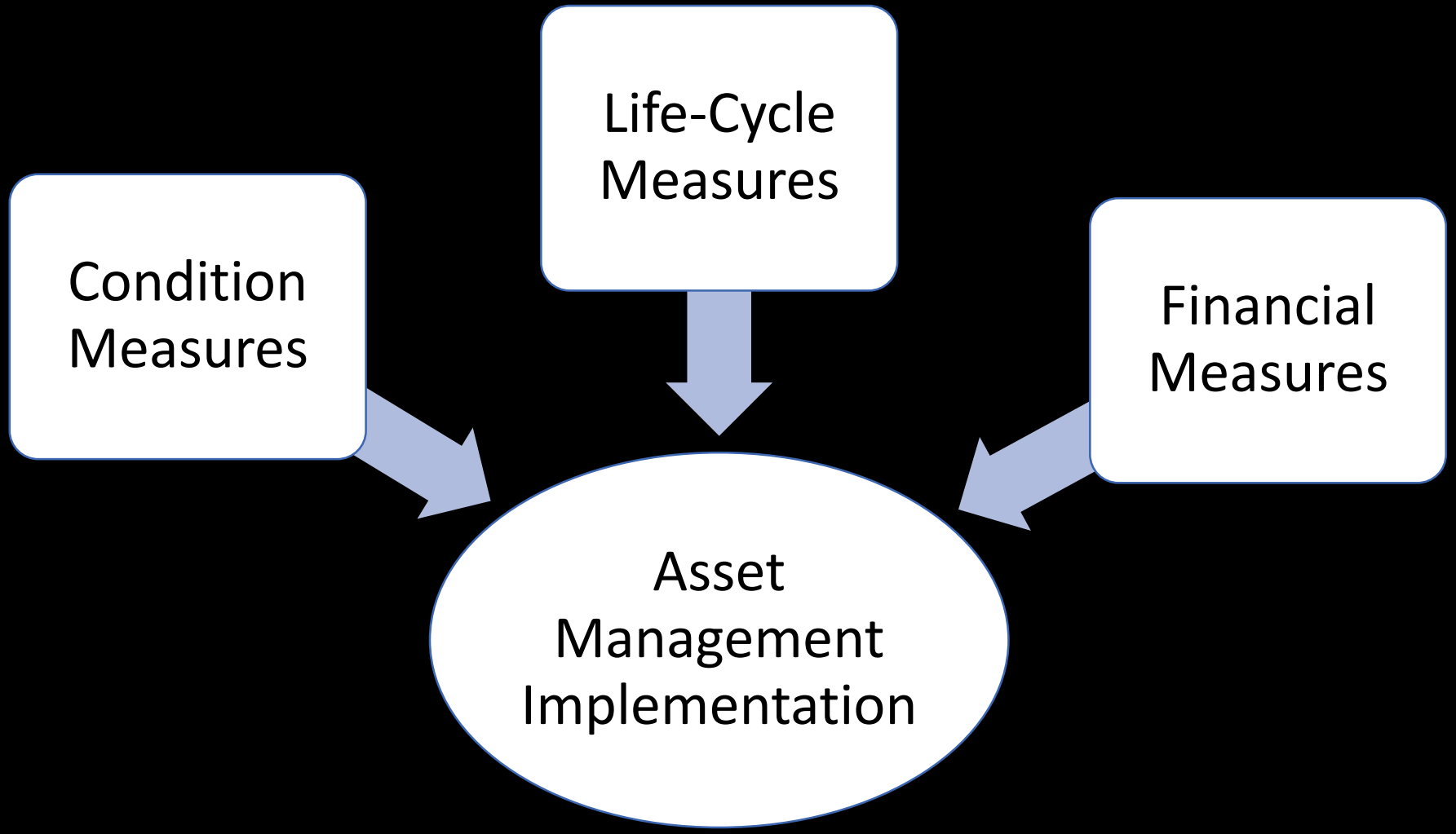
- Monitor and track amount of backlog addressed during any fiscal period
- Challenges:
  - How do we define “backlog”?
  - What’s an acceptable level of “backlog”?





Next-Gen Asset Management Implementation

Implementing a Comprehensive TAMP



On-going FHWA Project

- Phase II of FHWA project on next-generation performance measures and asset management
- Idaho Transportation Department selected as first pilot state
  - Effort kicked-off Summer 2019
- Project Team:
  - FHWA COR: Siva
  - APTech, Paul Thompson, Iowa State
  - ITD Pilot Lead: Jim Poorbaugh

Thank You!

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