global Transport Knowledge Partnership

Southeast Asia Community Access Partnership **SEACAP**

LOW VOLUME ROADS WORKSHOP
Napier, New Zealand, July 2009

Eco-roads & Rural Road Surfacing Solutions

Part 1 - Developing Regions Perspective

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REAAA
Driving Progress

Our Problem

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The Road Transport sector is 'hooked' on cement and bitumen for road infrastructure construction.

Cement and bitumen are capital, energy & transport intensive products contributing substantially to the global greenhouse gas problem. Globally, >100million tons of bitumen are used each year, mostly in the road sector.

World Bank estimates that globally over a **billion** poor people lack all-weather basic access. We need to find alternative low-cost, local resource-based, environmentally friendly, sustainable ways to connect these people and develop the national road networks.

The Urgency

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The price of oil has recently dropped from about US$147 per barrel to about US$60 per barrel.

This is a temporary respite. The natural output from the world's oilfields is declining faster than previously thought. The temporary downturn in demand due to the current widespread recession will give way to renewed pressure on global fossil fuel resources and 're-ignite' energy prices in the medium term future.

We **urgently** need to tackle both the challenges of global warming and basic access for the rural poor.

The Context

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Presentation focuses on developing country experiences

Important to remember the fundamental differences in operating environment, e.g.:

- Labour wage rates maybe US$1 – 10 /day
- Expensive credit
- Problems of supporting sophisticated equipment

Hence solutions usually need to be very different.

Things can only get better?

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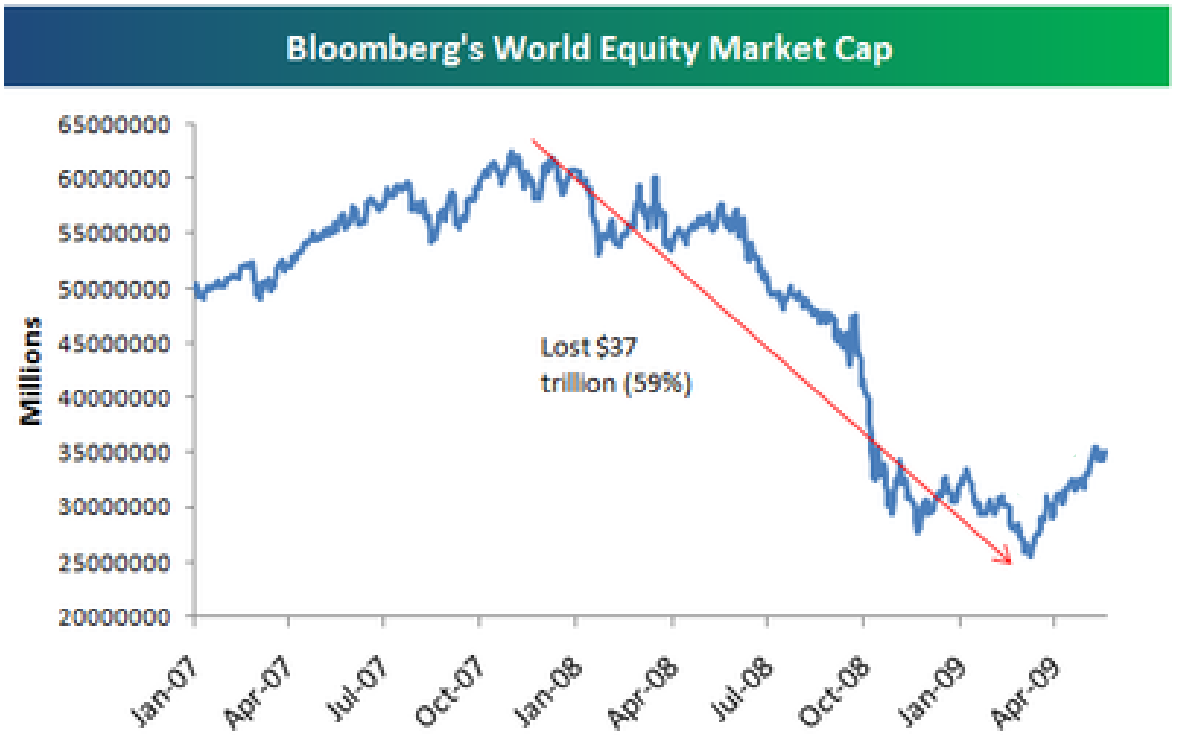

‘External’ Challenges

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- Global Economic Crisis – ‘wealth’ destruction
- Availability and cost of credit
- Energy set to cost more
- Demands for reduction of carbon footprint
- Availability of certain materials
- Poverty reduction and social cohesion
- Up to 85% of networks unpaved
- Productive employment creation

'Internal' Challenges

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There are a number of improvements we can make within the sector to achieve more eco-friendly, affordable and sustainable rural transport systems for developing regions:

- **More intelligent use of current technologies**
- Development of locally sourced, sustainable, binders and sealers

Action: Basic Access for all

In some regions less than 15% of roads are paved

Basic Access can be achieved with low-cost initiatives to ensure reliable, all-season passability for the local prevailing transport means.

In many locations the natural earth surface (ENS) can provide a motorable Basic Access surface, if it is shaped to shed rain water to each side, maintained, and simple culverts or drifts are built where water needs to cross the road.

Certain 'problem' sections of the route may require low cost, 'spot improvements'.

