

Road Asset Management (RAM)

May 2023

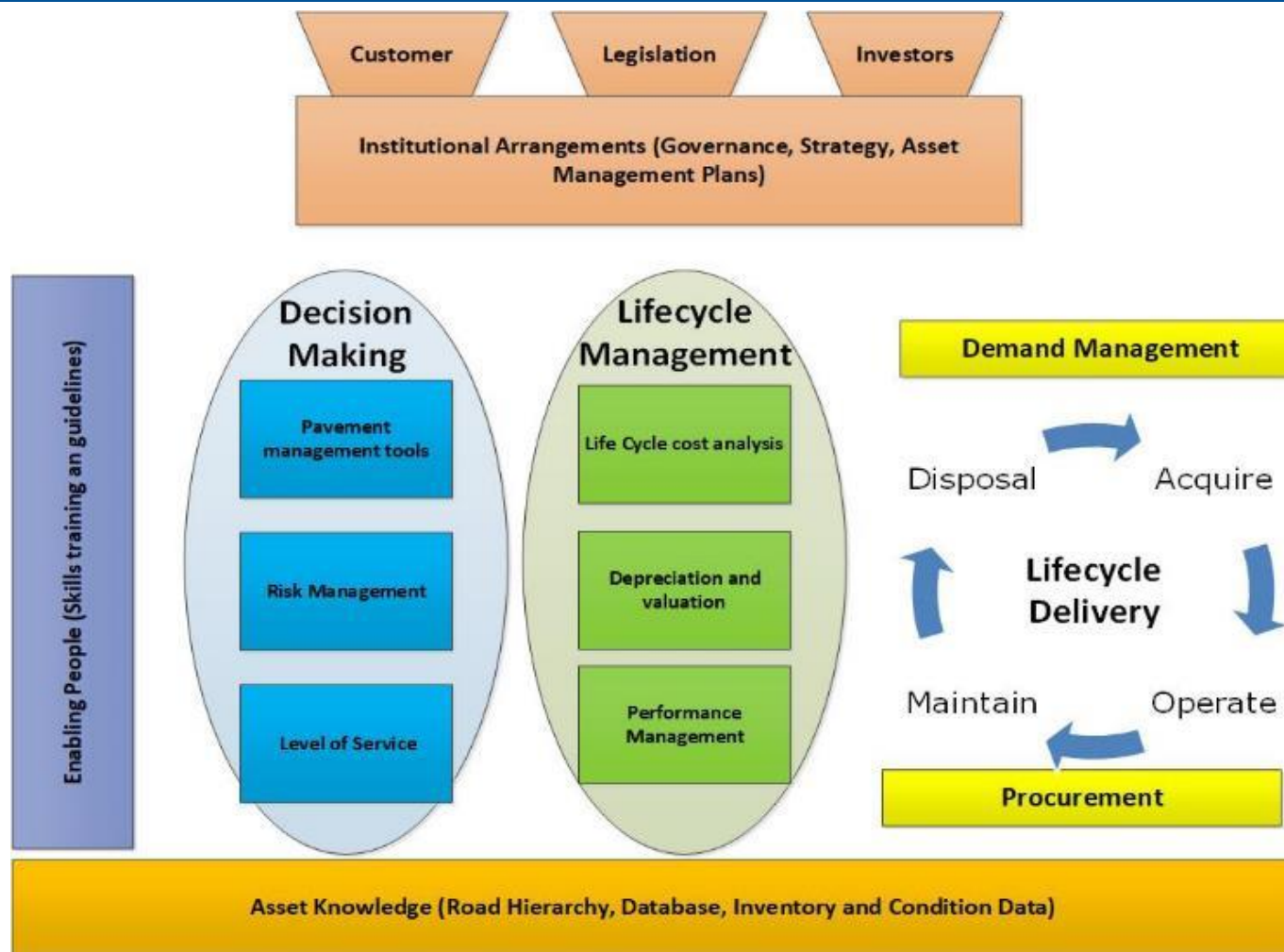
Session: Lifecycle Decision Making & Pavement Prediction Modelling

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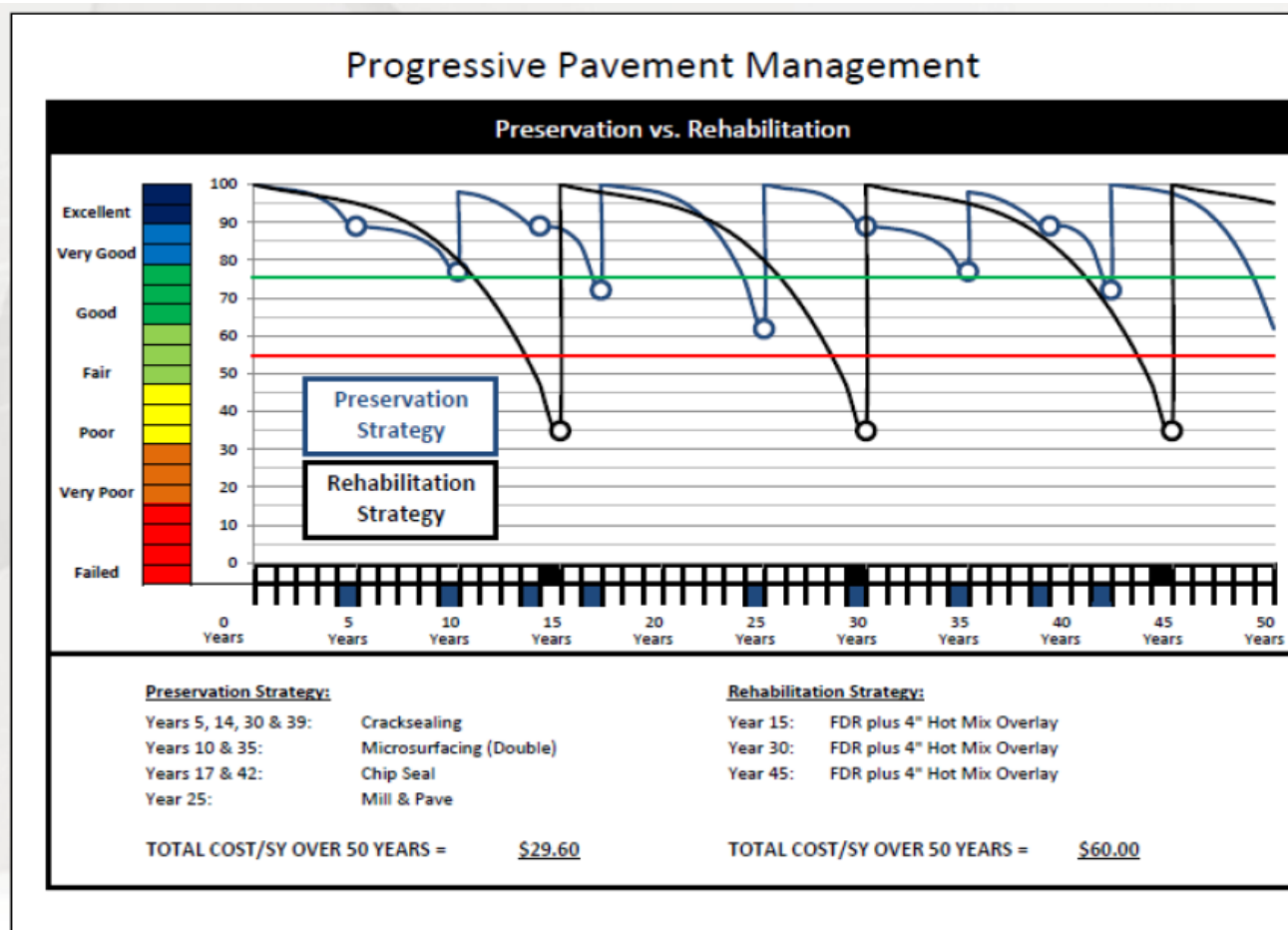
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Life-cycle Management : Getting the most from our Investment

