Sustainable Asset Life Cycle Management:

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Optimising Maintenance Strategies in the Process Industry to Maximise the environmental performance of Assets

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Problem Statement

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- Environmental implications were not taken into account prior to the 1980s in the process industry
  - Especially in developing countries
- Maintenance strategies focussed on:
  - Maintainability
  - Reliability
  - Cost

→ Short term focus

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- Total life cycle cost and environmental liabilities were consequently not taken into account

→ Long term focus

Objective

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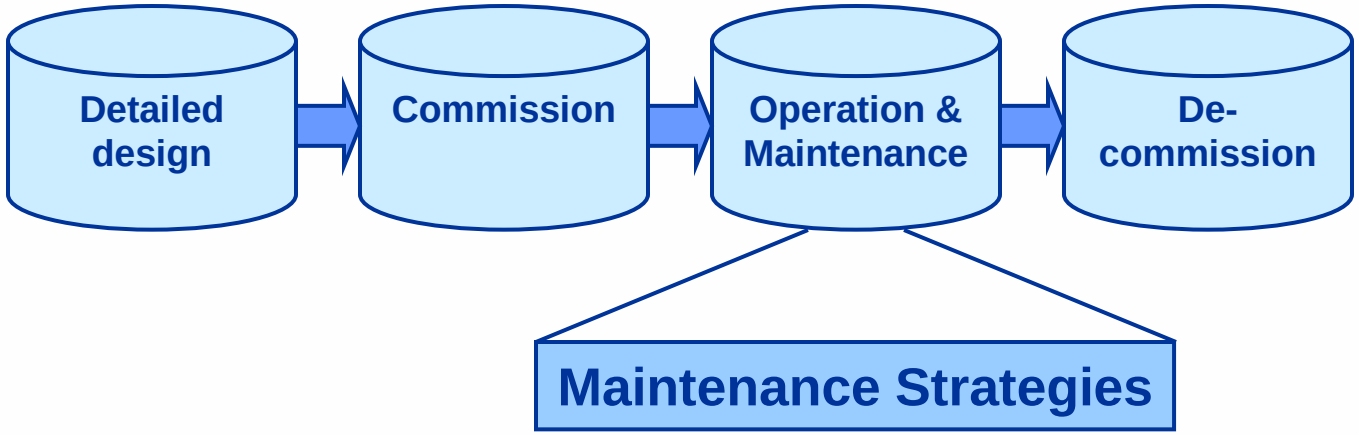
- **Total life cycle of assets**



  - **Must accommodate environmental impacts of assets**

- **Importance of Objective**
  - **To ensures a company's environmental credibility is acceptable to all its stakeholders**

Prior work in this field

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- **Literature review**
  - Maintenance strategies do not make provision for environmental impacts of assets during maintenance cycles
  - Absence of environmental considerations in design of the life cycles of assets
- **Limitations and key assumptions of this research**
  - Do not want to change Maintenance Strategies or redefine them
  - Do not change the life cycle phases of assets

- **Integrate LCM into Maintenance Strategies and Asset Life Cycles to optimize the environmental performance of assets**

Research approach

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- Case Study approach in the Process Industry of South Africa
- Maintenance Management environment and evaluate the current state of strategies towards environmental impacts of assets
- Recommendations and best practices will be proposed to be implemented in process industries

Maintenance Strategies

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- **Run-to-failure**
  - Run asset to failure and then repair it
- **Preventive Maintenance**
  - Fixed interval (repair, overhaul, replace) regardless its condition at that time
- **Predictive Maintenance**
  - Measure condition to assess when it will fail and take action to avoid the consequences of failure
- **Proactive Maintenance**
  - Monitor and correction of root causes to asset failures

Life Cycle Management of Assets

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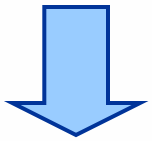
- **Classic definition of Life Cycle Management (LCM)**
  - Considers the product life in a holistic way with the aim of achieving maximum product performance



- **Therefore, with respect to assets**
  - Considers the asset life in a holistic way with the aim of achieving maximum asset performance

