Bicycle and Shared Path Design Taking into Account Whole of Life Costing

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Background

- Need for this project identified at Australian Bicycle Council workshops
- Austroads Guide to Traffic Engineering Practice, Part 14, Bicycles:
  - Covers geometric design and level of service
  - No standards or specifications for maintenance intervention
- Many paths but limited information
  - Only one known attempt to document
    - South Australia – Guide to Bikeway Pavement Design, Construction and Maintenance for South Australia
    - Draft only (1999)
    - Only applies to South Australia – wider range of conditions across Australia
- Older paths often have poor design (eg geometry, lateral clearances, surface) and are poorly-maintained

Objective

- Support informed decision-making for designing bicycle and shared paths through consistent estimation of whole-of-life cycle costs
  - Review Australian and international experience
  - Identify relevant factors for selection/design of bicycle or shared paths
  - Undertake a life-cycle cost analysis for a range of pavements
  - Input to infrastructure assessment and prioritisation processes
    - Path quality (location, width, surface quality, design standards) will also impact on level of usage (and hence benefits) as well as costs.

Relevant Factors

- Pavement loading (incl maintenance vehicles)
- Physical conditions (eg sub-soil, terrain)
- Environmental factors (eg climate)
- Materials types and properties
- Construction practices
- Pavement operation
- Maintenance programs and treatments
- Vegetation
  - Impact on pavements (tree roots, invasive grasses)
  - Sightlines and lateral clearances (as vegetation matures)

Whole of Life Costs Include …

- Initial construction
- Maintenance
  - Pavement structure and surface
  - Earthworks (where appropriate)
  - Sightlines and lateral clearances
- Capacity increases (where required)
- Rehabilitation
- Environmental impacts
  - Run-off
  - Physical disturbance

Key Questions

- What types of paths in current use?
- What is their design life?
- Are there any measures of performance?
- What are the maintenance triggers?
- What are the key factors in deterioration?
  - Usage-related - not traffic loading, unless access to other activities
    - paths in rail reserves may need to provide access for rail maintenance
    - Access across paths to adjoining properties
  - Environmental factors
- What documented experience and costs?

Critical Issues

- As paths age, maintenance and rehabilitation become more important
- Path surface quality important for cyclists
  - Initial (design) and ongoing
  - Poorly maintained paths will reduce usage
- Variation in local conditions – soils, materials, construction practices, loads, climate.
- Lack of maintenance history for paths
- Long timeframes for completion of networks can result in differing standards for various parts, especially if maintenance not adequately funded.

Deliverables

- Working Paper: Literature Review and Scoping - October 2004
  - Will determine if there is sufficient information, documented experience and knowledge to proceed further
- Working Paper: Specification and outline of whole of life costing methodology
- Draft methodology and reports - March/April 2005
- Final reports, Users’ Guide and Analytical Tool - July 2005
- Presentation to Australian Bicycle Council - July 2005

Process

- Deliverables will be available through the ABC website
- Timing of milestones allows for consultation within DOTARS and with ABC members
- Input sought through:
  - Australian Bicycle Council and member agencies
  - Key stakeholders, including peak cyclist organisations
  - Overseas contacts (UK, Europe and North America)
  - Information and Survey available at http://www.abc.dotars.gov.au/whole_life_costings.htm