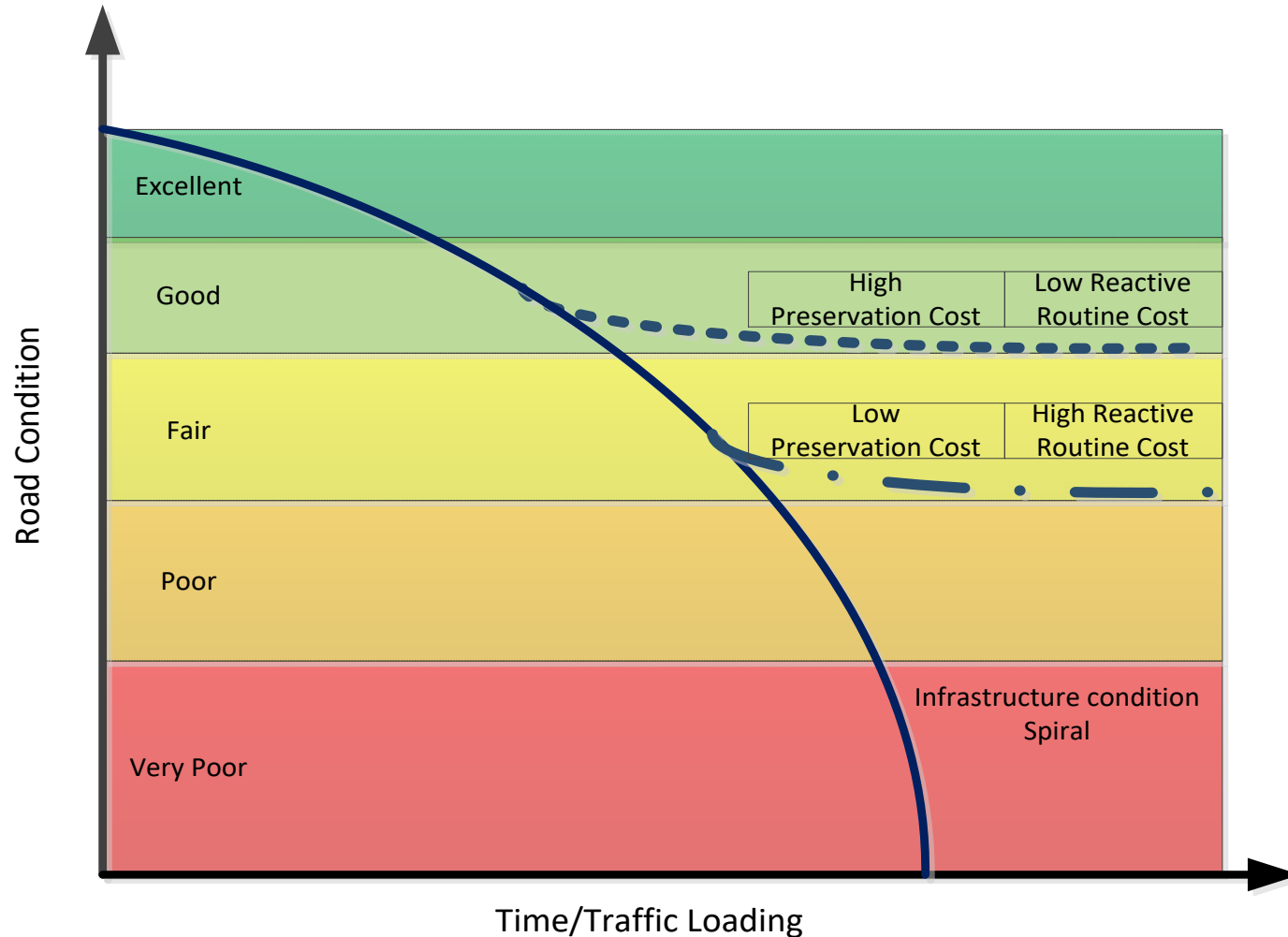


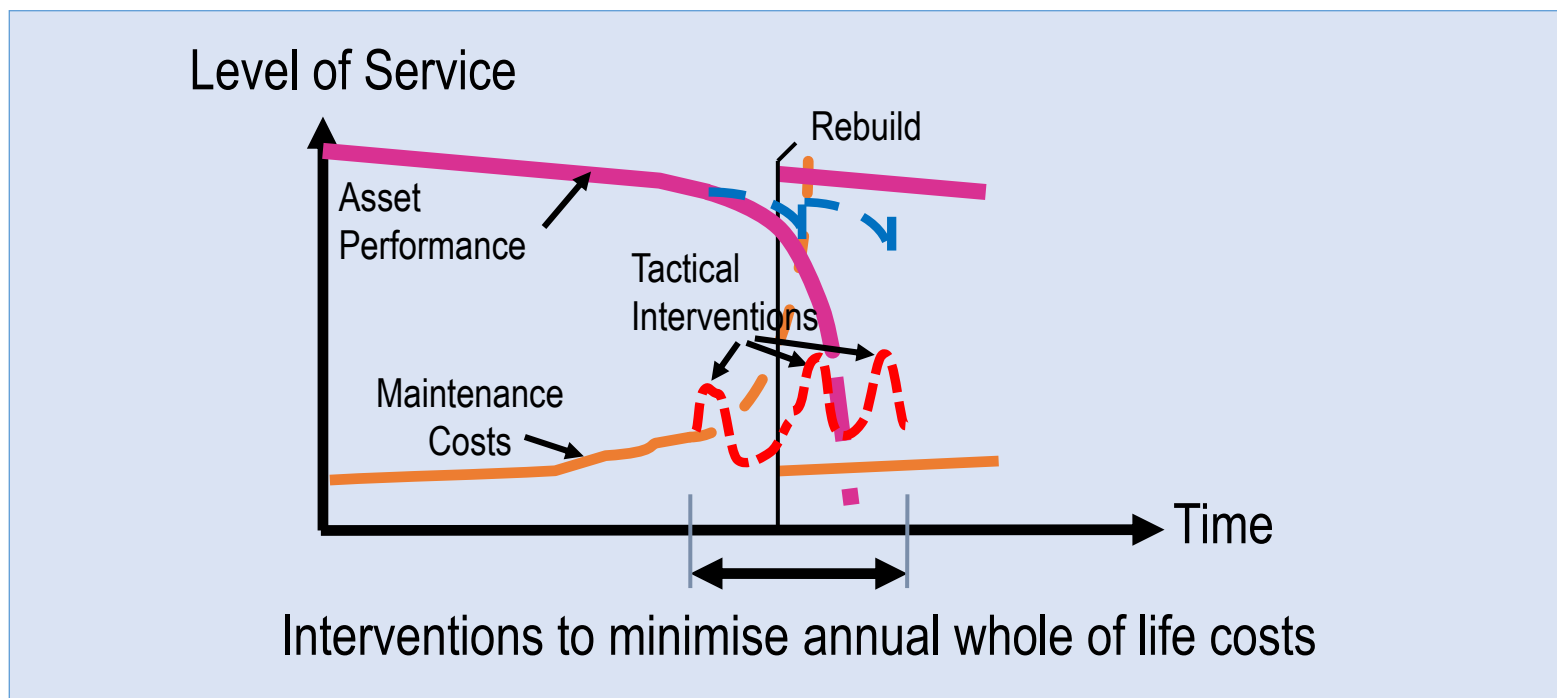
Life Cycle Cost Consider the Total Cost of Ownership

- Preservation approach costs less
- That means we are intervening earlier on roads



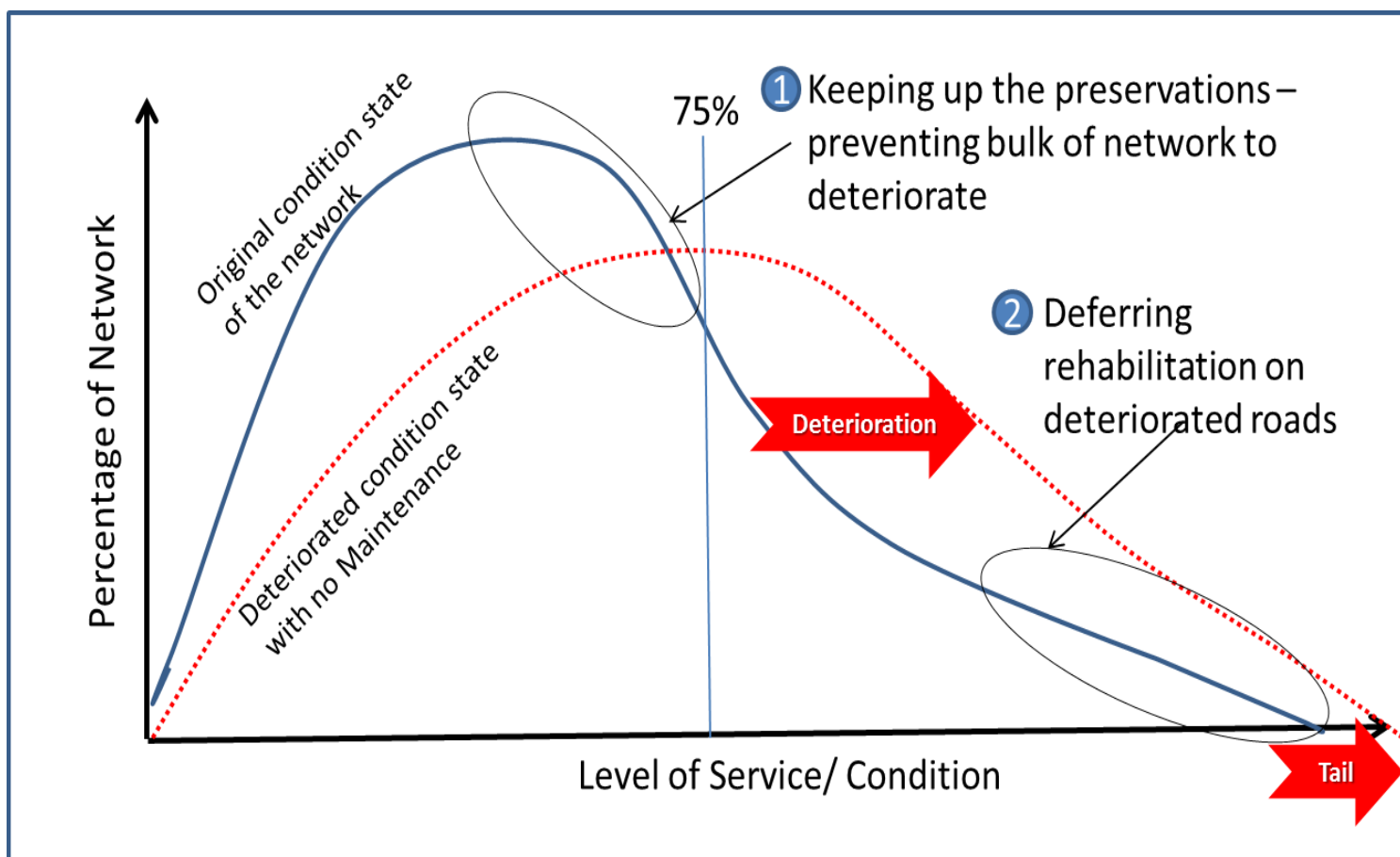
Maintain Infrastructure at Different Levels





