Florida Department of Transport APT and Instrumentation Workshop

The role of APT in the RDI of pavement technology

H L Theyse

Transportek CSIR

Structure of presentation

- Overview of full-scale testing and accelerated pavement testing
- The Research, Development and Implementation (RDI) process
- General comments on the utilization of APT in South Africa

Overview

The role of APT in the RDI of pavement technology

Definition of acronyms

- The purpose of Full-Scale Testing (FST) is to determine
  - the behaviour (trends and load sensitivity);
  - mechanical properties (resilient modulus);
  - structural bearing capacity (ESALS); and
  - performance of pavements (not pavement life).

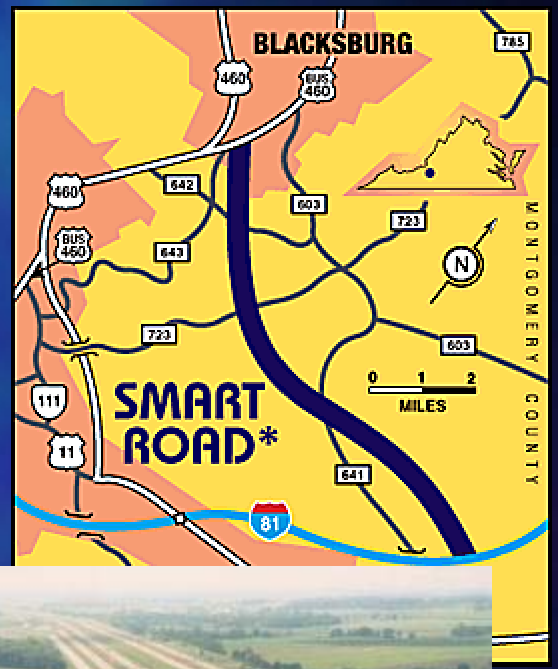
  under actual boundary (pavement geometry) conditions

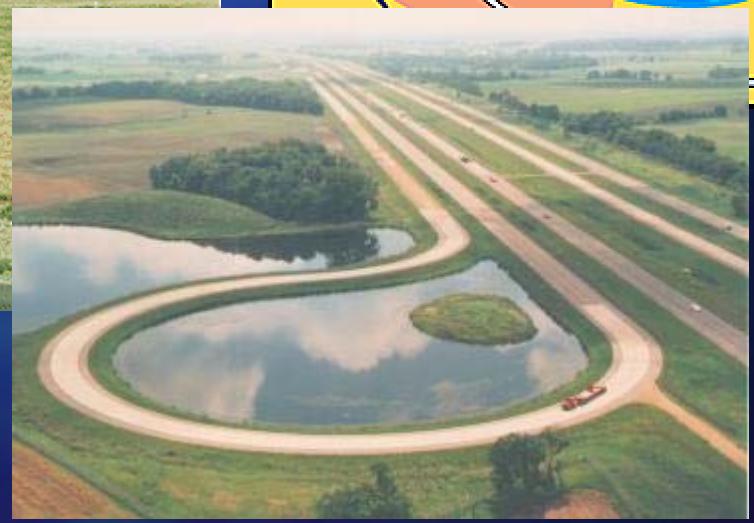
Definition of acronyms (continued)

- Types of Full-Scale Testing (FST)
  - Long Term Pavement Performance (LTPP) sections
  - Accelerated Load Testing (ALT)/ Accelerated Pavement testing (APT)
    - Test tracks and test roads
    - Wheel-tracking machines
      - Circular
      - Linear

Test tracks and test roads

- VT Smart Road
- Mn-Road
- Westrack





Circular wheel-tracking devices

- CAPTIF New Zealand
- LCPC France
- Romania

Linear wheel-tracking devices

- LINTRACK
- PTF - Nottingham
- RTM- Denmark

Mobile linear wheel-tracking devices

- ALF - Australia
- MLS - Texas
- HVS – South Africa

Regions of full-scale APT activity

- Europe
  - Cost 347 programme
  - www.pave-test.org/altpave.htm
  - 9 facilities listed
- United States
  - TRB committee A2B09
  - www.ksu.edu/pavements/trb/A2B09/index.htm
  - 15 facilities listed
- Australia and New Zealand
  - 2 facilities listed
- South Africa
  - 2 HVS machines

Heavy Vehicle Simulator (HVS) programmes

- HVS Nordic
- US Army Corps of Engineers, CRREL
- US Army Corps of Engineers, WES
- CALAPT
- RSA
- Florida

HVS Nordic

- HVS Mk IV
- Shared between Sweden and Finland
- Validation of designs
  - Finland
  - Iceland
- Sweden
  - Steel reinforced flexible roads
  - Data for mileage tax

US Army Corps of Engineers, CRREL, WES

- CRREL (HVS Mk IV)
  - Subgrade studies
- WES (Bigfoot, double size HVS)
  - Airfield design (extremely high loads)
  - Validation of design methods

CALAPT, California

- Two HVS Mk III machines
  - Field machine
  - Rigid pavements
    - Fast setting concrete
    - Dowel bar retrofit
  - RFS machine
    - Flexible pavements
    - Drainage layers
    - AC fatigue and rutting for modified binders