Action: Spot Improvement Strategies

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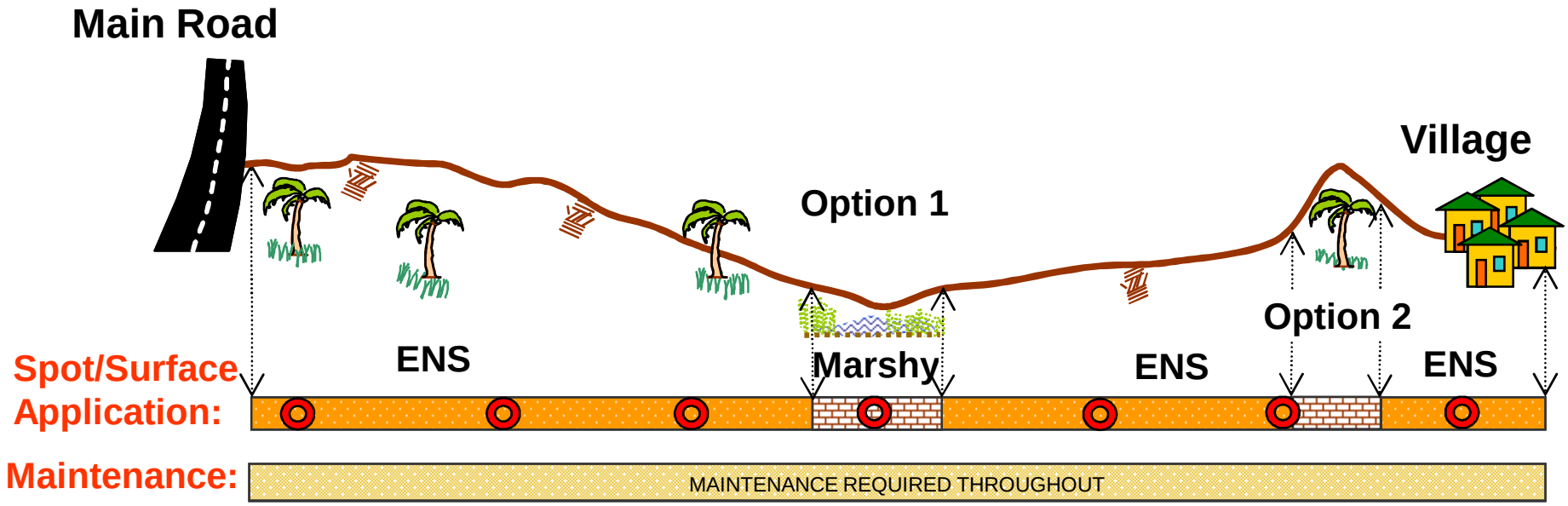
Problem sections on earth roads (e.g. weak soils/dust/ hill/swamp/drainage/erosion) should be tackled using a wide range of proven low cost, labour based spot improvement options & low cost structures.

Spot improvement strategy

Example application over a typical rural route



Low Cost Structure or culvert

Surface Options

Engineered Natural Surface (ENS) (Earth Road)

Maintenance

Action: Durable Surfaces & Paving

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Wide range of durable surface/paving options available for Low Volume Rural Roads.

Selection should be based on consideration of the factors shown on the next slide.

Local guidelines should be developed based on **Whole Life Costing** of the various feasible surface/paving options,

including realistic maintenance regime assessment.

Action: Durable Surfaces & Paving

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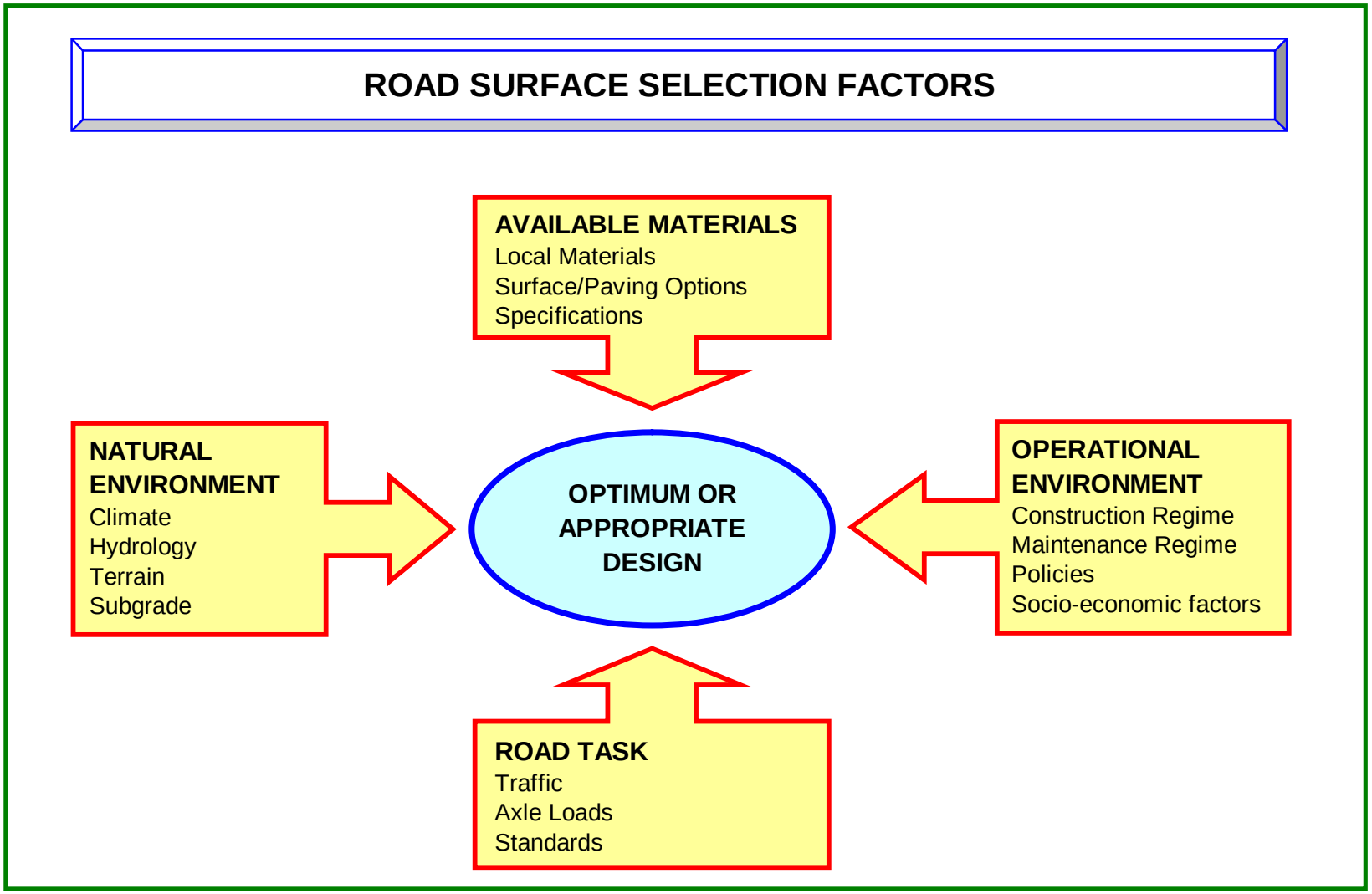