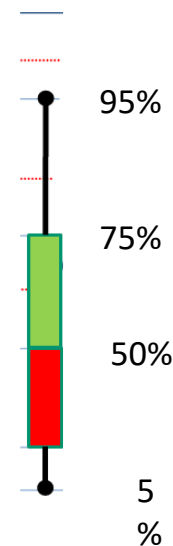
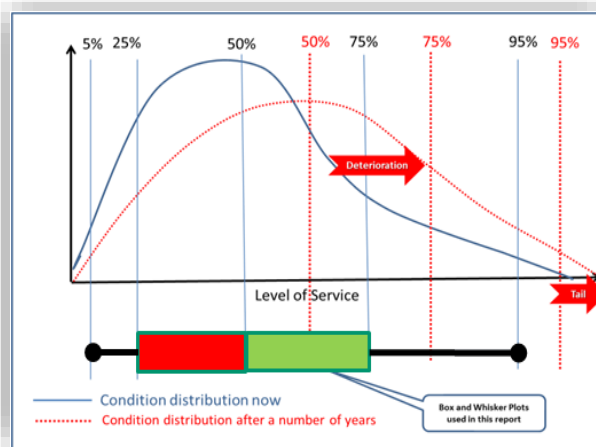
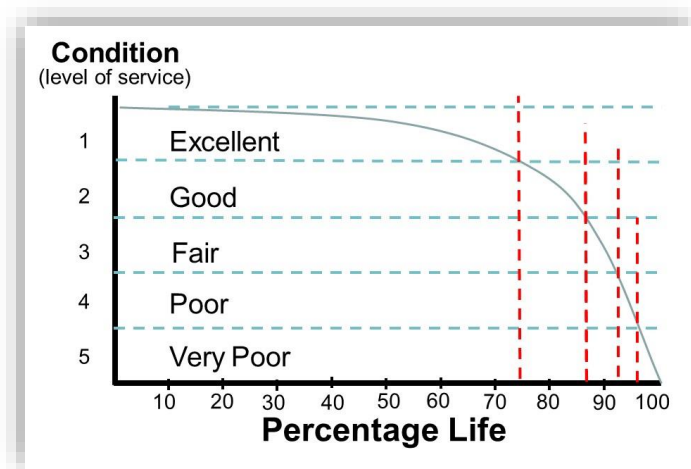
Source: David Fraser