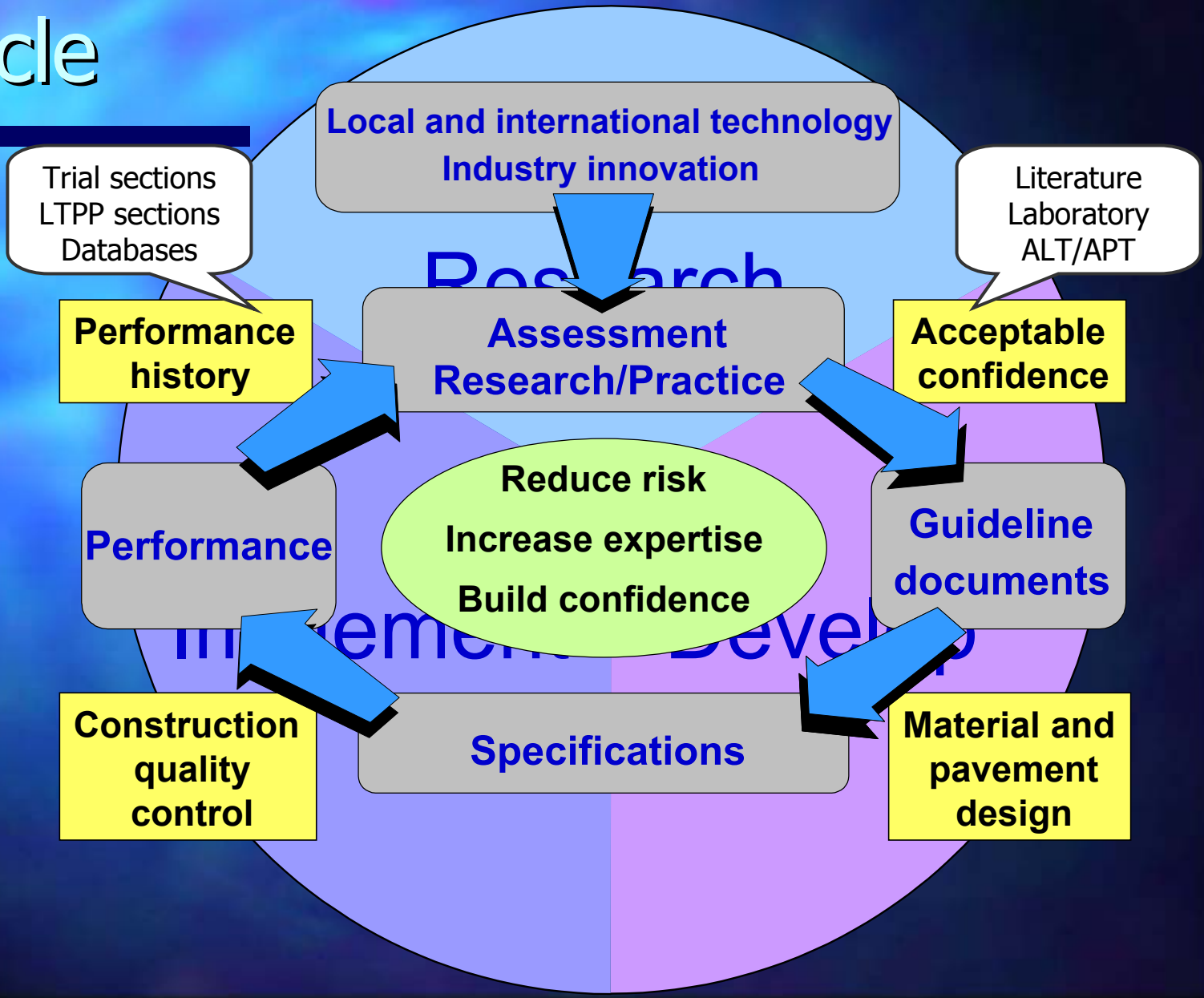
Florida

- Presentation on Wednesday

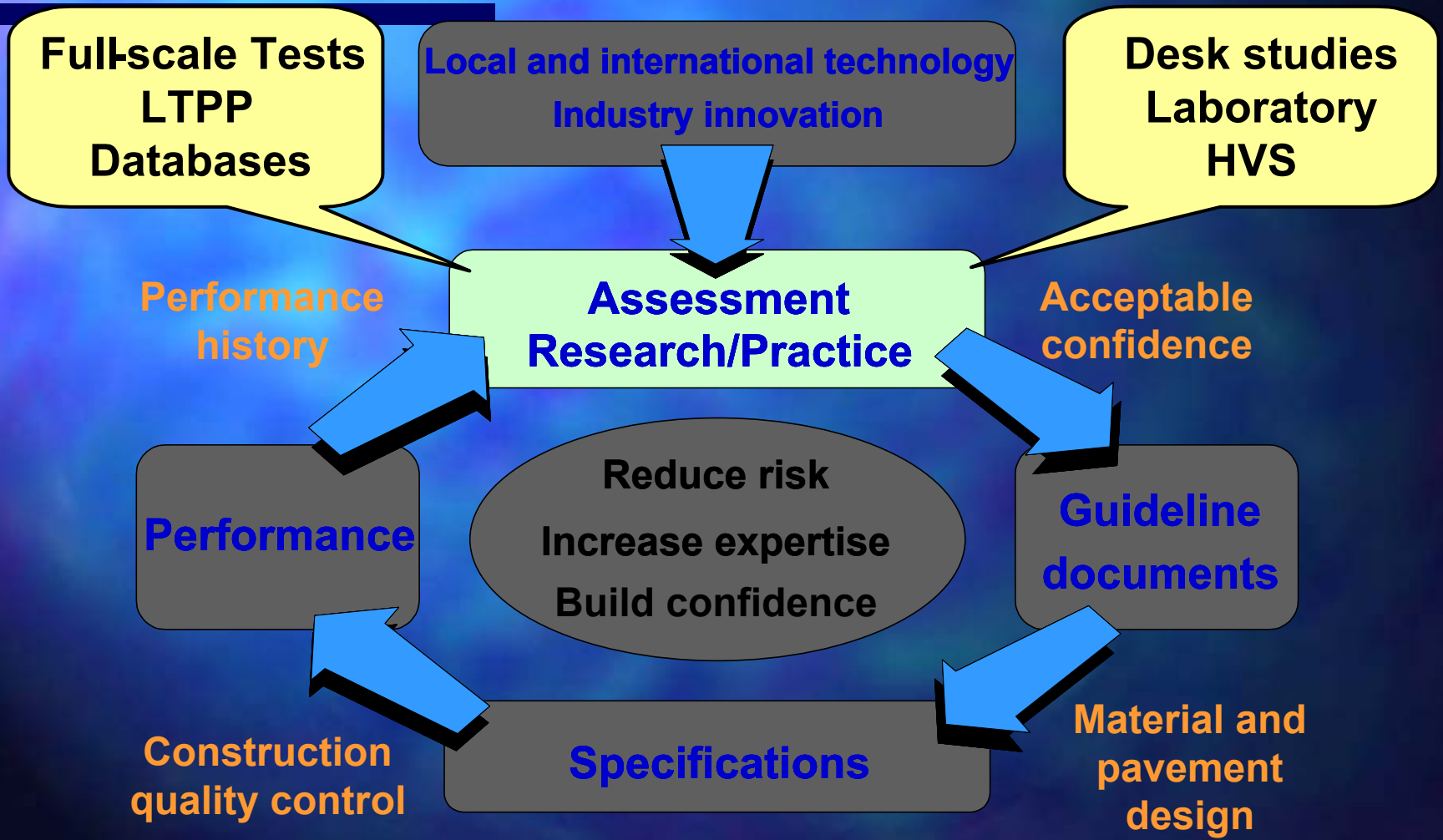
The Research, Development and Implementation process

The role of APT in the RDI of pavement technology

Utilisation of ALT/APT:
RDI cycle



Research: Assessment phase

