CAPSA'15
11TH CONFERENCE ON ASPHALT PAVEMENTS FOR SOUTHERN AFRICA
Innovation for Quality and Value
16 - 19 August 2015 - - - Sun City - South Africa - -

Recommendations for Application of the Results of the Pavement LCA 2014 Symposium to Southern Africa

John Harvey
University of California Pavement Research Center, UC Davis

Co-Authors

Agnés Jullièn, LUNAM Université, Ifsttar, Nantes, France

Wynand Steyn, University of Pretoria, Gauteng, SA

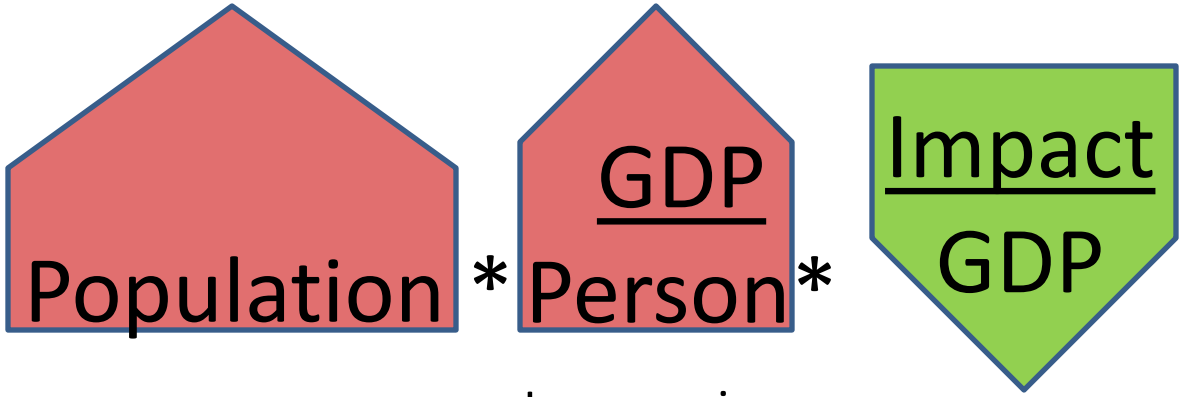
Alissa Kendall, University of California, Davis, CA, USA

David Jones, UCPRC, Davis, CA, USA

Arash Saboori, UCPRC, Davis, CA, USA

Master equation for environmental impacts

Environmental impact as function of Gross Domestic Product (national economic output) =



Increase in wealth and economic activity

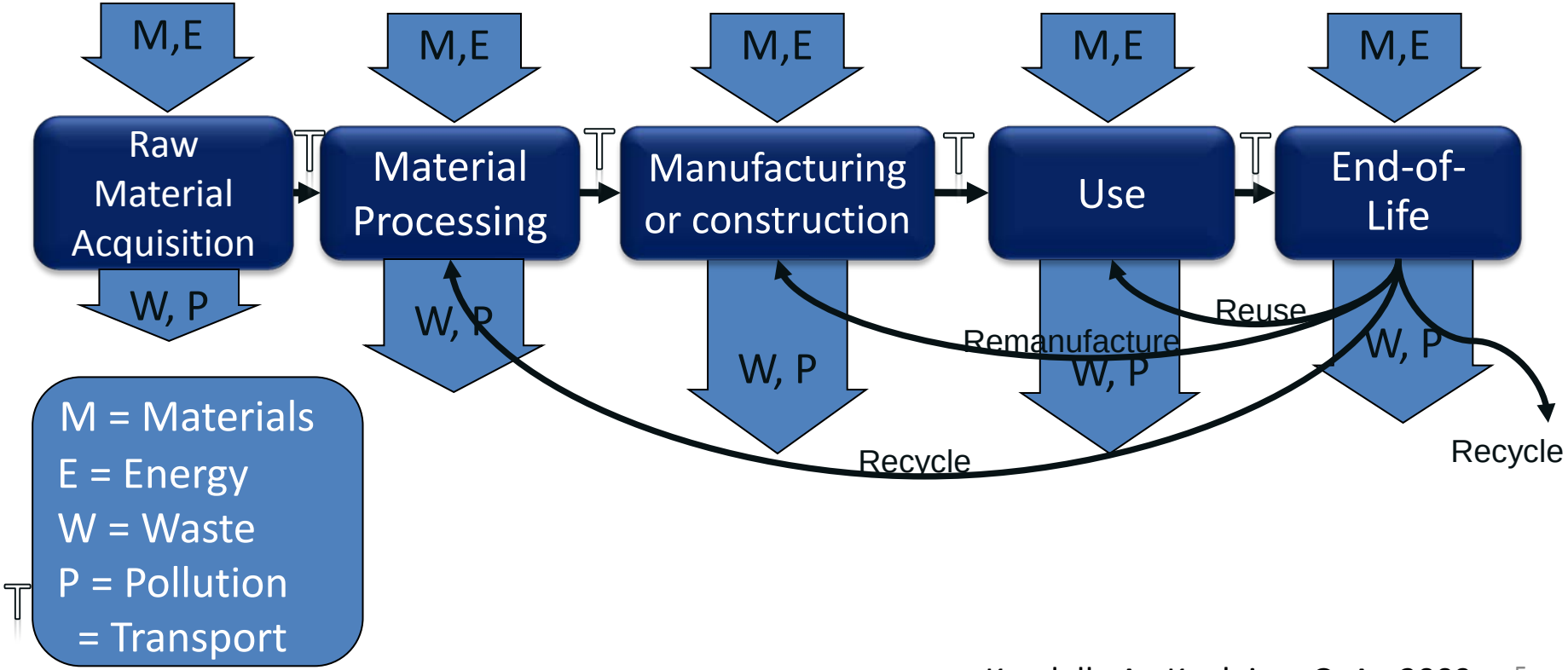
Technological efficiency (how to measure?)