Action: Do not use Gravel Surface where:

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- **Gravel quality is poor** *(it should meet local durability, grading and plasticity specifications/recommendations)*
- **Gravel deposits are limited/environmentally sensitive**
- **Haul distances are long** *(suggest cost analysis for haulage >10km)*
- **Rainfall is very high** *(>2m/year),* **or dry season dust problems**
- **Traffic levels are high** *(more than 200 motor vehicles/day)*
- **Longitudinal Gradients > 6%**
- **Sub-grade is weak or soaked (flood risk)**
- **Compaction & thickness cannot be assured** *(bad quality control)*
- **Camber and side Drainage are not provided, or**
- **Adequate maintenance is not provided** *(on say >50% of network)*

Stone Paving

Natural stone can be used in a crushed or shaped form, for example:

- *Stone Macadam*
- *Cobble Stone Paving*
- *Pavé*
- *Dressed Stone*

Brick Paving

Burnt Clay Brick paving can be an important option in areas lacking hard stone resources, for example in delta regions. The clay can be fired to high quality bricks using small scale kilns and renewable energy sources, such as waste rice husk. Materials haulage can be minimized and local employment created in brick production for roads and building construction.

Bitumen Surfaces

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A range of surface and paving options is available using bitumen as a seal or binding material. They can be particularly suitable for labour based methods if emulsions are used. Techniques include 'chip' seals, sand seals, gravel seals, and bitumen macadams. The thin seals will require suitable pavement layers to be constructed between the road foundation and surface.

Concrete Paving

Concrete paving can be a high initial cost paving option. However this can be more than offset by Whole Life Cost benefits to make this a very attractive solution. It is possible to achieve very high quality, durable paving with high traffic carrying capacity, resistance to overloading and very low maintenance, using simple local building trade skills.

Paving may be in the form of incremental brick laid within restraining kerbs, or un-reinforced or reinforced slab. As with all surfacing/paving options, quality control is essential to ensure a good, durable, value-for-money investment.

Action: Standards & Specifications

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Many national rural road standards and specifications are inappropriate and unaffordable, e.g.:

- Desirable, but unrealistic
- Often based on conditions elsewhere
- Do not optimise local resource use
- Proven options often not included

Action: Effective Maintenance

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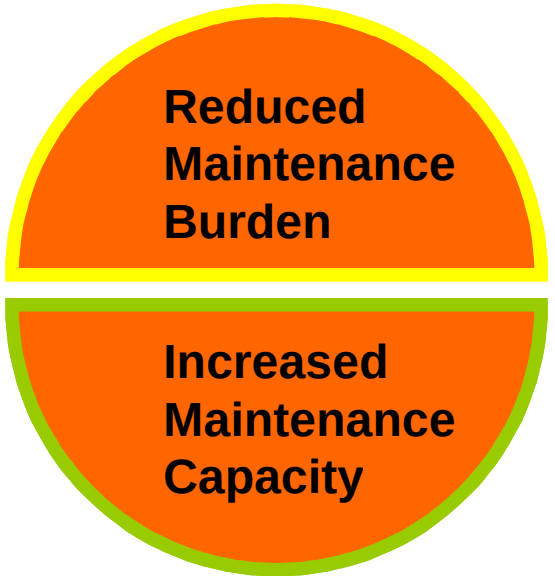
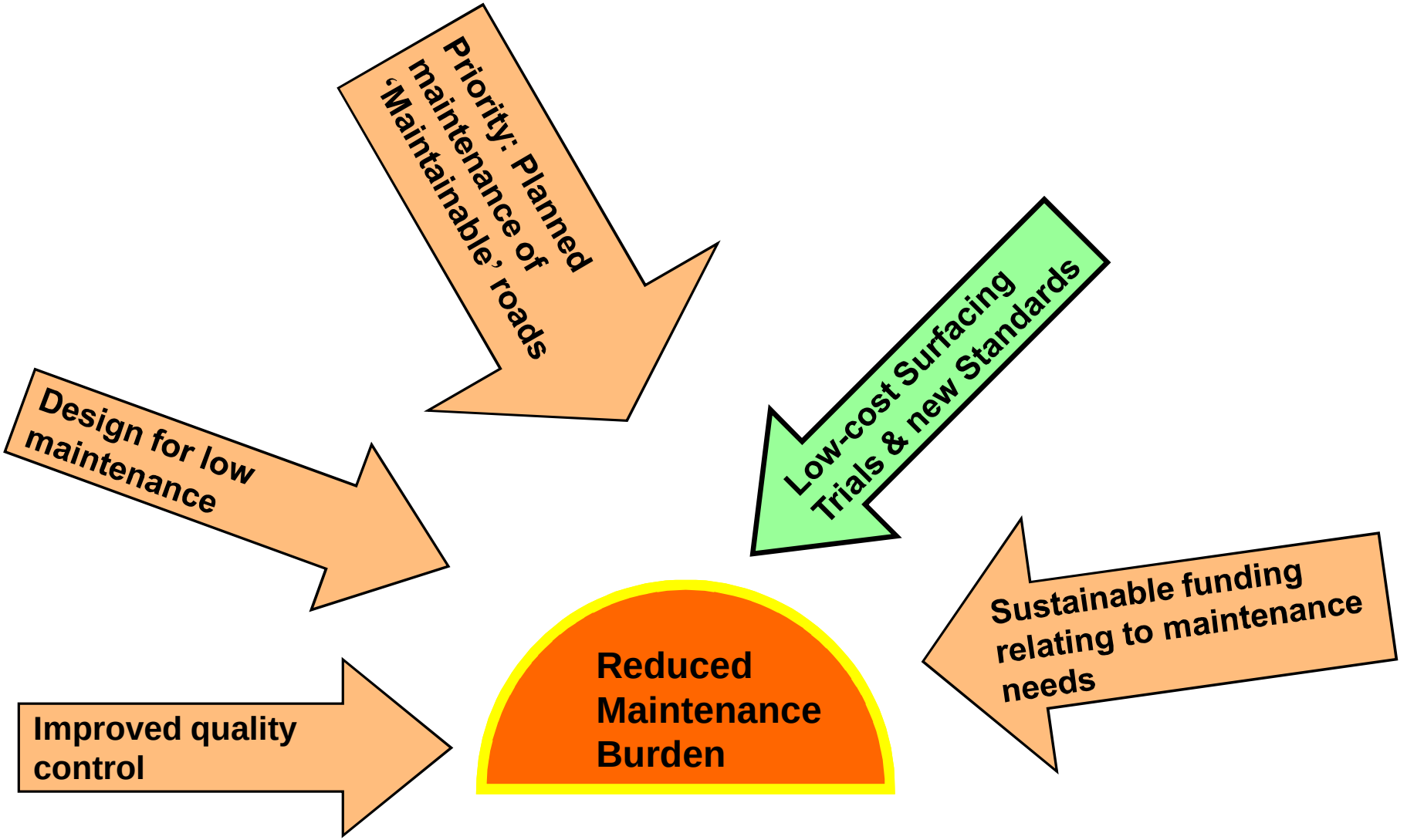
Start road design process with assessment of maintenance capacity