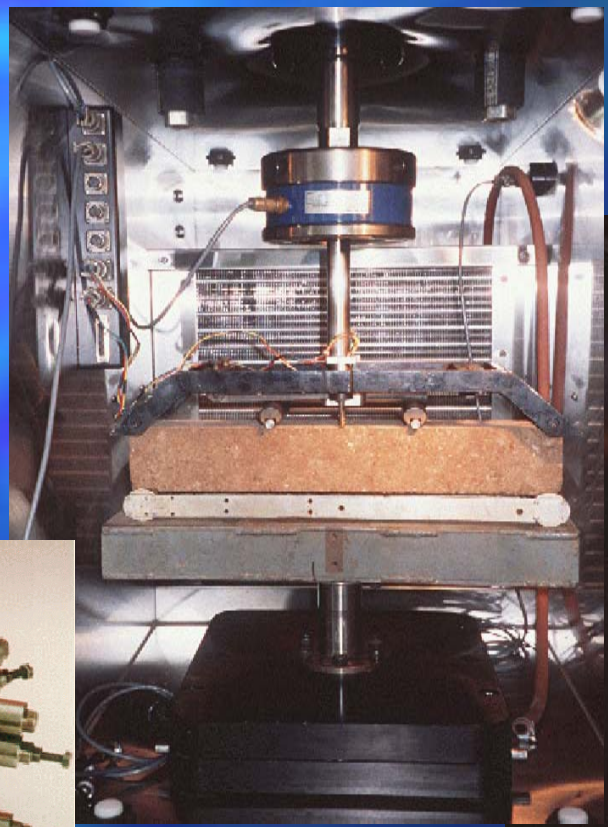


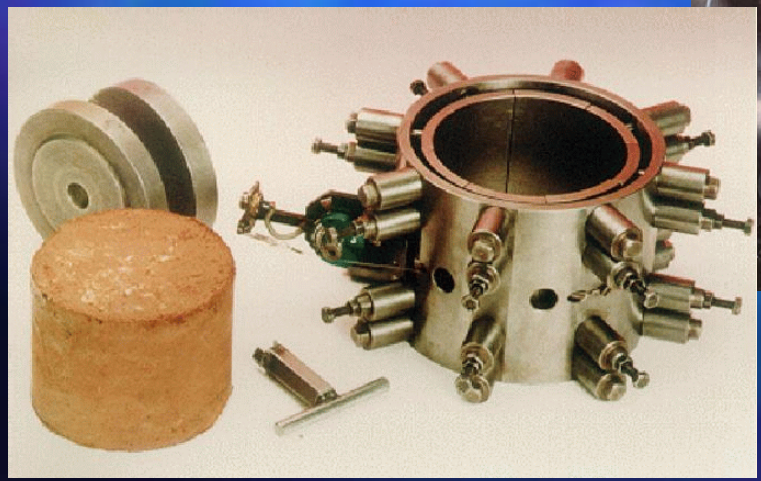
Assessment

- Investigate properties, behaviour and performance
- Rapid initial assessment
  - Advanced laboratory testing
  - Heavy Vehicle Simulator
  - Field trials
- Subsequent cycles
  - Long-term track record