Ehrlich and Holdren (1971) Impact of population growth. e.g. via LCA
Science 171, 1211-1217
Slide adapted from R. Rosenbaum, Pavement LCA 2014 keynote address

Life Cycle Assessment (LCA)

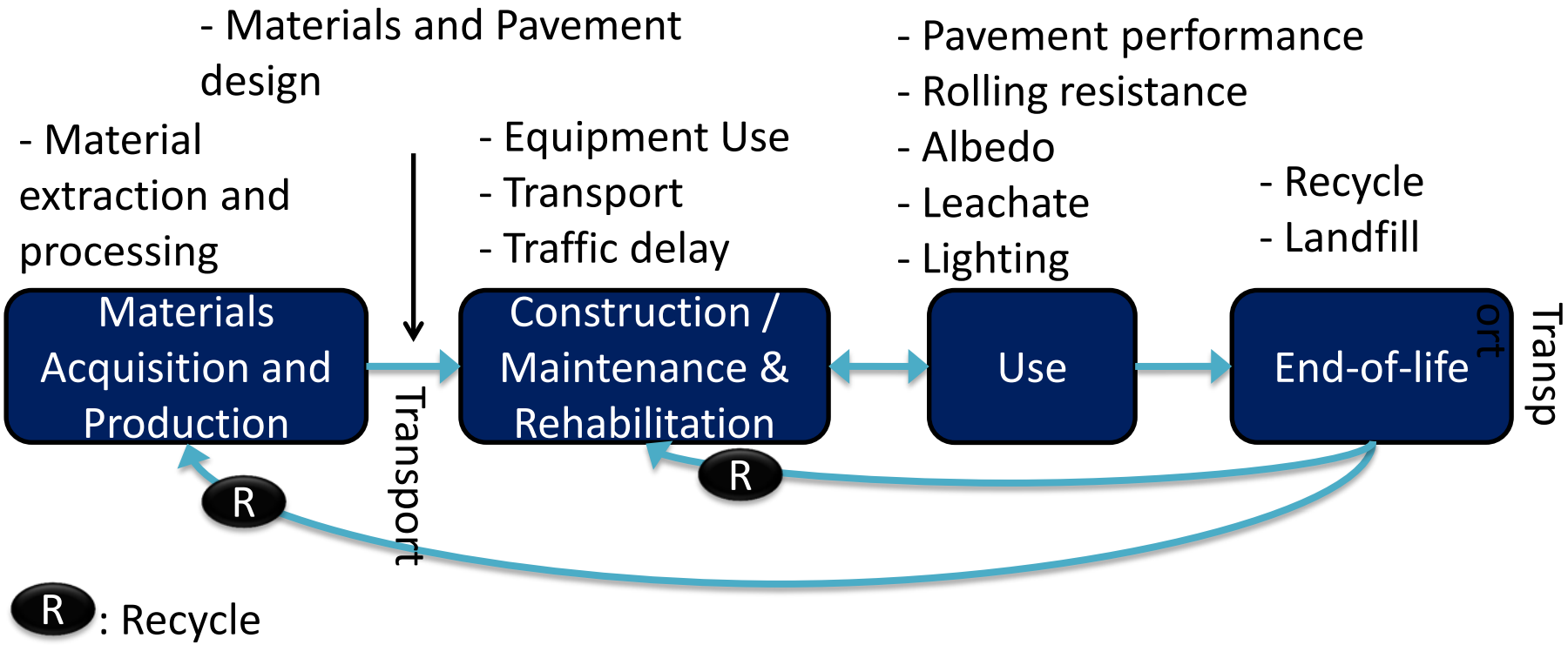
- A method for characterizing and quantifying environmental sustainability using a cradle-to-grave perspective, and considering system-wide impacts for a product, policy, or system
- The purpose of an LCA is typically to compare the performance of alternatives, to anticipate unintended consequences of a decision or technology, or to identify environmental “hot spots” that might be targeted for improvement.