- **From the perspectives**
  - Optimal cost
  - Maximised environmental performance
  - Social beneficiation

New integrated Asset Life Cycle Management model

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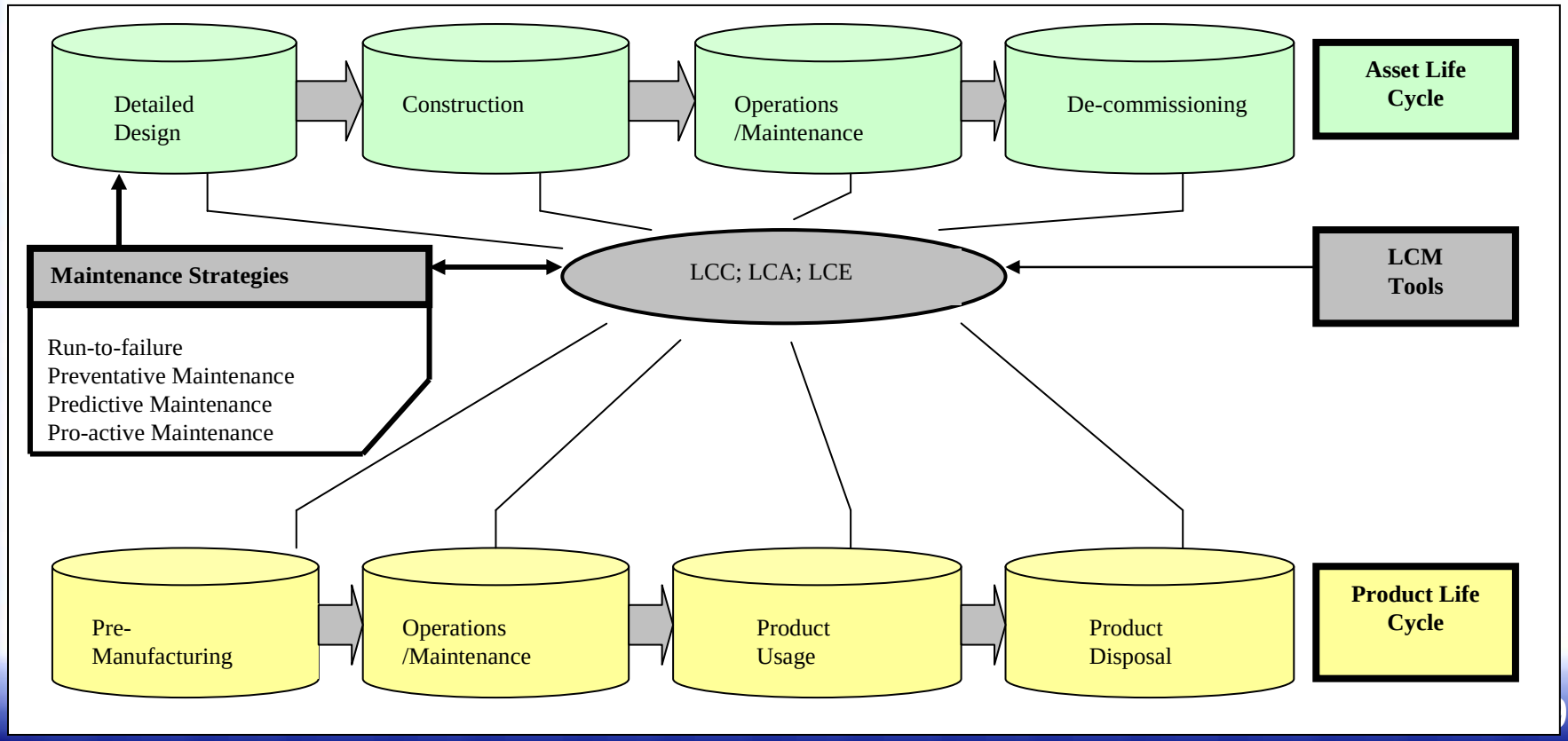
Future Requirements	(Holistic Optimisation)
Efficiency	(Cost)
Safety	(Products, Consumers and Industrial Safety)
Environmental Soundness	(Raw materials, Fuels, Emissions, Waste)