Rapid initial assessment
Advanced laboratory testing

- High-gain
- Fundamental understanding
- Improved modelling

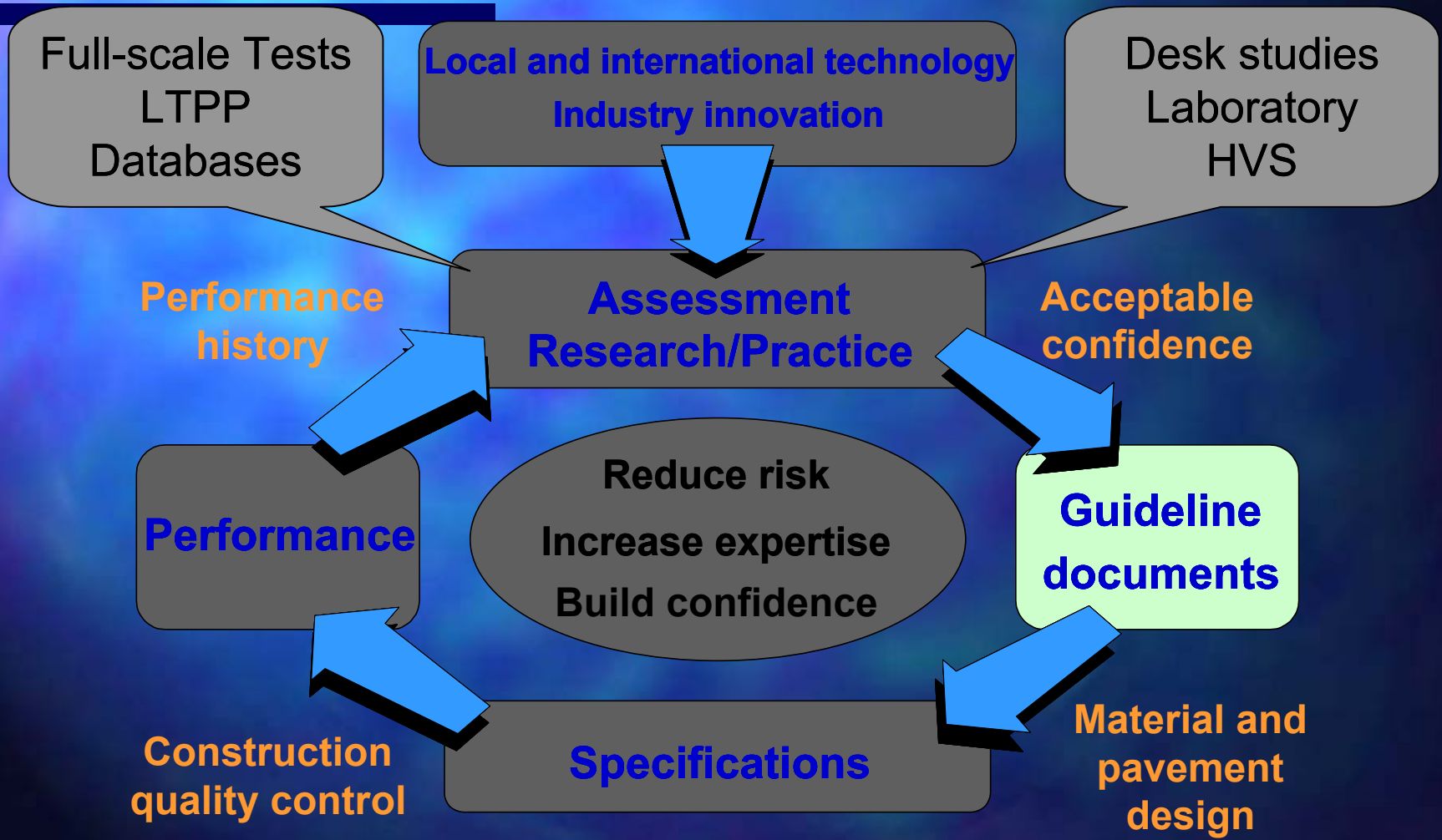




Rapid initial assessment HVS

- Full-scale testing
- Practical understanding
- Realistic time-frame
- Spurs interest
- Catalyst for training and development