Generic Life Cycle



Kendall, A., Keoleian, G. A., 2009

Pavement Life Cycle



From: Kendall et al., *2010*

Four Key Stages of Life Cycle Assessment

Key steps include definition of Goal (question) and system boundary definition – essentially, what can be left out of the LCA?

Where we translate the inventory into meaningful environmental and health indicators

Goal Definition and Scope

Life Cycle Inventory Assessment

Impact Assessment

Interpretation

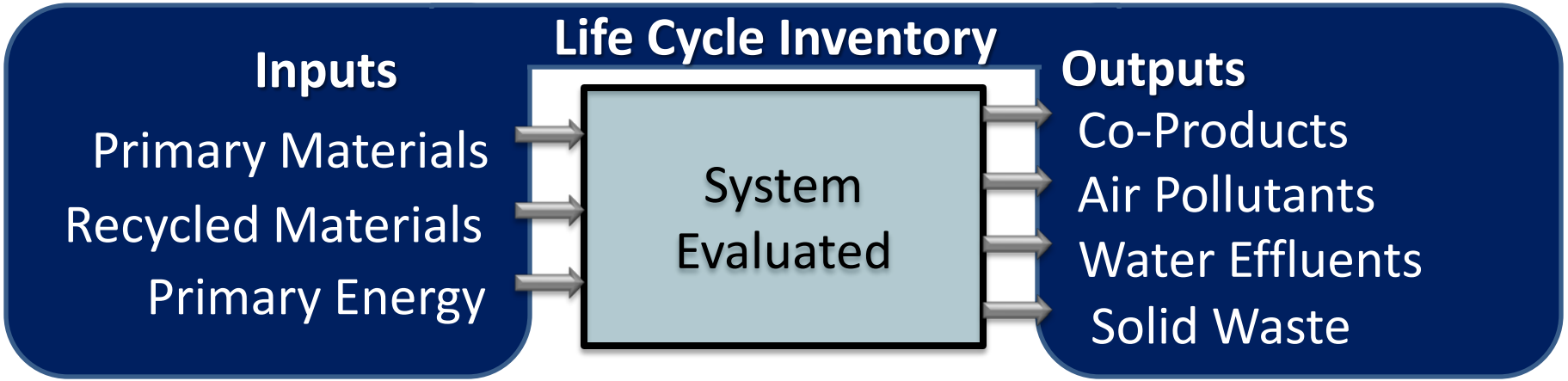
The "accounting" stage. Where we track all the inputs and outputs from the system

Where the results of the impact assessment are related back the questions asked in the Goal