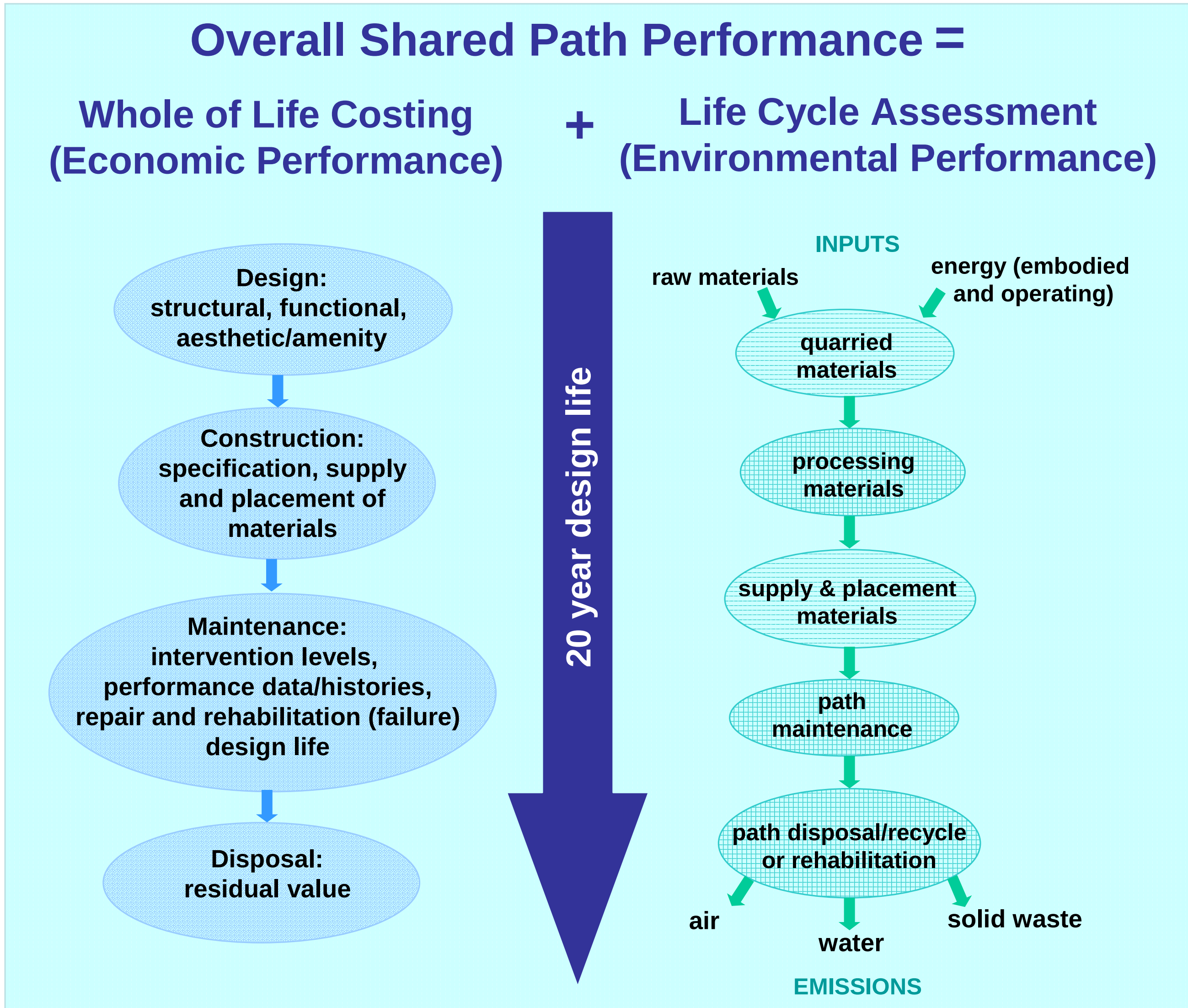
Whole of life (WOL) methodology – economic performance

- Considers the following over the life cycle:
  - construction and acquisition costs
  - maintenance and rehabilitation costs
  - benefits
  - disposal costs, etc.
- Need to know:
  - service life of path
  - path life performance and criteria for measuring it
  - impact of maintenance
  - quantification of costs and benefits
  - method of evaluation (NPV, etc.)

Whole of life (WOL) methodology - environmental and social performance

- Need to consider environmental and social performance as well as economic performance
- Quantifying the environmental impacts as an additional criteria
  - Estimate impact on climate change in terms of CO_2 emissions from materials used
  - Estimate resource use through quarrying, processing and constructing
- Quantifying social impacts
  - Benefits from diversion of traffic from existing transport and reduced noise, etc.