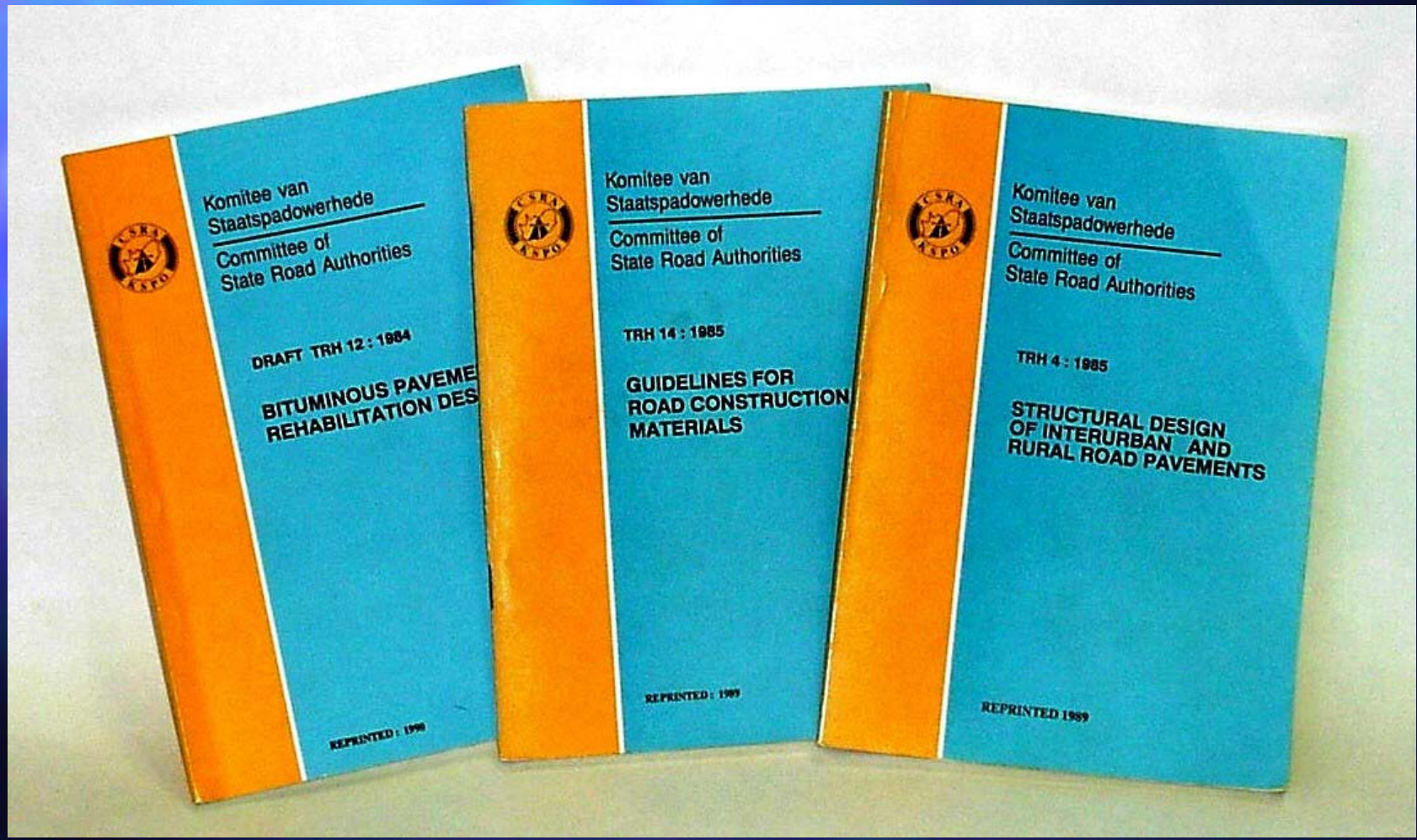
Development: Guideline documents



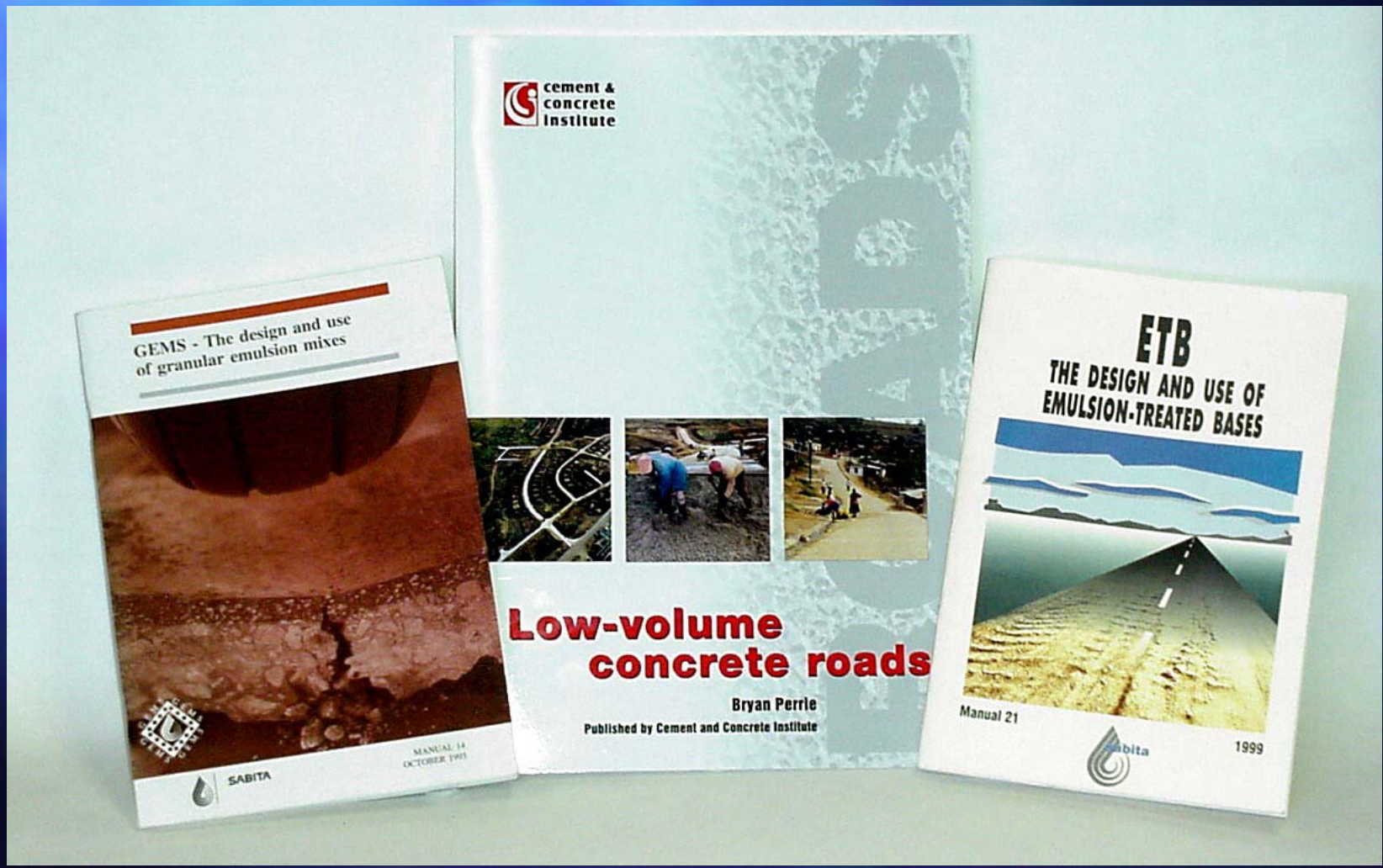
Guideline Documents

- Acceptable confidence established
- Translates fundamental and practical understanding to application guidelines
  - Design philosophy
  - Sound engineering principles
  - Design process