Case study 1:
Surface Bed Cracking

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- **Major Problems:**
  - No maintenance strategy was followed
  - LCM tools were not incorporated into the design phase of the life cycle of the asset
    - Reconstruction of slabs where expansion joints should have been
- **Safety:**
  - All cracks resulted in tripping hazards in the area
- **Efficiency:**
  - No maintenance resulted that slabs could not be repaired and had to be demolished

Case study 1:
Surface Bed Cracking

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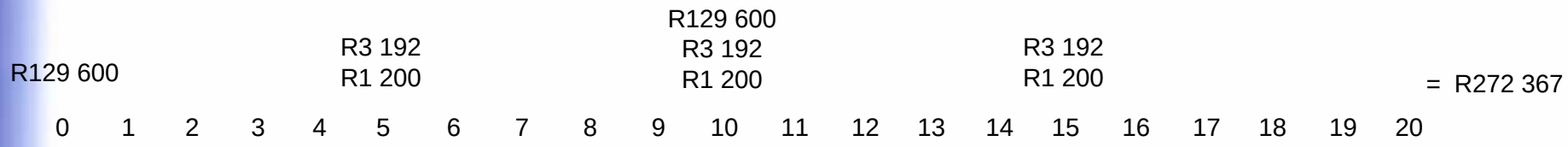
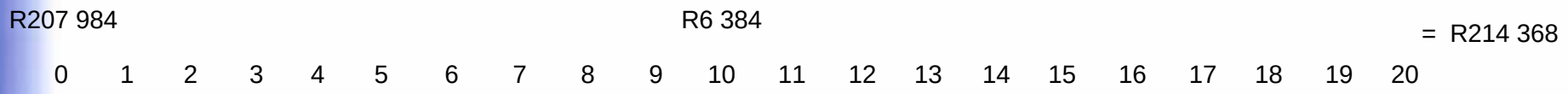
EXISTING SLAB: (6m x 6m)

Construction Cost : R3600 x 36m^2 = R129 600.00
Construction Joints: R133/m x 24m = R3 192.00
Crack Sealing: R100/m x 12m = R1 200.00



REHAB SLAB: (3m x 3m)

Construction Cost : R5 600 x 36m^2 = R201 600.00
Construction Joints: R133/m x 48m = R6 384.00



$\therefore$ R214 368 / R272 376 = 21% $\longrightarrow$

Costs are shown in present South African Rands: 1 AUD = 4.7 ZAR

Case study 2:
Relining of an evaporation pond

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- **Major Problems:**
  - Maintenance strategy was run-to-failure
  - The sludge in the pond could not be removed without damaging the liner
  - The old design had a herringbone system underneath the liner
    - Constructed in the soil