Overall path performance – economic, environmental and social



Critical issues for economic performance

- Estimating life of path (20 years?)
- Surface condition change over path life – from acceptable smoothness to unacceptable
- Maintenance intervention – triggers, treatments and frequency?
- Maintenance varies with path type and age
- Impact of maintenance on condition and life

Surface condition limits

- Roughness IRI < 3.5
- Vertical steps < 15 - 20 mm
- Cracks < 10% and < 8 mm width
- Texture < 0.8 mm (concrete); < 1.6 mm (asphalt/chip)
- Need more definitive information in this context

Maintenance intervention

- To manage surface (and structural) conditions
- A range of triggers for various treatments
- Little is known in this context about maintenance performance
- Can prolong life and reduce WOL

Maintenance – types and frequency

Pavement type	Maintenance type		Frequency (yr)
	Routine	Periodic	
Unsealed granular	Erosion repairs (after rain)	Resurfacing and reshaping	3 – 5
Sprayed seal	Crack sealing Pothole repair Edge break repair (regular)	Resealing	7 – 14
Asphalt	Pothole repair Edge break repair Crack sealing (regular)	30 mm overlay Patching Rut regulation	10 5 – 10 5 - 15
Concrete	Edge damage repair Spalling repair Cracking repair (regular)	Joint repairs Retexturing Patching Slab replacement	4 – 6 15 10

Summary of outcomes of review

- Verification needed about concrete versus asphalt life performance
- Maintenance treatment performance largely untested
- Environmental impact of path design and materials needs to be included in decision process
- WOL methodology suitable and should stimulate data collection on performance and costs, etc.

Concrete pavement - features

Concrete		
Advantages	**Disadvantages**	**Comments**
•Long life > 40 yrs	•Joints reduce rideability	•Performance influenced by joint movements
•Durable	•Highest initial cost	•Suitable for weak subgrades
•Constructible	•Cracks with settlement	
•Adaptable	•Failure involves major repairs	
•Good cold weather surface	•Joints move with unstable subgrade	
	•Unattractive	

Asphalt pavement - features

Asphalt		
Advantages	**Disadvantages**	**Comments**
•Moderate life > 20 yrs	•Needs frequent maintenance	•Suitable where maintenance is well managed
•Hard/smooth surface	•Subgrade m/c change can cause failure	•Not suitable for expansive clays (needs thick pavement)
•Withstands movement	•Needs space to construct	
•Lower repair cost than concrete	•Needs edge constraint	
•Suits local environment	•Needs weed spraying	

Chip sealed pavement - features

Chip Sealed		
Advantages	**Disadvantages**	**Comments**
•Moderate life ≈ 20 yrs	•Needs frequent maintenance	•Geotextile improves life performance
•Hard surface	•Subgrade m/c change can cause failure	•Not suitable for weak subgrades
•Withstands movement	•Uncomfortable riding surface	
•Lower repair cost than asphalt	•Stone size is too large	
•Suits local environment	•Needs weed spraying	

Granular unsealed pavement - features

Granular unsealed		
Advantages	**Disadvantages**	**Comments**
•Moderate to low cost	•Unrideable in the wet	•Low trafficked paths left unsurfaced
•Natural surface	•Needs regular and frequent maintenance	
•Smooth surface if well maintained	•Erodible	
	•Needs periodic regravelling	
	•No good for steep grades	

Brick or clay paver pavement - features

Brick or clay pavers		
Advantages	**Disadvantages**	**Comments**
•Flexible surface	•Poor ride quality	•Not often chosen
•Can be re-laid (maintenance)	•Debris clogs space between pavers	
•Attractive in some environments	•Low skid resistance with surface sand	

Whole of Life Costing and Project Appraisal

- More complete representation of costs and impacts
- Benefits also need to be based on life-cycle costs
  - Level of use
  - Greenhouse gas emissions from extraction, transport, refining and distribution of oil-based fuels
  - Externalities
    - Air pollution - production <u>and</u> exposure
    - Health
    - Urban form
    - Safety and security
- May need to redefine projects in the light of appraisal outcomes