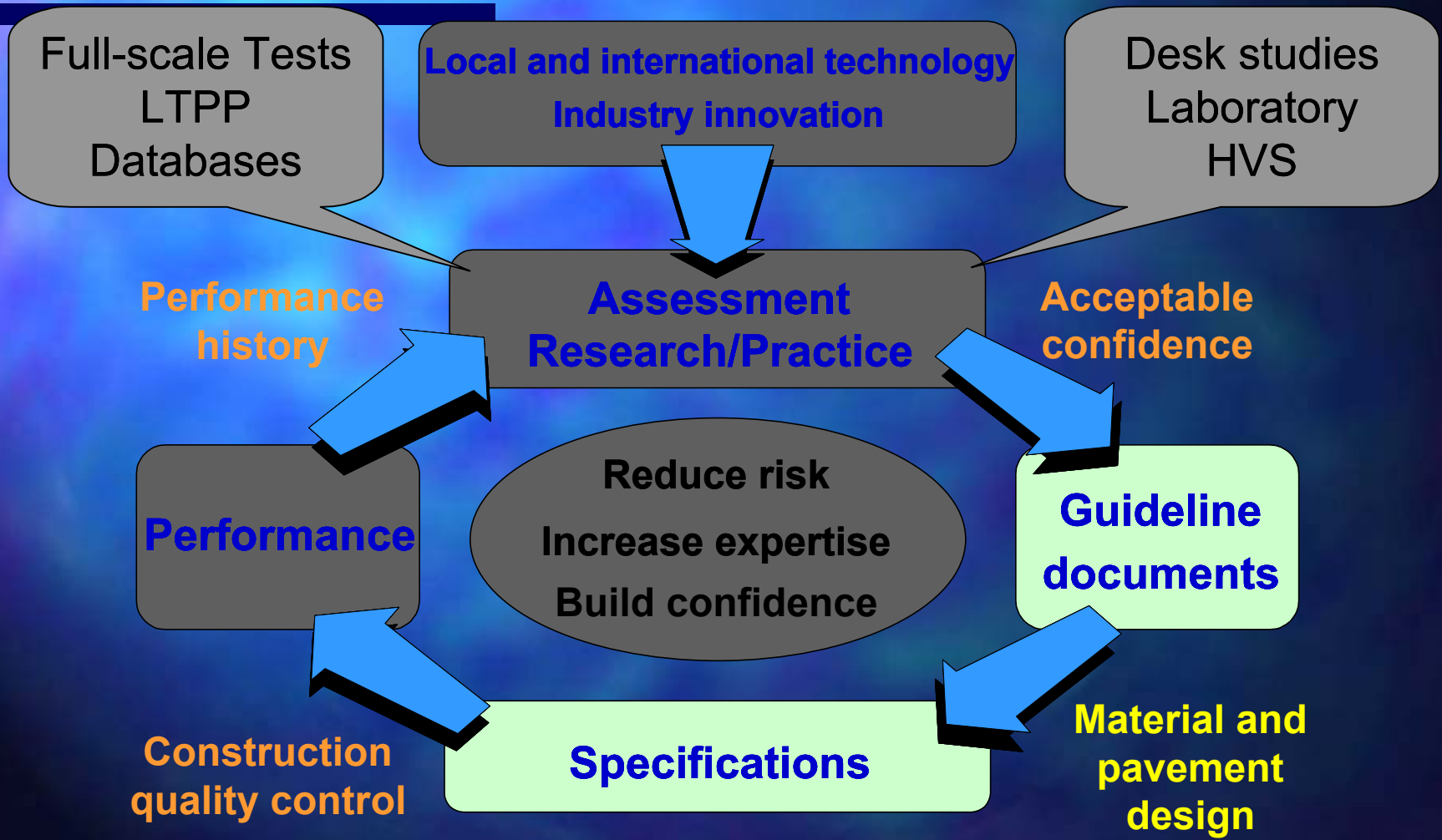
National Guideline Documents



Private Industry Guideline Documents



Development: Design methods



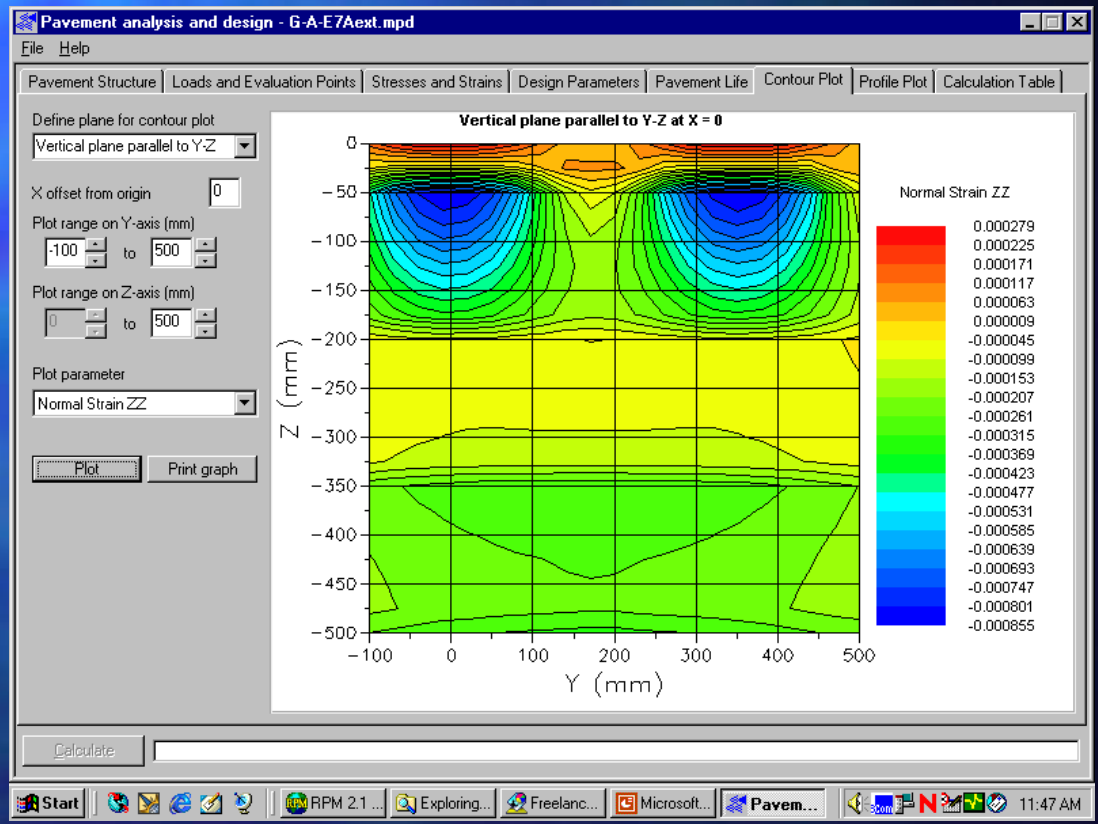
South African material and pavement design methods

- Converts design philosophies and engineering principles contained in the guideline documents to quantified designs on paper
- Prescriptive calculation procedures and test methods of the design process

South African material and pavement design methods

South African material and pavement design methods

- Tools to assist design engineer
- No intelligence
- Proper application through experience



Development/Implementation: Specifications

Standard and project specific specifications

- Translate the paper design to
- measurable items for
- quality control during construction

Standard and project specific specifications

Performance

- Performance history over long-term
- Feeds into assessment
- Experience improves confidence, reduce risk
- Improve guideline documents and design methods
- Improve performance

The utilization of APT in South Africa

The role of APT in the RDI of pavement technology

Practical implementation:

- New ideas quickly proven by a fast first cycle in RDI spiral
  - Thin surfacing layers
  - Crushed stone, G1 bases
  - Lightly cemented material
  - Labour-intensive construction
  - Foamed bitumen and emulsion treatment
- Proper understanding of pavement behaviour