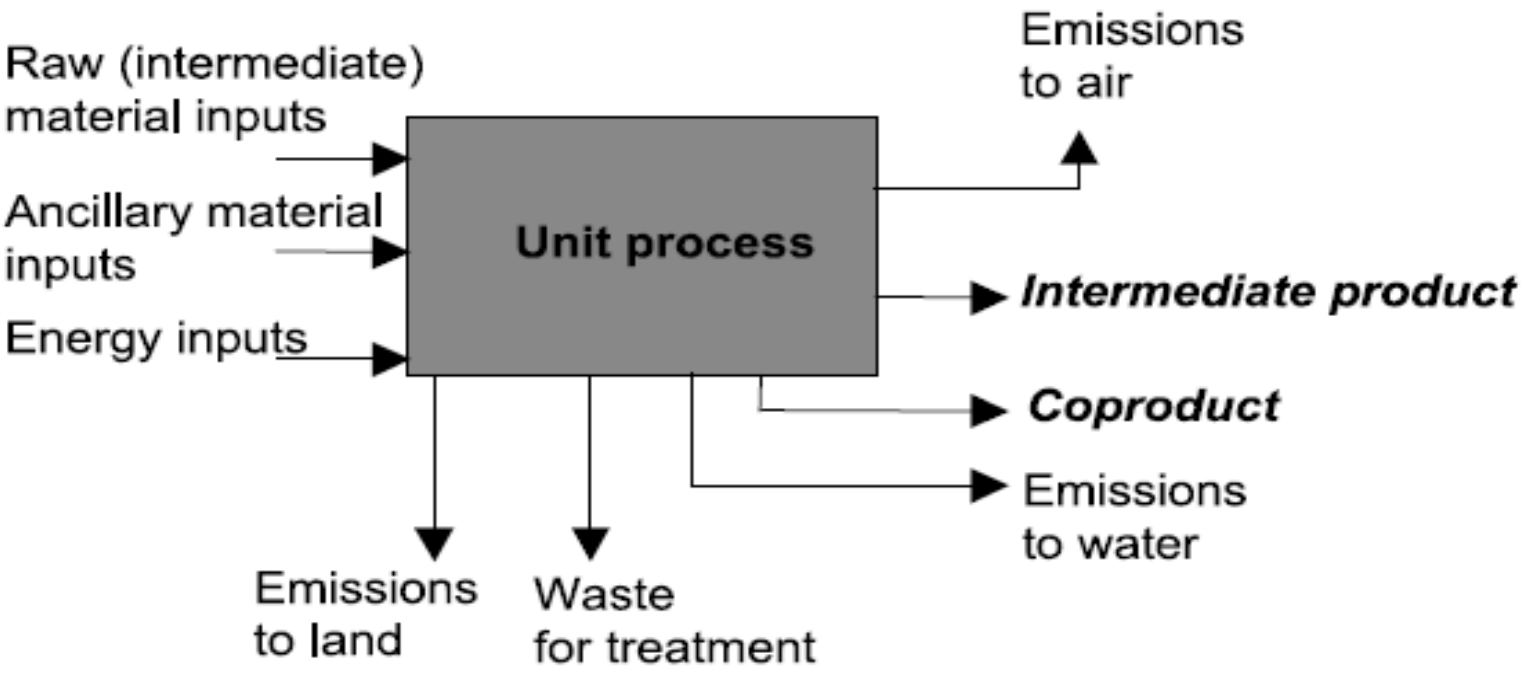
Figure based on ISO 14040, adopted from Kendall

Life Cycle Inventory (LCI)

- The quantification of relevant inputs and outputs for a given product system throughout its life cycle