Improving Rural Road Maintenance



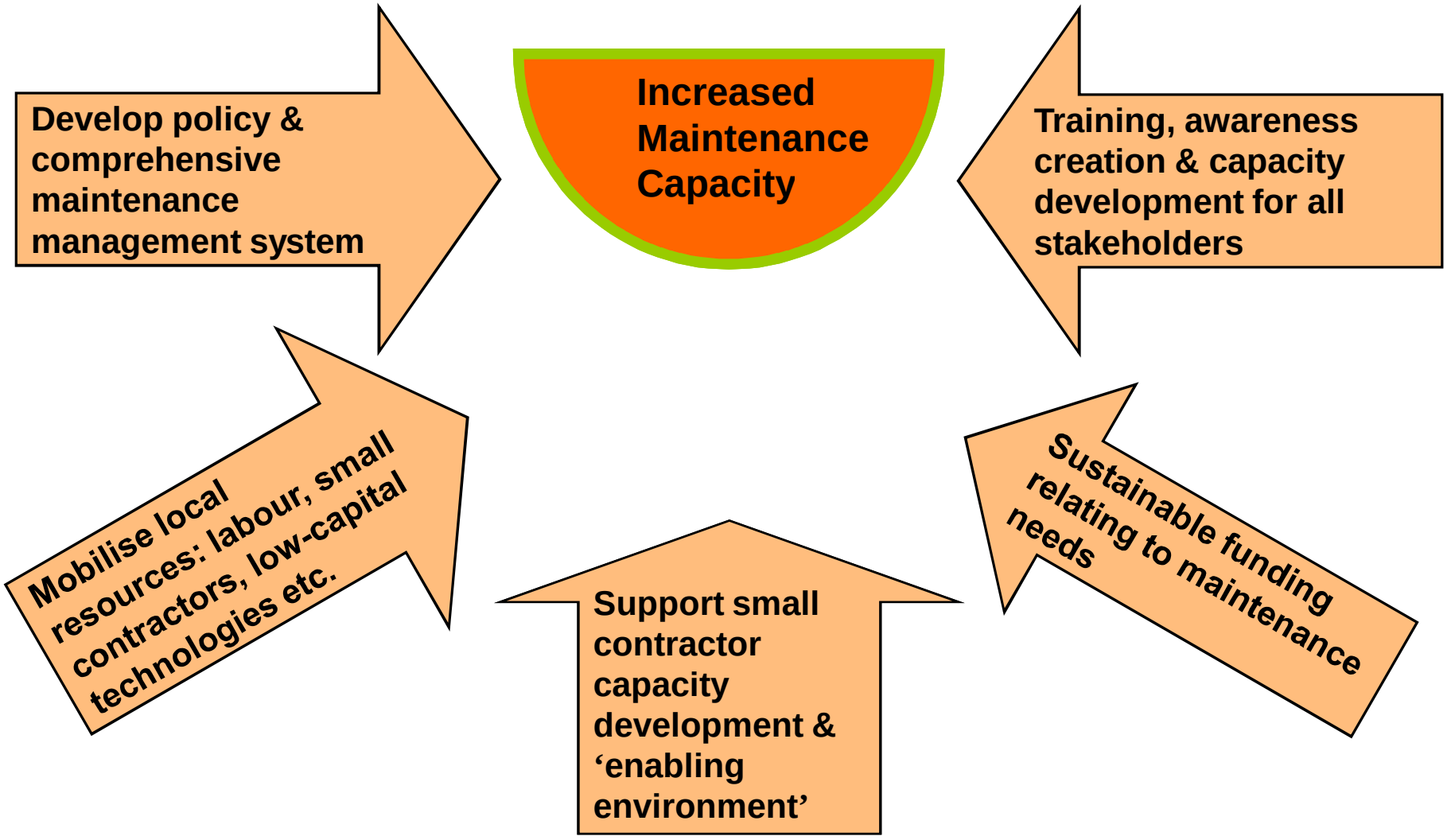
Improving Rural Road Maintenance

1 – By reducing the maintenance burden



Improving Rural Road Maintenance

2 – By increasing maintenance capacity



Action: Local Private Sector

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Special attention is needed to produce an 'enabling environment' for local enterprises in the face of:

- Weak policy on Small Enterprise development
- Biased contract documentation
- Poor access to & high cost of credit
- Late payment problems
- Irregular workload

Local markets are usually far from perfect and require intelligent 'enabling'.

Action: Mainstreaming Knowledge

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Problem: Poor uptake of available knowledge

- End point 'On the shelf' syndrome
- Lack of local research and knowledge review and adaption mechanisms
- Little demonstration of good practice
- Latest research not taken up in training and education
- Professional bodies weak

These constraints need to be tackled.

Action: Governance

The road sector is seen by many to be corrupt or opaque, e.g.

- Lack of transparency in contract award-management
- Lack of effective financial and physical audit mechanisms
- Little or no price or performance information available
- Do communities get value for money?

Action: http://www.gtkp.com/sectors.asp?step=4&typeOfPage=0&contentID=437

Summary: Internal Sector Actions

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- Basic access for all
- Spot improvement strategies
- Durable surfaces & paving
- Intelligent use of gravel
- Appropriate standards and specifications
- Effective maintenance
- Development of local private sector
- Mainstreaming knowledge
- Improved governance
- Development of eco- binders & sealers

Intelligent creativity

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By more intelligent and professional use of the available resources and technologies we could build AND maintain more, lower cost, more sustainable roads with the financial and physical resources currently available:

- Earth Road maintenance from US$500/km/year
- Earth Road Rehabilitation from US$2,000/km
- Paving from US$10,000/km

'Partnerships' could substantially reduce costs

However we need to be creative/inventive and look beyond our current 'comfort zone'

The way ahead

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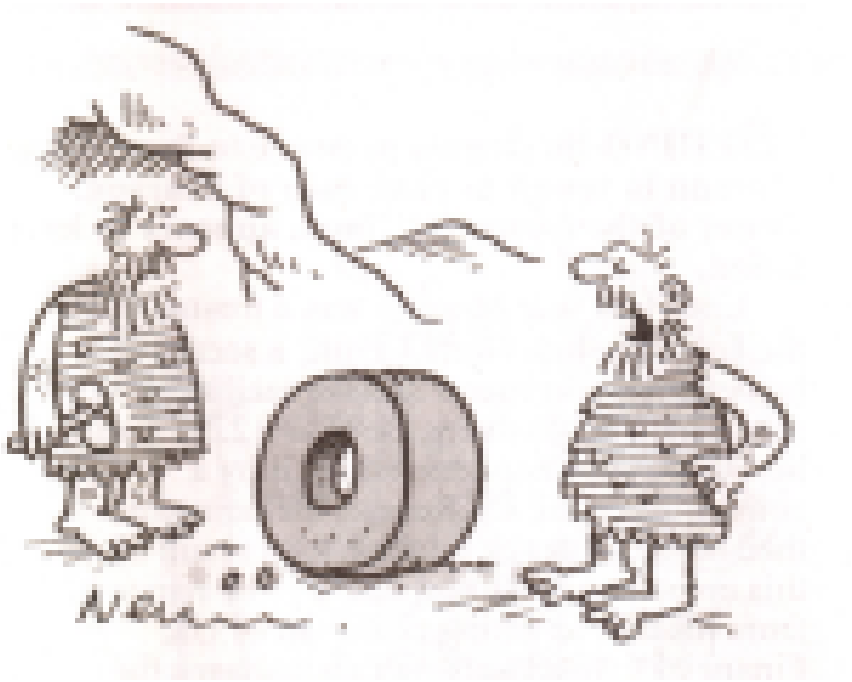

If it's not 'green', forget it!

Further Information

The following dissemination forums support Low Traffic Volume Rural Roads (LVRR) knowledge in the REAAA region:

global Transport Knowledge Partnership:

www.gtkp.com

SEACAP **Southeast Asia Community Access Partnership**:

www.seacap-info.org

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global Transport Knowledge Partnership