  - Pavement balance
  - Inverted pavements
  - Top-down and bottom-up failure

G1 crushed stone bases

- Extremely high density specification
- Removal of excess fines through "Slushing"

Thin surfacing layers: Seals and asphalt

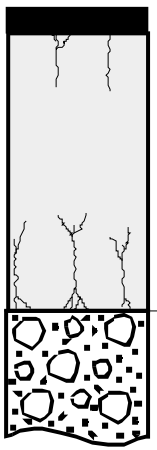
Lightly cemented layers

Labour-intensive construction

DISR with foamed bitumen and emulsion treatment

Pavement balance

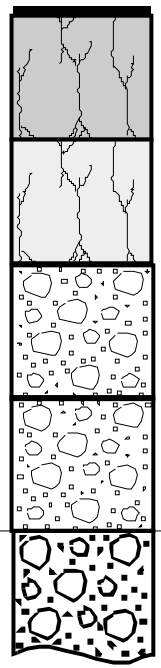
- Gradual decrease in strength and stiffness with depth



50 mm Asphalt concrete

330 mm lightly cemented material:
E = 2000 MPa

In-situ subgrade:
CBR: 3 - 7%, E = 50 MPa



Double seal

150 mm lightly cemented material:
UCS 1,5 - 3 MPa, E = 2000 MPa

150 mm lightly cemented material:
UCS 0,75 - 1,5 MPa, E = 800 MPa

150 mm imported subgrade:
CBR: 15 - 25%, E = 120 MPa

150 mm imported subgrade:
CBR: 7 - 15%, E = 70 MPa

In-situ subgrade:
CBR: 3 - 7%, E = 50 MPa

Inverted pavements

Philosophical approach to the utilisation of ALT/APT

- Basic principle of APT
  - Accelerate the cumulative effect of traffic loading by:
    - Decreasing the duration of the rest period between successive load applications
    - Increasing the magnitude of individual load applications
  - Do not normally accelerate the effects of
    - The environment (ageing/curing, seasonal cyclic variations)
    - Human interventions (maintenance)
      - Can control and test specific combinations of these variables