Theory: How Roads Deteriorate



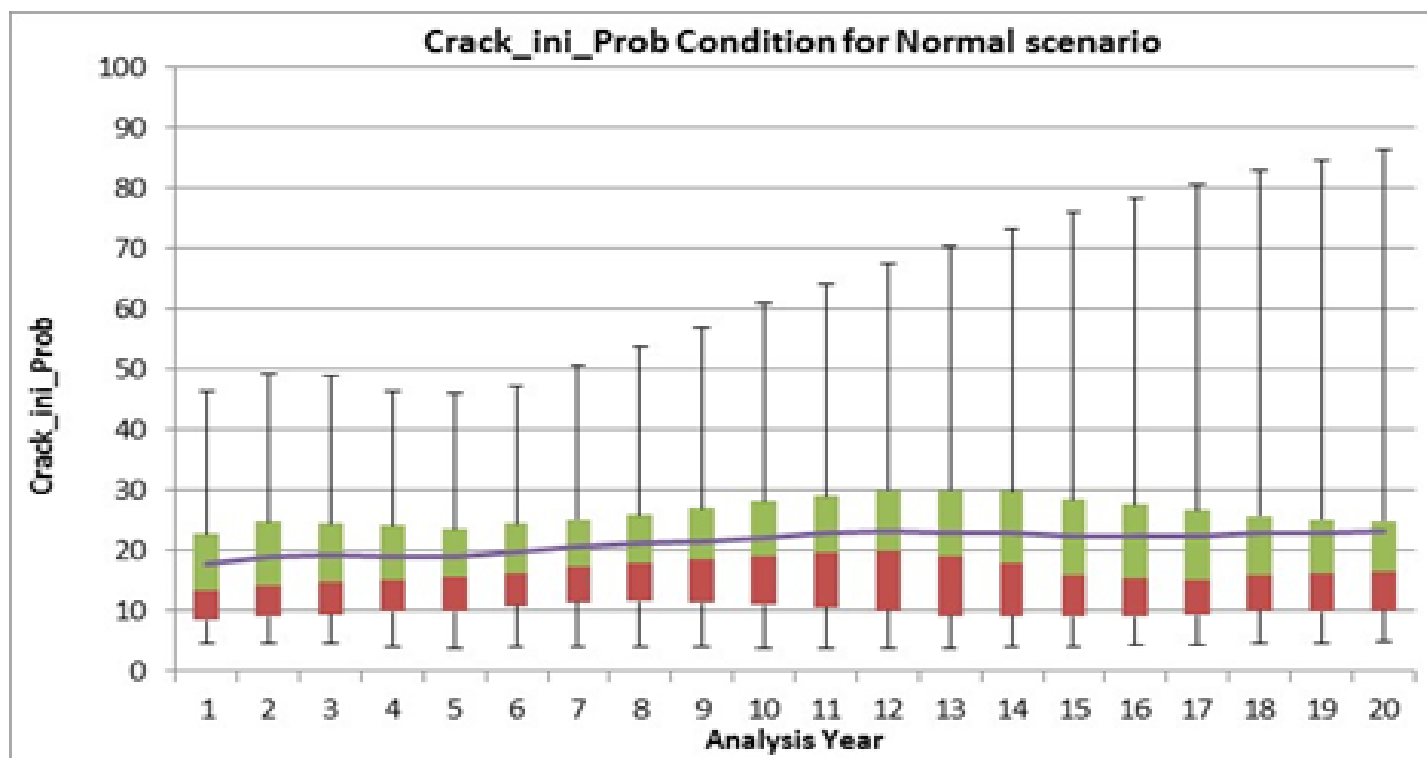
Think network first – then element

- Keeping an eye on the 75th percentile trend is a useful network indicator

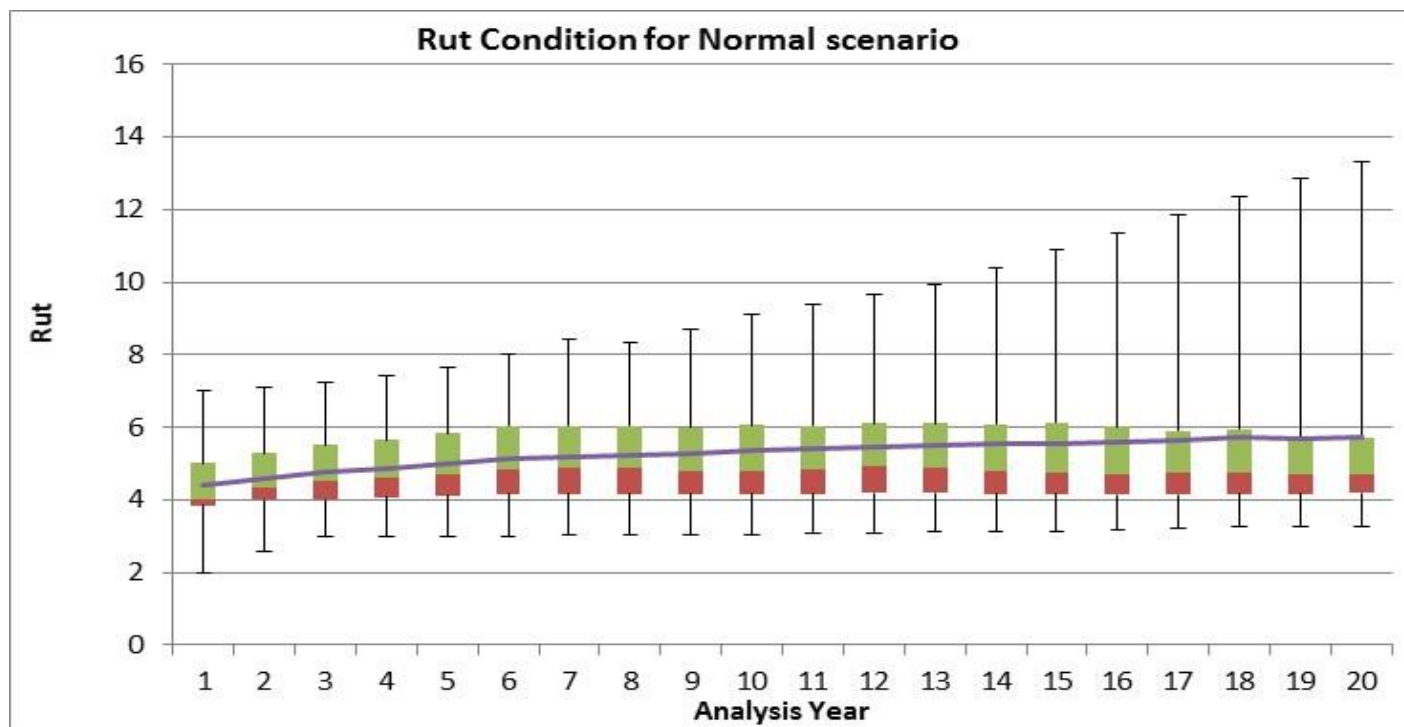


Source: David Fraser

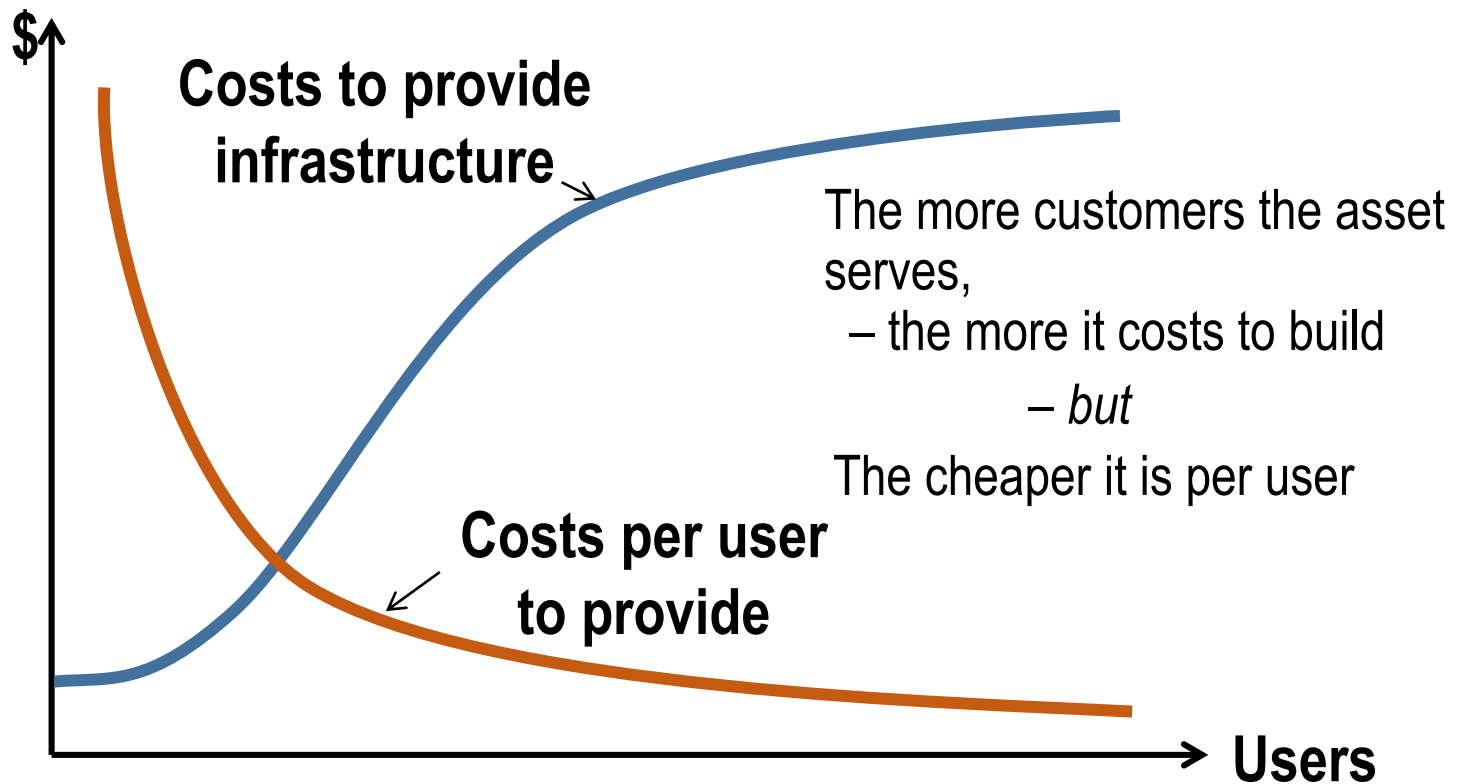
Results Surface Performance Overlaid



Pavement Performance Overlaid



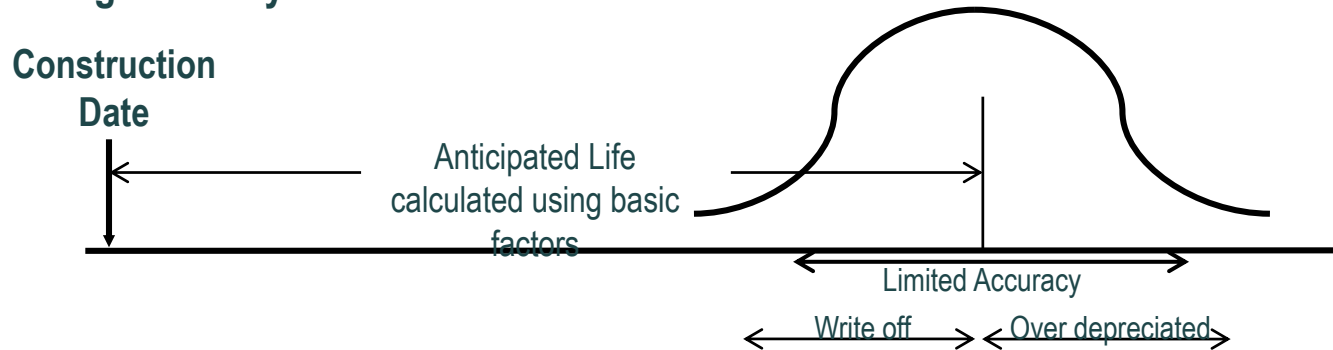
Asset Cost to User



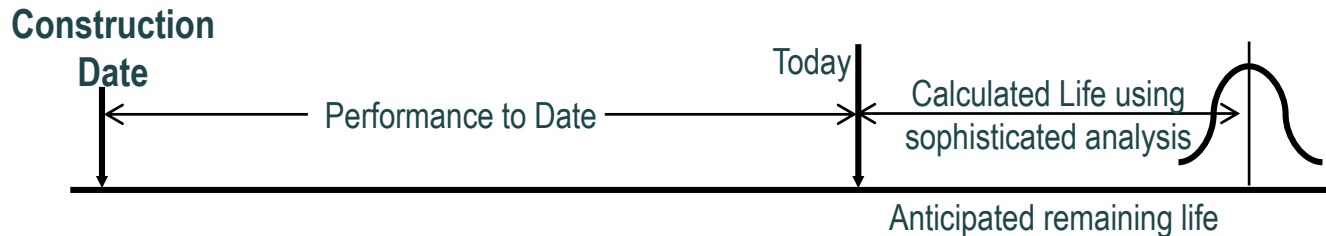
Source: David Fraser

Fine Tuning Analysis – Needs Forecasting

Original Analysis based on construction date



Sophisticated analysis based on today, yesterday and tomorrow



More accurate, with improved confidence in anticipated life and Condition!