Southeast Asia Community Access Partnership **SEACAP**

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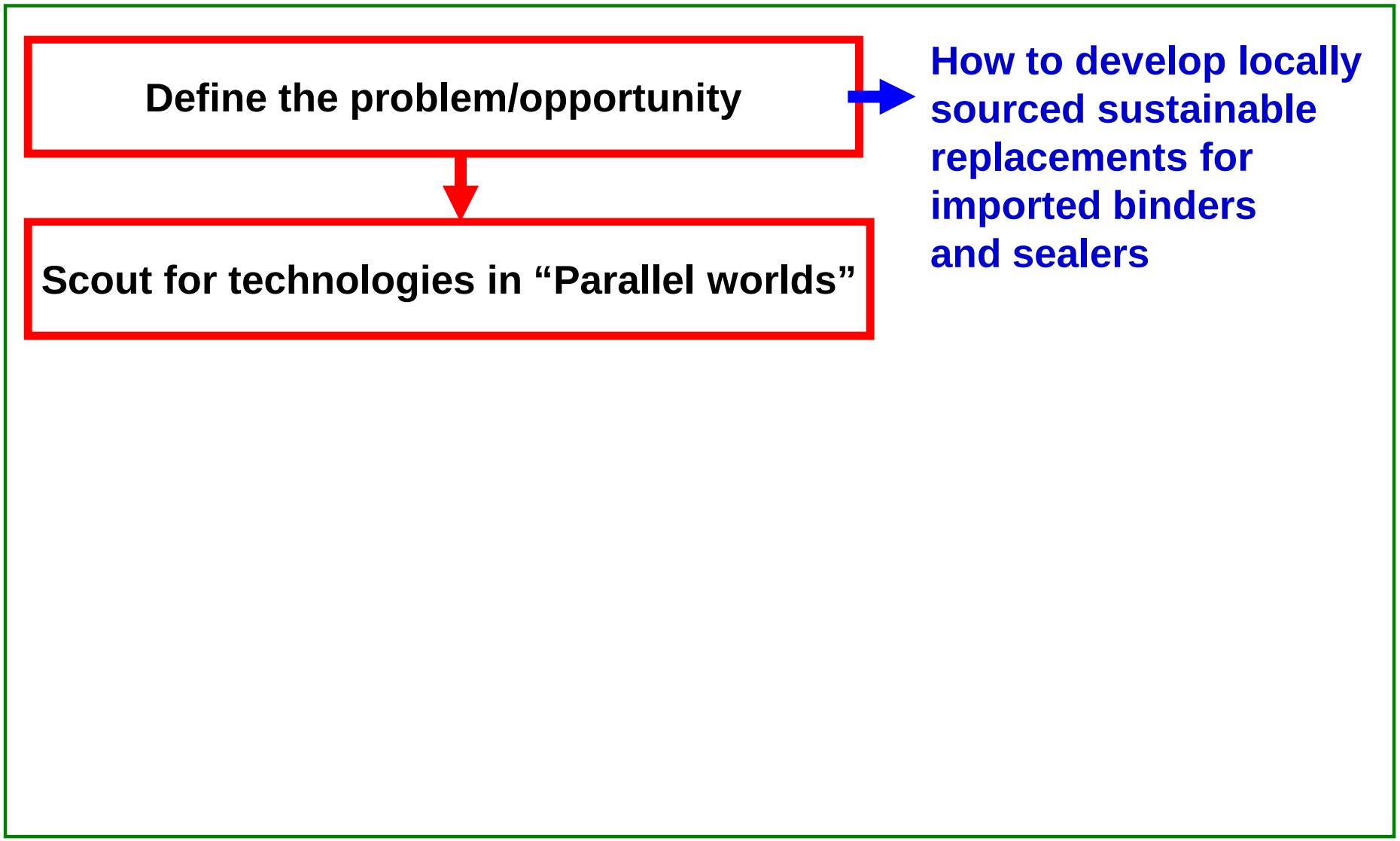
Eco-Roads & Rural Road Surfacing Solutions

Part 2: Alternative Technology Scan

Bob Lennox
Innovations Unlimited

Work Flow of Creative Approach



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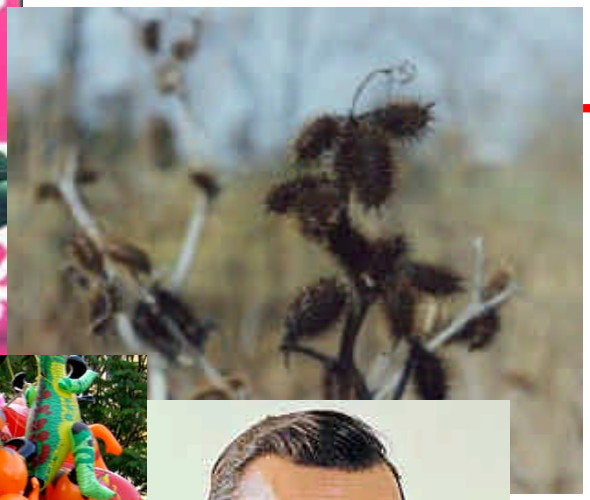
Parallel Worlds