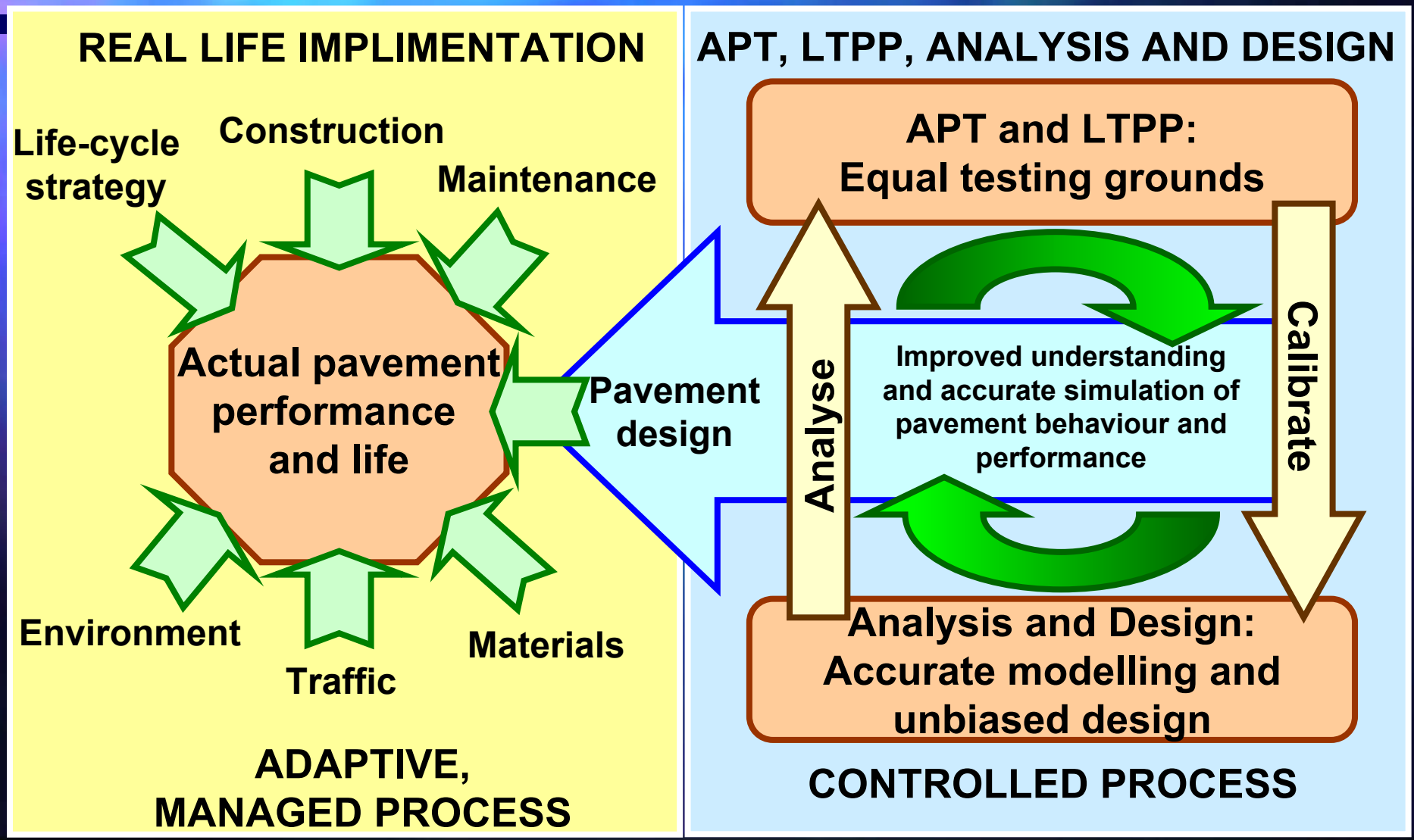
Utilisation of ALT/APT: Testing philosophy

Simulation test:
Exact replica of the real-life conditions that the pavement is subjected to:
- Geometry/boundary conditions
- Environment
- Traffic loading
- Human intervention
- Example: LTPP, simulation software

Transition test:
Displays some of the characteristics of both the simulation and modeling test:
- Geometry/boundary conditions
- Environment
- Traffic loading
- Human intervention
- Example: Full-scale ALT

Modeling test:
Recreation of a specific combination of variables under controlled conditions:
- Geometry/boundary conditions
- Environment
- Traffic loading (stress condition)
- Human intervention
- Example: Triaxial test

Utilisation of ALT/APT:
Integration of activities



Utilisation of ALT/APT:
To summarise

- Essentially aimed at determining the
  - mechanical and structural performance properties of pavements and pavement materials and
  - certain functional performance properties under given conditions
- Accelerates the learning process, knowledge base and confidence in pavement materials and designs

Background to the Transportek presentations

- Focus on
  - Flexible pavements
  - Mechanical/structural characteristics and properties
    - Resilient modulus
    - Shear strength
    - Response parameters (σ and ε)
    - Plastic strain
    - Fatigue
  - Behaviour and performance parameters
    - Deflection trends
    - Rutting trends
    - Response parameter trends
    - Crack pattern development