Source: David Fraser

Forecasting Deterioration of Road Assets

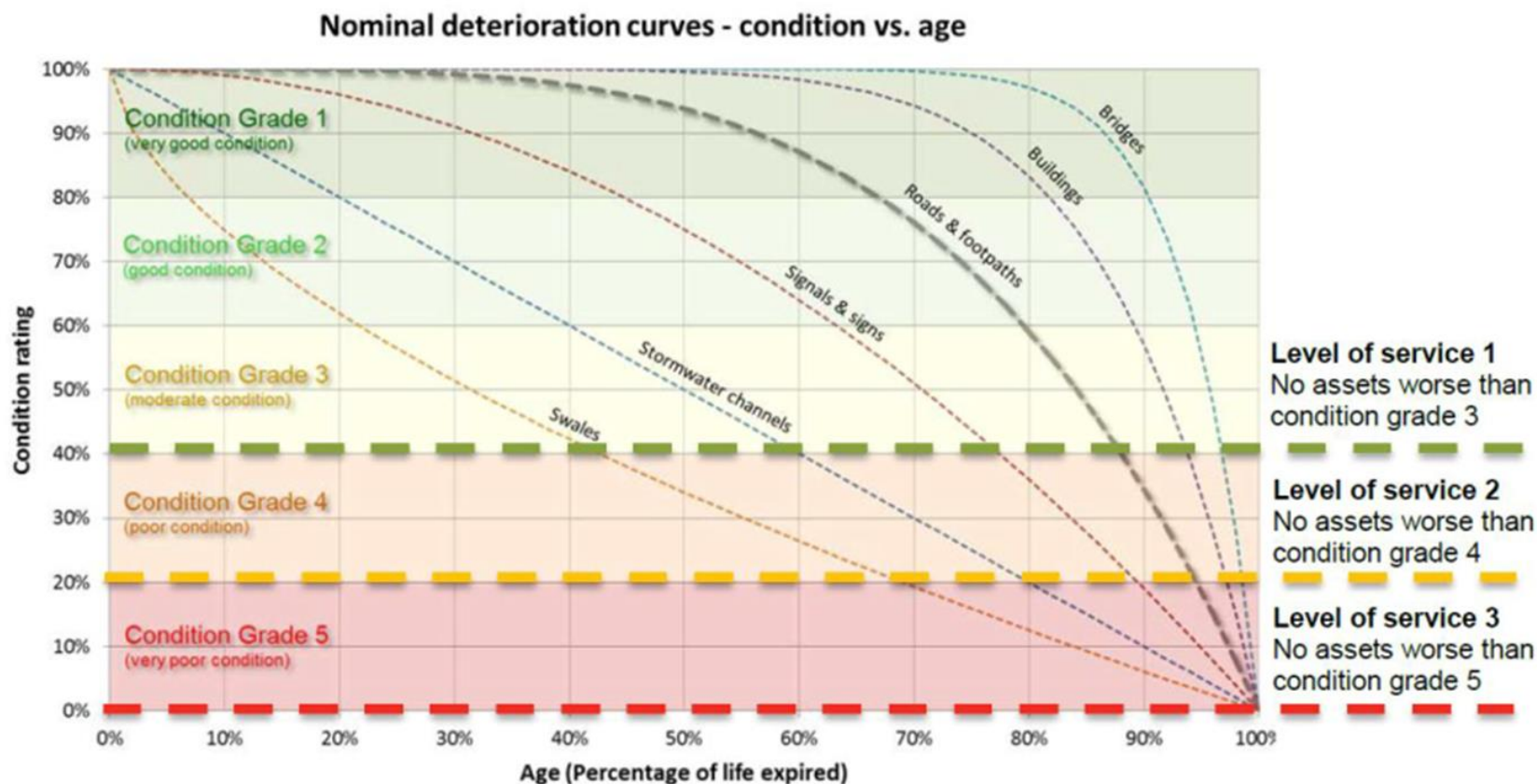
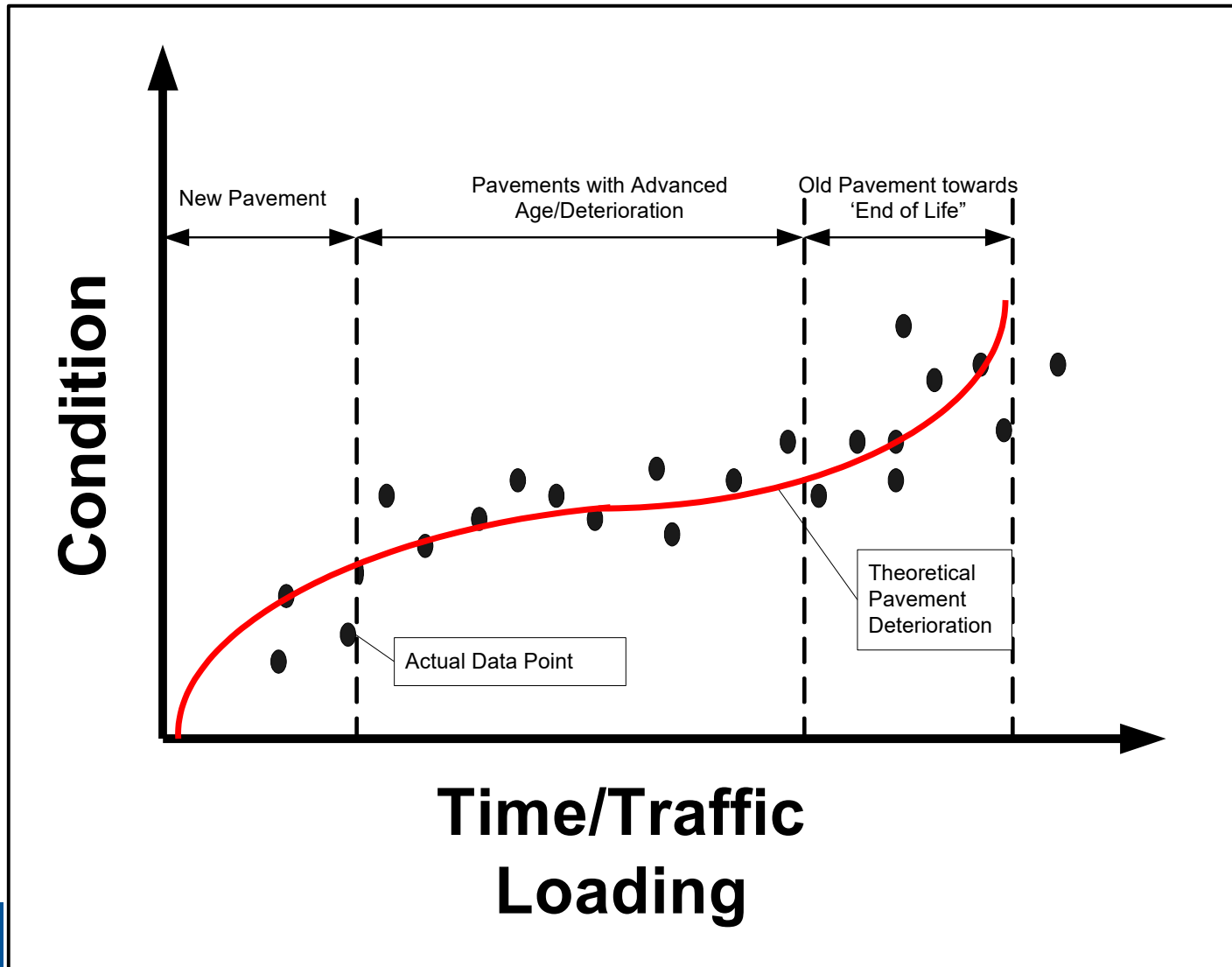


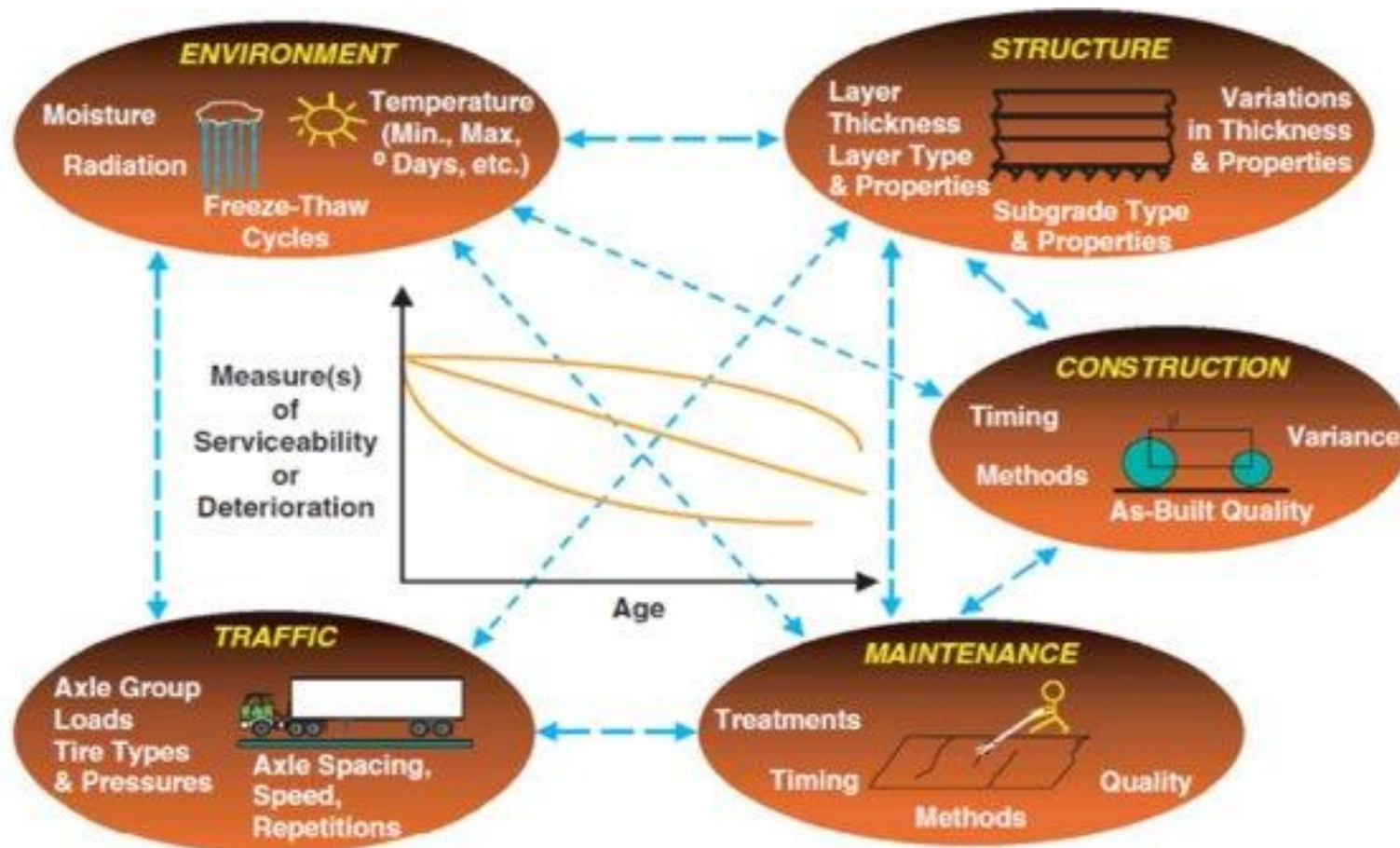
FIGURE 1 Condition grades, deterioration rates and condition-based levels of service.

Source Auckland Transport

Condition/Age Distribution



Road Deterioration: Influencing Factors



Source Tighe et al, 2007

Empirical Model Forms

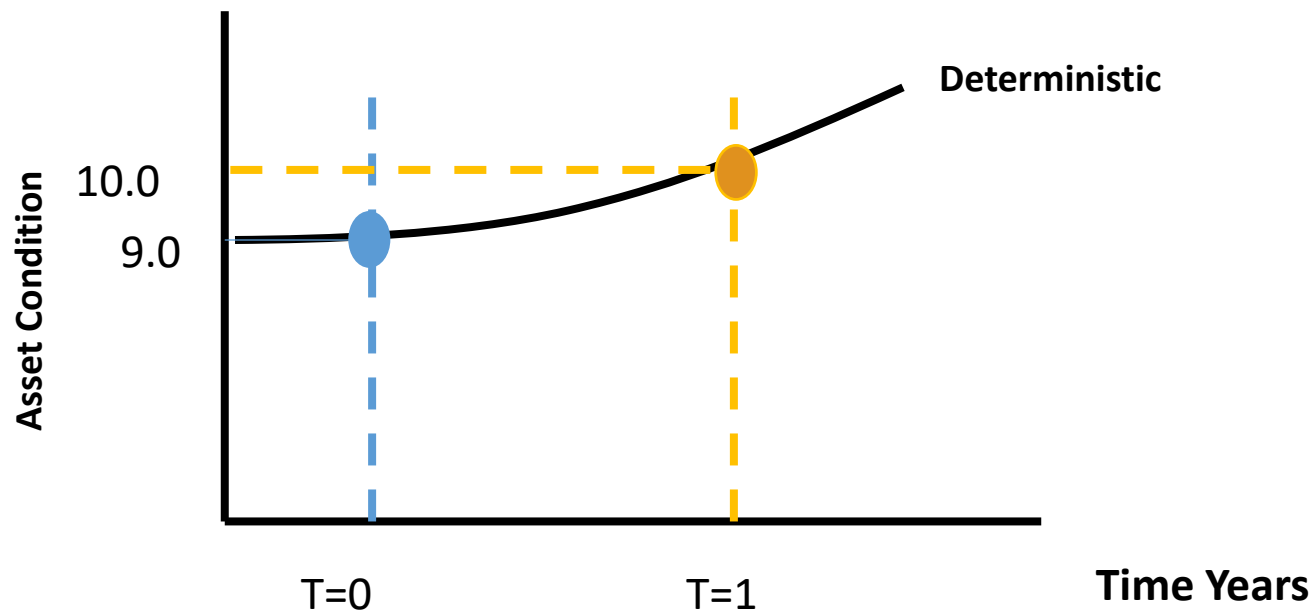
- Deterministic

“Predict future as a precise value on the basis of mathematical functions of observed or measured deterioration”