Other Businesses Industries



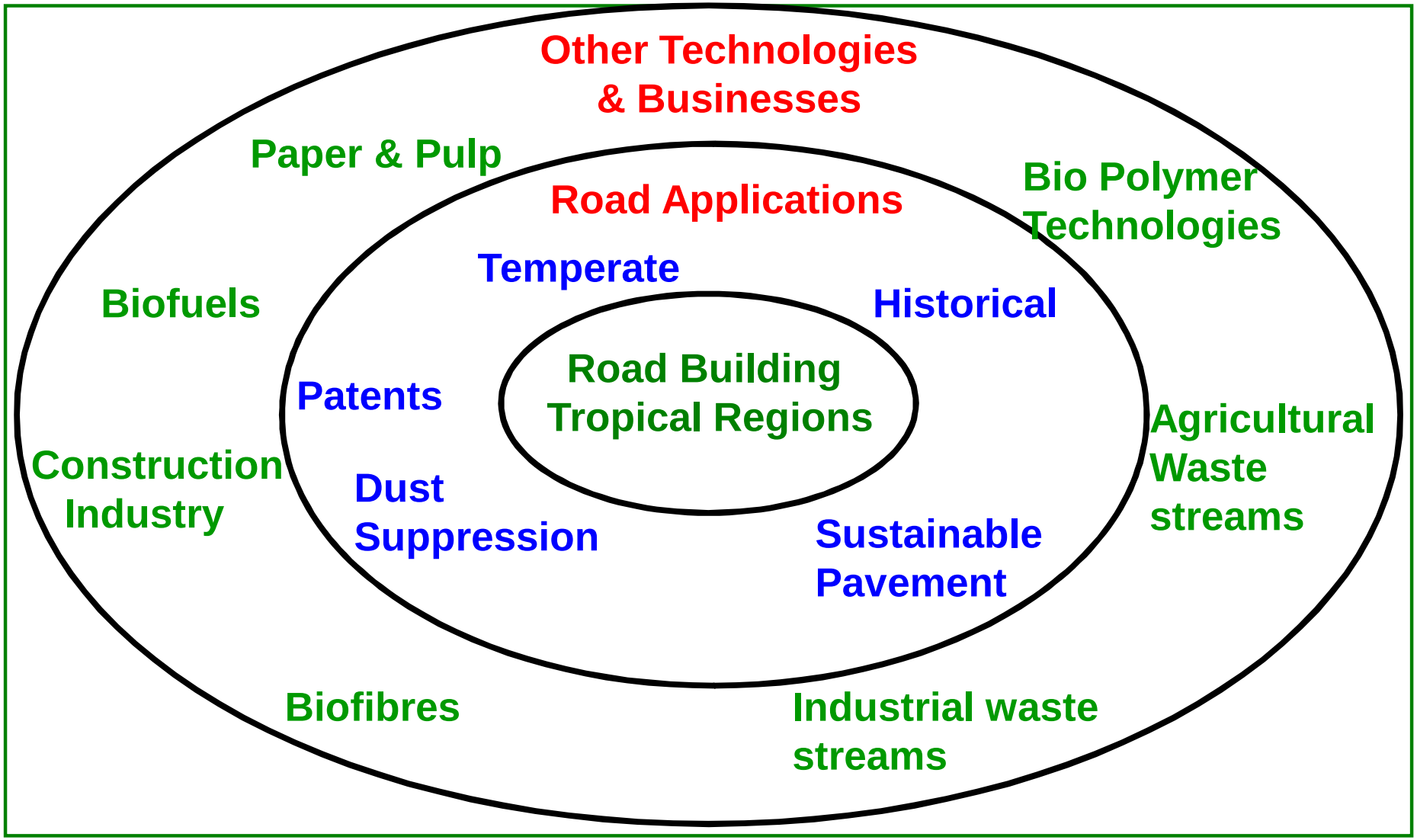
The World of Nature

Other Places

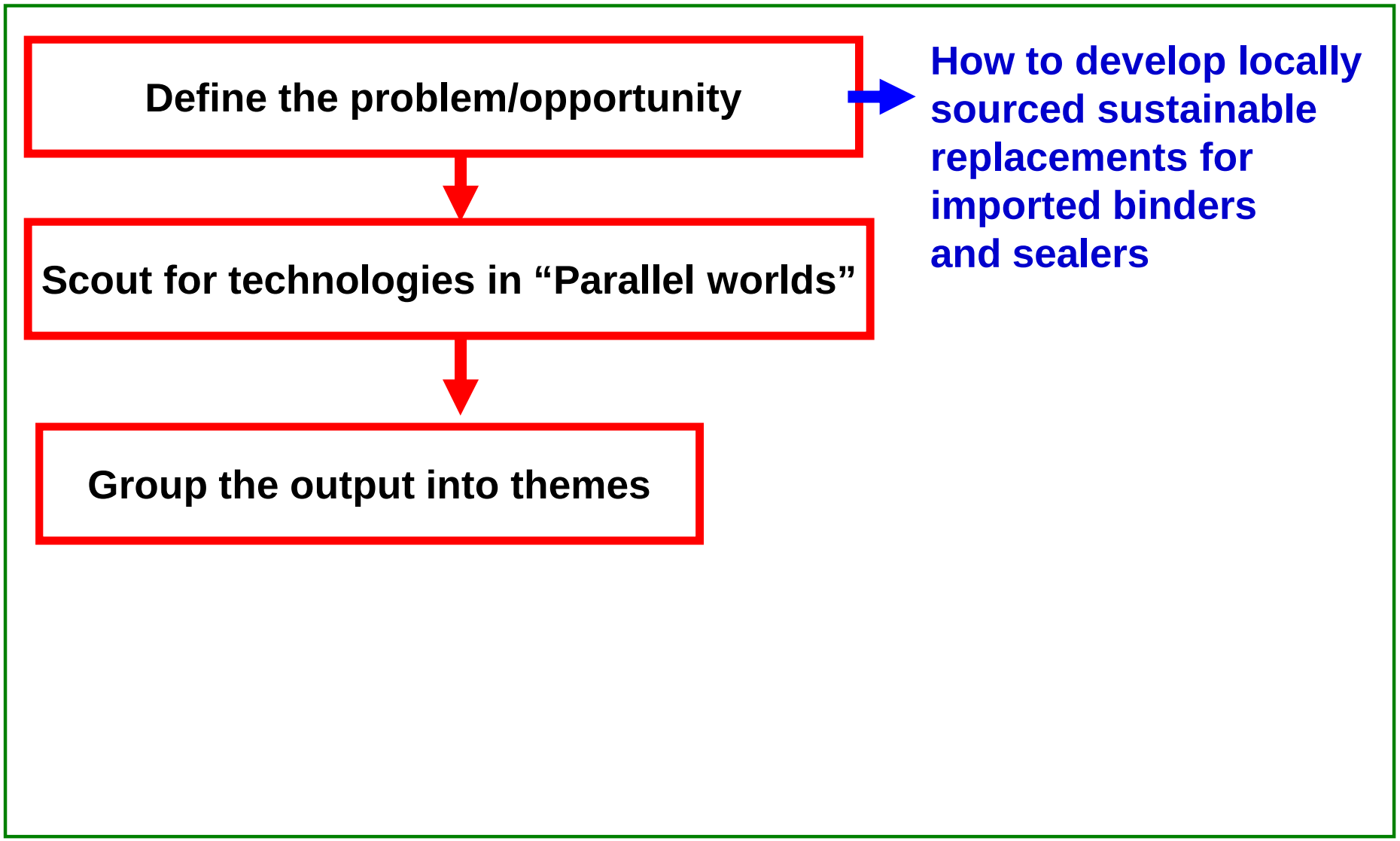
Other Environments, Characters

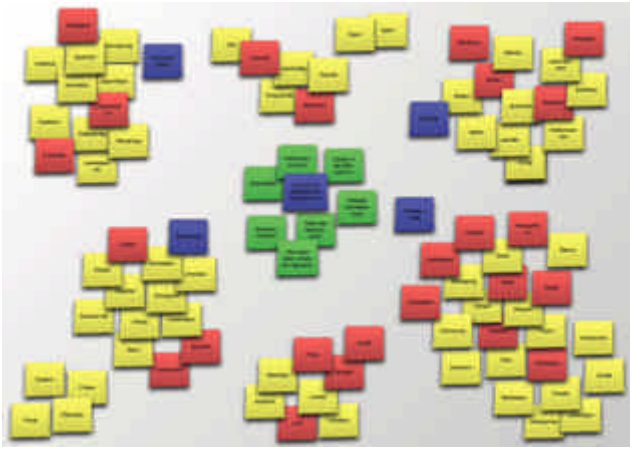
(Method: Stealing solutions)

Technology Scouting Strategy