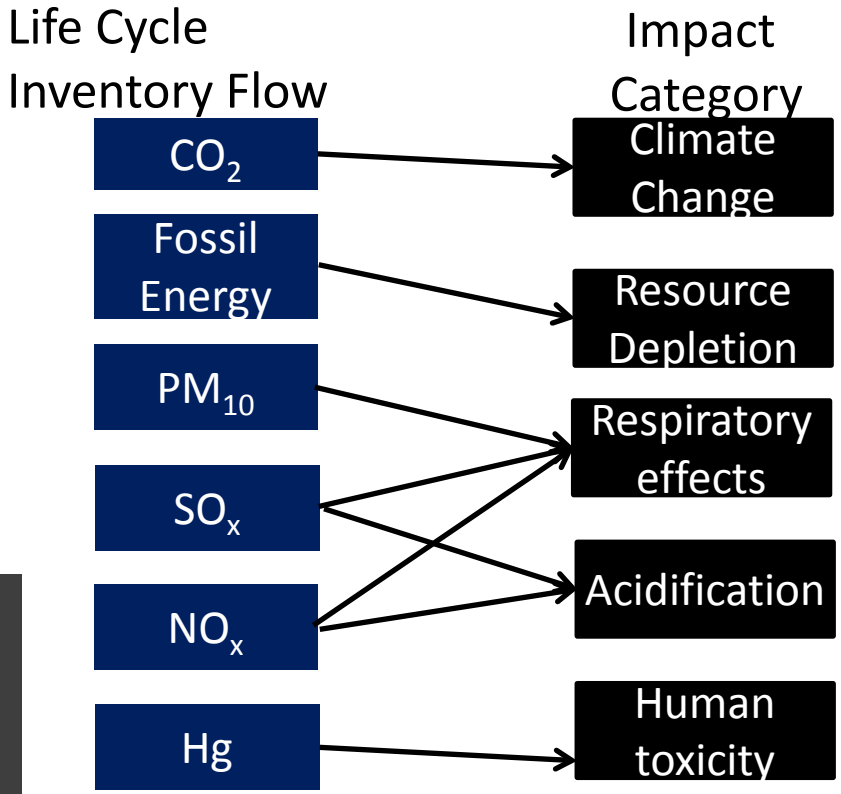
Develop Unit Process Models



ISO

Life cycle impact assessment

- Translate resources consumed or pollutants emitted into effects on humans or the environment



Note: Most Pavement LCA to date focused only on global warming (greenhouse gases) and energy use

Group	Impact Category (CML and TRACI)	Comment
Energy use	Fuel, non-renewable[1] Resources, non-renewable Resources, nonrenewable, secondary Fuel, renewable Resource, renewable Resource, renewable, secondary	Small uncertainty, both energy use and energy sources used as materials should be addressed
Resource use	Resource, renewable Resources, non-renewable[2]	Small uncertainty
Emissions	Climate Change[1, 2] Ozone layer depletion[1, 2] Acidification[1, 2] Tropospheric Ozone[1, 2] Eutrophication[1, 2]	Small uncertainty, global, biogenic CO_2 requires special attention Small uncertainty, global Small uncertainty, regional Medium uncertainty, local Small uncertainty, local
Toxicity	Human toxicity[2], respiratory[1] Human toxicity, carcinogenic[1] Human toxicity, non-carcinogenic[1] Ecotoxicity[1], fresh water[2] Ecotoxicity, marine water[2] Ecotoxicity, soil[2]	High uncertainty, incomplete
Water	Fresh water use	Small uncertainty
Waste	Hazardous Non-hazardous	Small uncertainty

Life cycle interpretation

- Answer the questions posed by the goal to produce conclusions, recommendations and decision-making support, with these elements:
  - Identification of major issues based on findings of LCI and LCIA stages
  - Check completeness, sensitivity and consistency
  - Write conclusions, discussion on limitations, and further recommendations
- Recommended to do sensitivity and uncertainty analysis and discuss limitations when answering goal questions

LCA Standards

- International standards exist (ISO LCA Standards):
  - 14040 Principles and Framework
  - 14044 Requirements and Guidelines
  - 14047 Impact Assessment
- Most all pavement LCA guidelines should follow these globally accepted guidelines
- But they provide general guidance, not detailed information necessary for individual products or systems

Note: Carbon (or energy) footprints are a narrow and incomplete form of LCA, where only one kind of environmental impact is tracked and quantified

LCA Standards

- UCPRC Pavement LCA Guidelines (2010)
  - First Comprehensive summary of pavement related LCA, few details
  - Transparency checklist so that readers of LCA can understand what was included, what was not included, and assumptions
- EN 15804:2012+A1 (2012 and update)
  - Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products
- US Federal Highway Administration (FHWA) Guidelines for Pavement LCA (expected early 2016)
  - Comprehensive and detailed
  - Step-by-step for different purposes and levels of user expertise
  - Aligned with ISO and EN requirements
  - Reviewed by FHWA, state DOTs, industries