- Probabilistic (Stochastic)










“Predict future as the probability of occurrence of a range of possible outcomes”

Stochastic Modelling – TMP Example



Source: Elke Beca

Stochastic Example

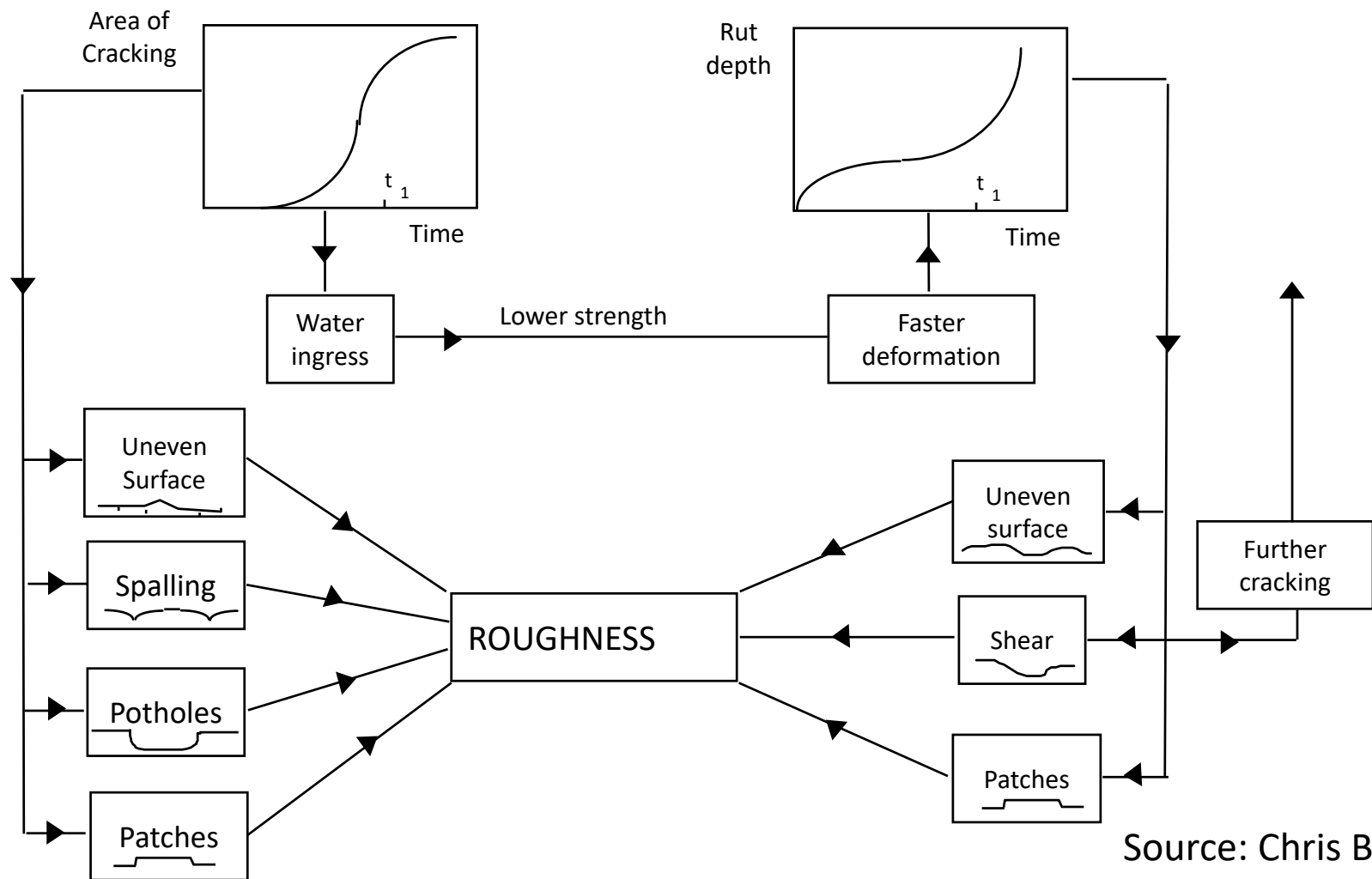
		Any Other Day			Day After Big Game		
		Tomorrow			Tomorrow		
							
Today		80%	19%	1%	90%	0%	10%
		50%	45%	5%	90%	0%	10%
		25%	25%	50%	90%	0%	10%

Source Elke Beca

- HDM uses ‘Deterministic Models’
- Predicts a single future outcome based on current situation
- Developed using ‘structured empirical approach’
 - Knowledge of how pavements perform used to set framework for statistical analysis
- Incremental
 - Change in condition based on current condition:
 $\Delta \text{CONDITION} = f(a_0, a_1, a_2)$
 - Can use any start point so flexible

Source: Chris Bennett

HDM-4 Interactions Between Distresses



Source: Chris Bennett

Distresses Modeled

Bituminous	Concrete	Block*	Unsealed
<p>Cracking Rutting Ravelling Potholing Roughness</p> <hr style="border-top: 1px dashed black;"/> <p>Edge break Surface texture Skid resistance</p>	<p>Cracking Joint spalling Faulting Failures Serviceability rating Roughness</p>	<p>Rutting Surface texture Roughness</p> <p>*not in software</p>	<p>Gravel loss Roughness</p>

Source: Chris Bennett

- Moisture

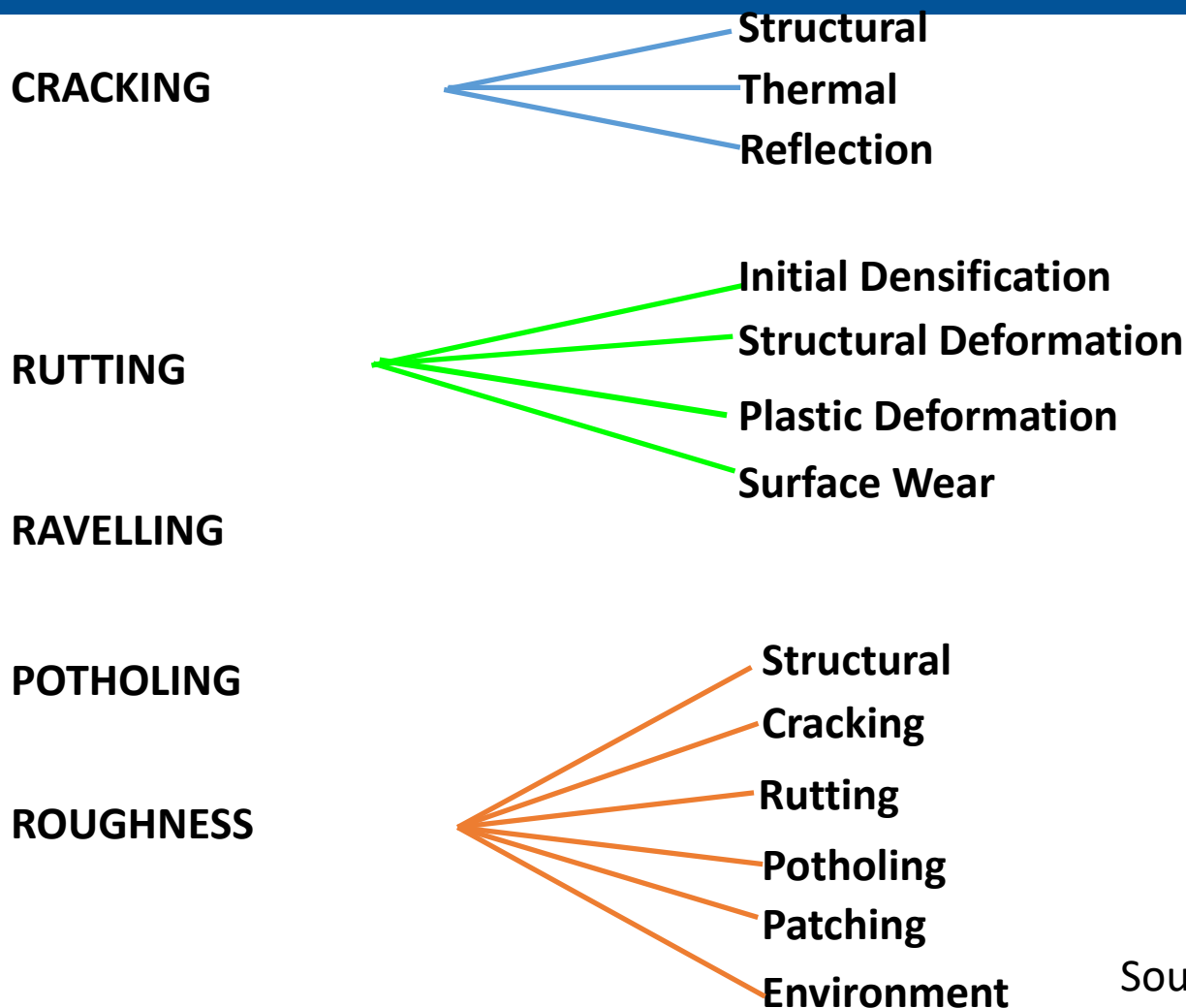
- Arid
- Semi-arid
- Sub-humid
- Humid
- Per-humid