Case study 2:
Relining of an evaporation pond

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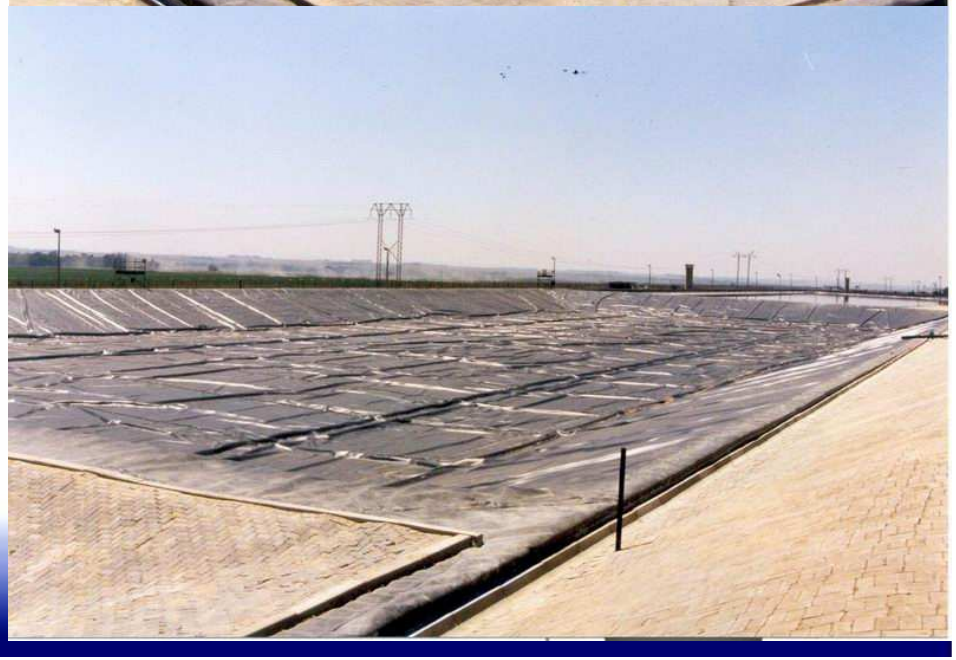
- **Safety:**
  - Vacuum of sludge out of pond
    - Dangerous working environment
- **Efficiency:**
  - No maintenance could be done on the liner
    - Due to sludge built up
  - Could not remove sludge without damaging the liner
  - Leaks in the liner could only be traced when entering the herringbone



Case study 2:
Relining of an evaporation pond

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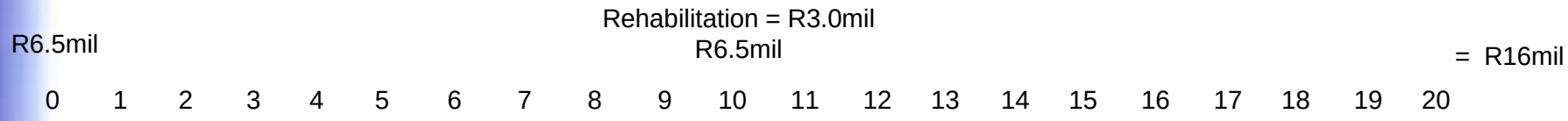
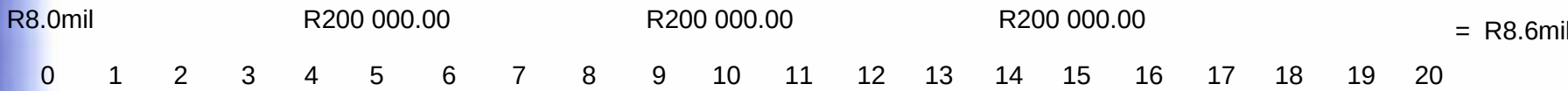
OLD DESIGN:

Construction Cost : R6.5mil
Rehabilitation Cost: R3.0mil



NEW DESIGN:

Construction Cost : R8.0mil
Clean-out cost for basin : R200 000.00



$\therefore$ $\frac{\text{R8.6mil}}{\text{R16mil}} = 46\%$ $\longrightarrow$

Costs are shown in present South African Rands: 1 AUD = 4.7 ZAR

Optimized Maintenance Strategies

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Proactive Maintenance →

- Focus on the most cost-effective way to manage the failure mode of an asset
- Be more proactive in terms of environmental risks
- Design cost will initially be higher but the LCC for the total life cycle of the asset will be lower.

Predictive Maintenance →

- Focus on the most cost-effective way to manage the failure mode of an asset
- Predict environmental risks
- Design cost will initially be higher but the LCC for the total life cycle of the asset will be lower
- Predictive measures will be designed into the asset from the beginning of the asset life cycle

Conclusions

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- Maintenance Managers and environmental experts have input into design
  - Cost may initially be higher but life cycle cost will be lower over total life cycle
- More strict legislation
  - “green products”
- The model ensures
  - Maintenance Strategies + LCM tools = Long term sustainability of assets & Lower total life cycle cost
- Therefore
  - Give a holistic view of assets’ environmental performances, safety and efficiency from design phase to disposal phase
    - Cradle-to-grave principle

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Closure and (limited) questions