Applications of LCA

- Project-level decision support:
  - Design evaluation
  - Contractor procurement combining cost and LCA impact indicators
- Network-level decision support:
  - Allocation of maintenance and rehabilitation funding to improve impacts
  - Treatment selection combining cost and LCA impact indicators
- Policy-level decision support:
  - Evaluation of specifications for materials, construction quality, smoothness, etc
- Materials producer communication to customers
  - Environmental Product Declarations (EPD)

Movement towards standardization for pavement LCA: Symposia

Pavement Life Cycle Assessment Workshop

University of California, Davis
Davis, California
May 5-7, 2010

July 10-12, 2012
Nantes, France

International Symposium on
Life Cycle Assessment and Construction

rilem · International Society for Industrial Ecology · SETAC · IFSTTAR · CSTB le futur en construction

PAVEMENT LCA 2014

2010 UC Davis Workshop
2012 Nantes Symposium (RILEM)

International Symposium on
Pavement LCA 2014

Davis, California, USA
October 14-16 2014

Information
- Download Brochure
- Downloadable Flier
- Provisional Program
- Important Dates

- Recognized need to develop pavement LCA community
- Standardize methods, spread knowledge

Plenary Topics

- Application of Pavement LCA in Northern Europe
- Current status and future of standardizing LCA in US
- Approach for developing regional inventory datasets
- Integration of LCA into pavement management systems
- Integration into new design methods
- Use of LCA in different infrastructure delivery methods
- Panel discussion: Implementation of LCA by different organizations: state DOT, local government, FHWA, industry (asphalt & concrete) perspectives
- Sponsors: TRB, FHWA, Caltrans, Int. Soc. for Asphalt Pavements, Int. Soc. For Concrete Pavements

Breakout Questions and Summary

- 17 questions posed to discussion groups of government, industry and academia
- Some Results:
  - Up-to-date regional inventory data is needed for improvement and credibility of LCA results
  - Regional applicability of impact indicators needs to be taken into consideration, such as water use and air pollution indicators
  - LCA use will most likely happen faster through incentives and procurement rules in Design/Build/Maintain and Design/Build contracts than through regulation.

Some Results of Breakout Sessions

- The implementation of LCA in the USA will likely follow a path similar to that taken for life cycle cost analysis
- Greater access to environmental impact data from pavement LCA will likely increase the public attention to pavement. Information, such as the impact of pavement condition on vehicle fuel use, other road user costs and freight damage may influence business and road user decision-making and pressure on road owners
- Regarding the inclusion of environmental considerations in local agency decision-making:
  - Agencies will always focus on three measures of success: profitable contractors, agency savings and happy pavement users, with environmental considerations influencing those parameters

LCA can be complicated

How to get started with “life cycle thinking”

1. Define question to be answered and specific environmental and other goals or decisions to be made
2. Define system boundaries
   - Identify items that are the same and do not need to be considered
3. Define the functional unit and approach
   - Specific project variables, cases for impact calculation of comparison, analysis period
4. Model the system
   - Measure flows of materials and resources into the system, and waste and pollution as well as product coming out of the system
5. Quantify differences between alternatives over the life cycle

Suggested way forward for southern Africa

- Use European and North American developments in pavement LCA practice, adapting them to southern Africa requirements and resources
- Prioritize southern Africa needs which focus on socio-economic development as well as environmental degradation
- Develop impact indicators for southern Africa socio-economic priorities
- Begin with “life cycle thinking” for the environment
- Prepare for potential market and other pressure to produce EPDs
- The time frame for development and implementation of LCA is a five to ten year process, but with early payoffs as approaches are developed and become more sophisticated

CAPSA/ISAP Pavement LCA Workshop Questions

1) What is the awareness and what, if any, is the political or other mandate in Southern Africa to begin to use LCA?

2) What are the highest priorities for improving the environment through pavement decisions in southern Africa? Human health, ecosystems, climate change, non-renewable resource depletion?

3) In your mind, what is the most important thing that can be done to improve sustainability of pavement operations in southern Africa? Longer life pavement, materials processes, construction quality, smoothness? Why beneficial or not?

4) What LCA impact indicators might help identify how road maintenance can improve human health and the environment, and compare benefits of investment in roads with other government investments?

5) Should southern Africa begin to move forward? Why or why not? If yes, how?

Questions?

Pavement LCA 2014 website:

http://www.ucprc.ucdavis.edu/p-lca2014/