- Temperature

- Tropical
- Sub-Tropical hot
- Sub-Tropical Cool
- Temperate Cool
- Temperate Freezes

Source: Chris Bennett

Deterioration Models - Bituminous



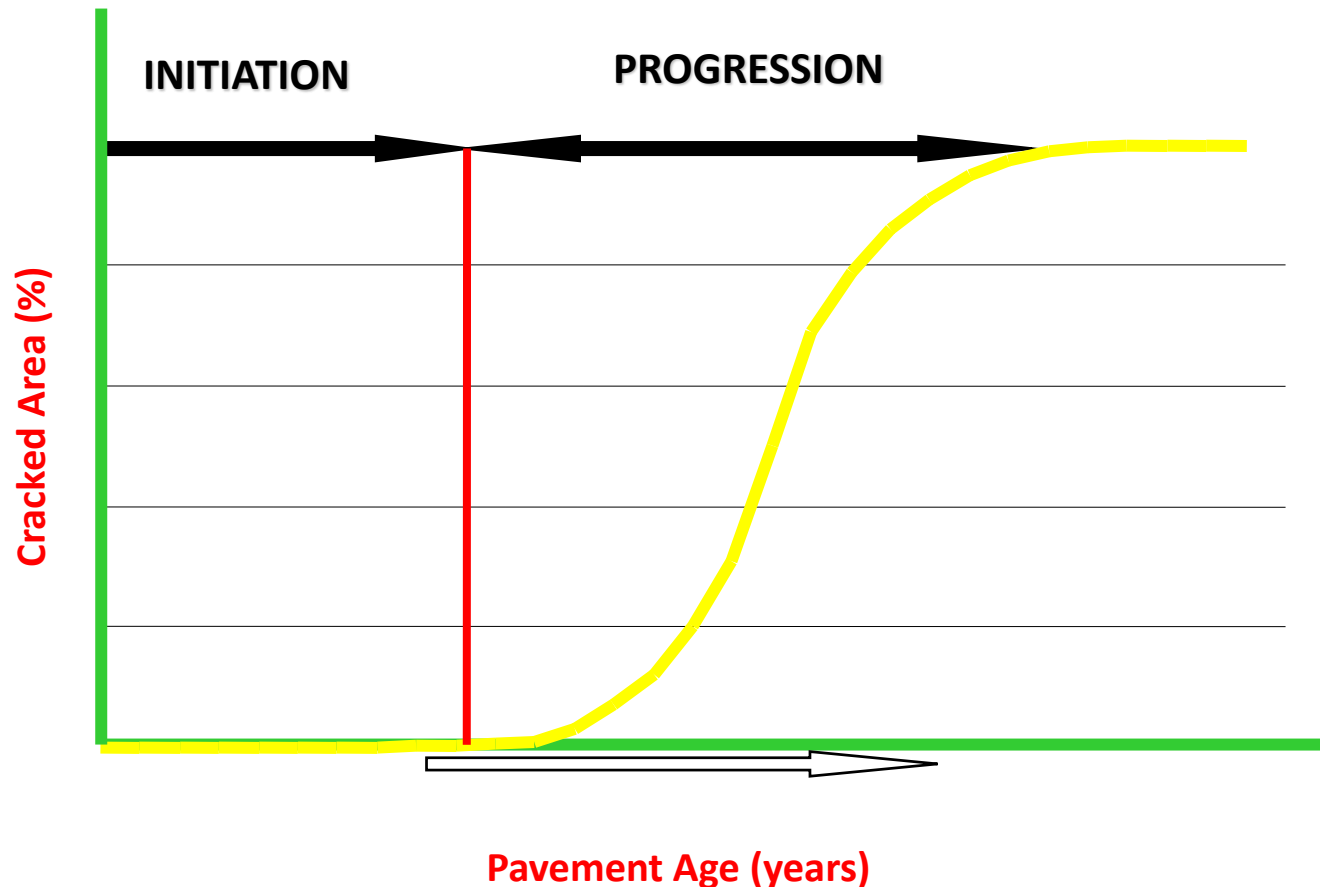
Source: Chris Bennett

Concrete Models

Cracking	% of slabs cracked	JP
	Number per km	JR
Faulting	mm	JP, JR
Spalling joints	% of transverse	JP, JR
Failures	Number per km	CR
Serviceability	Dimensionless	JR, CR
Roughness	m/km IRI	All

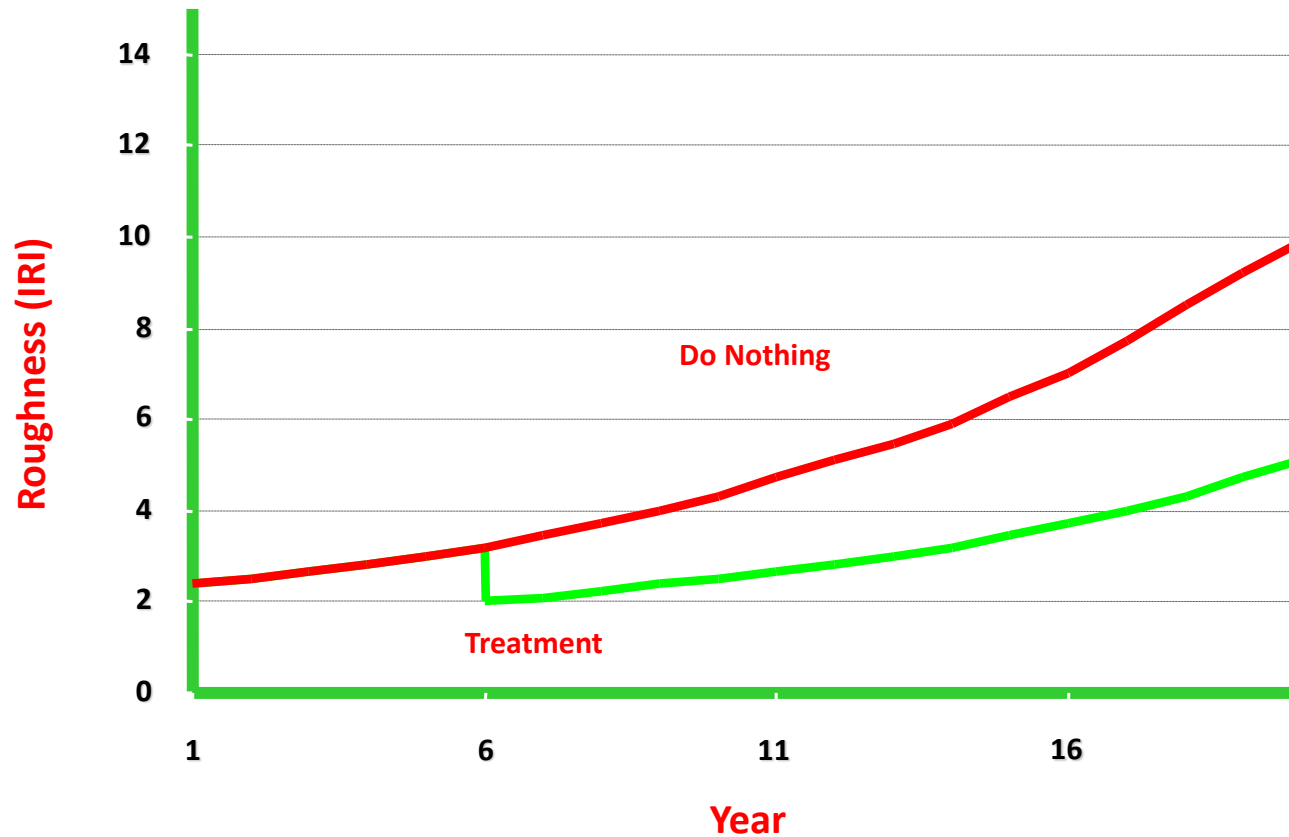
Initiation and Progression

- Cracking, raveling and potholing have initiation and progression periods

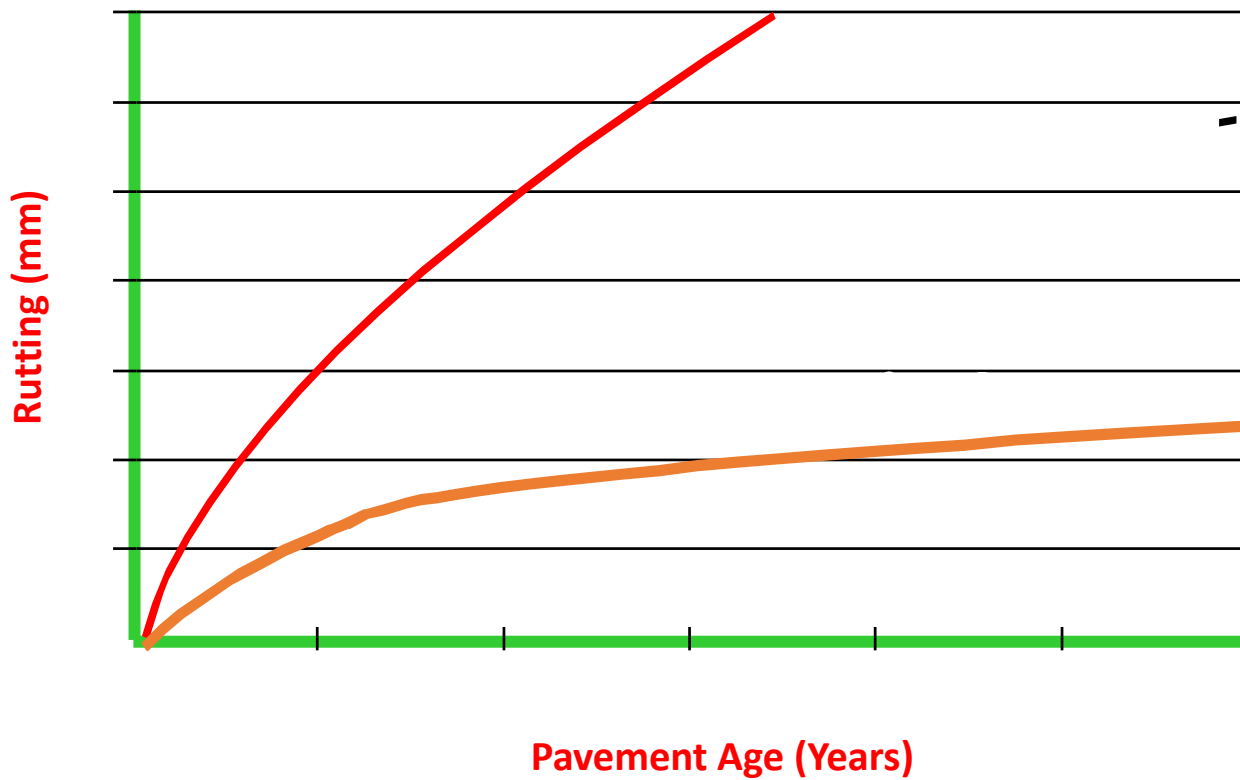


Roughness

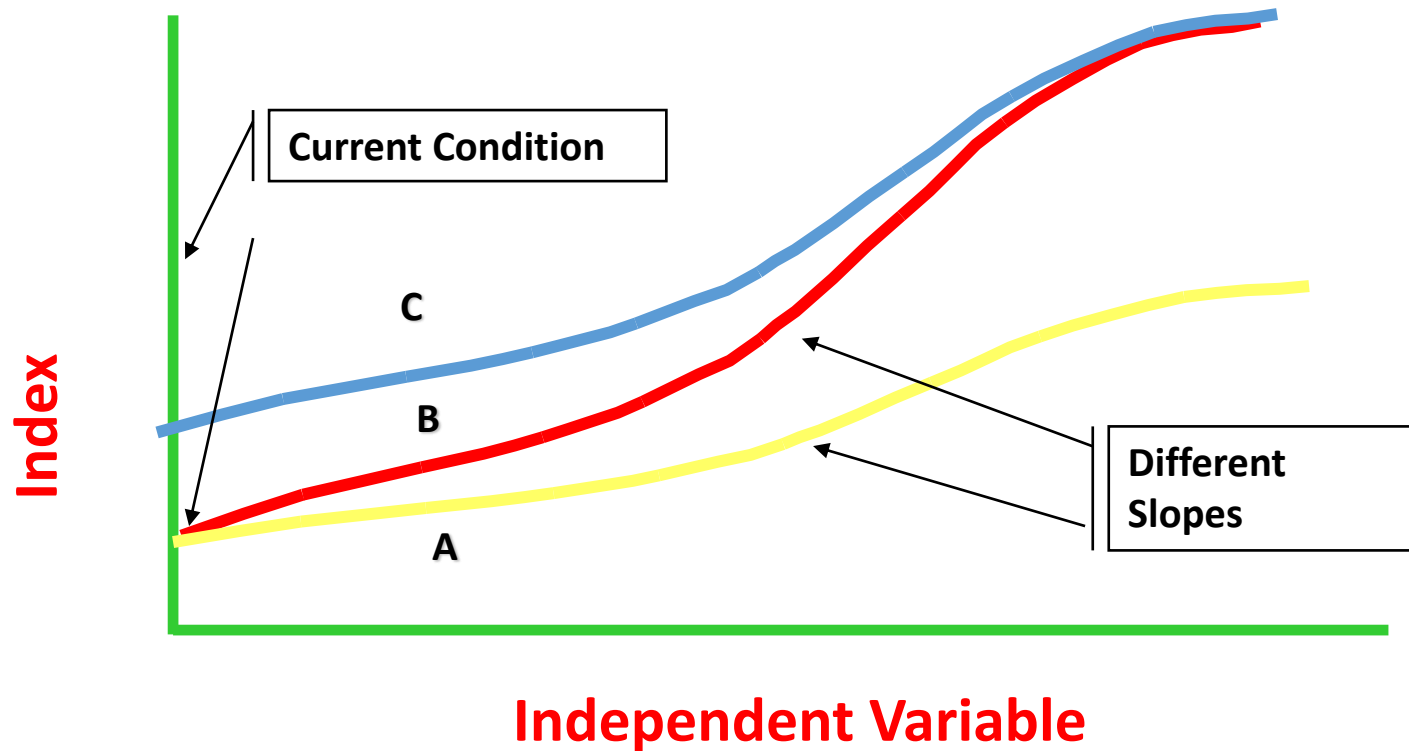
- Roughness = F(age, strength, potholes, cracking, raveling, rutting)



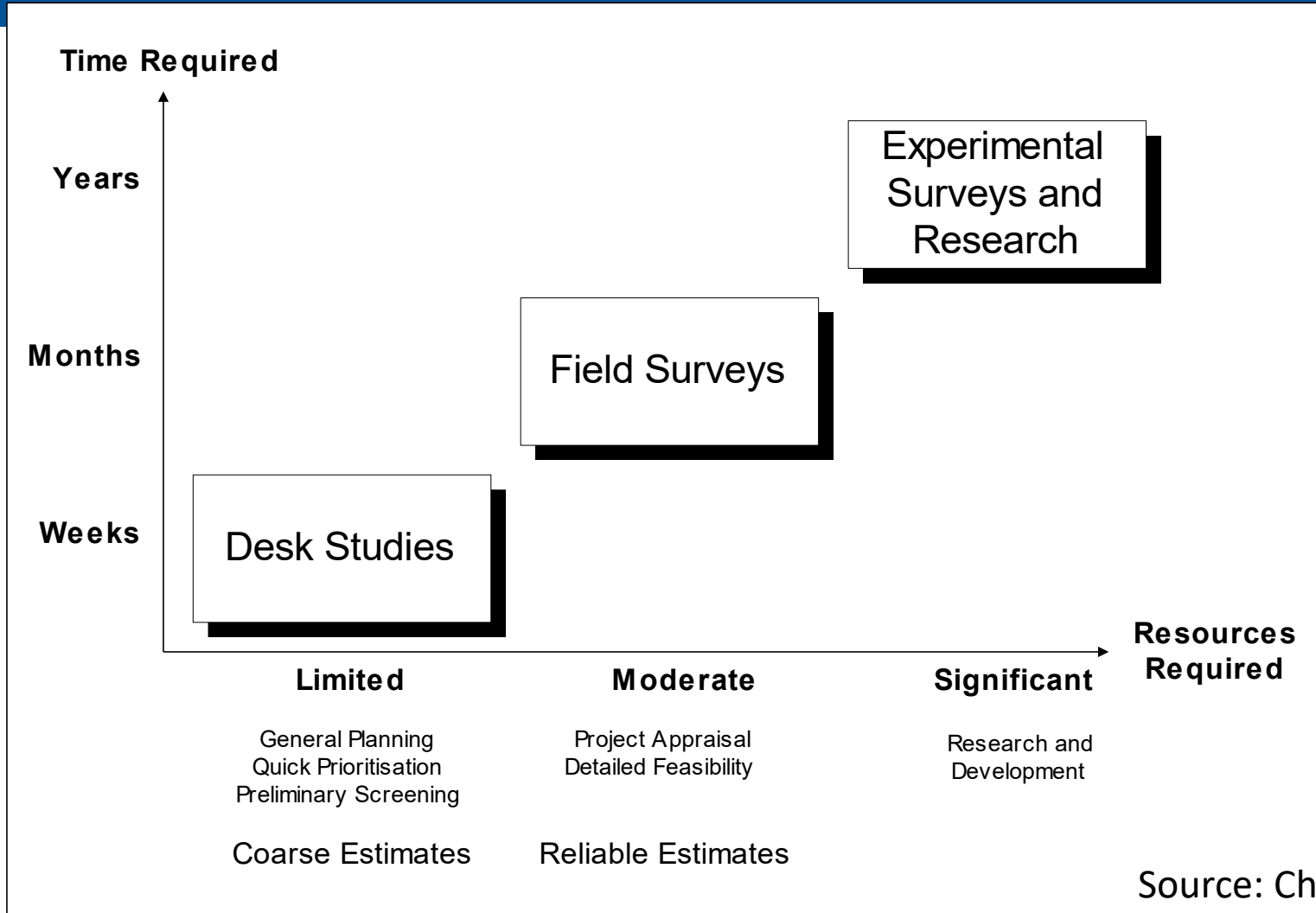
- Rutting = F(age, traffic, strength, compaction)



Calibration is Needed for Models



Hierarchy of Effort



Source: Chris Bennett



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