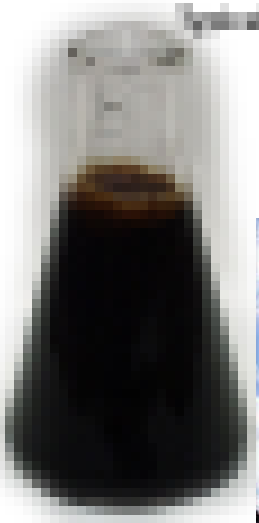


Work Flow of Creative Approach





Sort Into Themes



Themes & Inspiration

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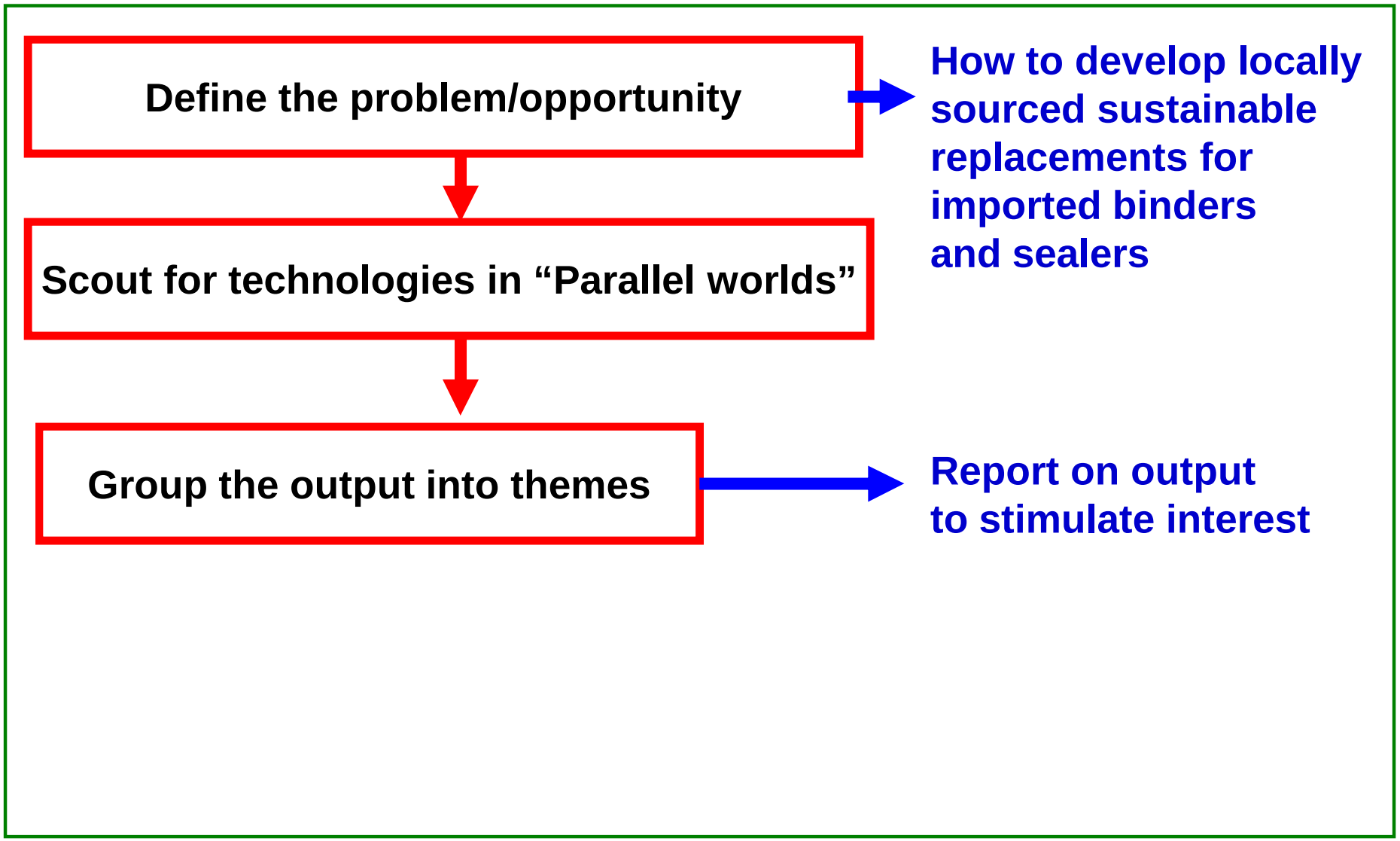
Raw Material Themes	Inspiration
Lignin from wood or palm	Paper & Pulp Industry
Lignin Derivatives	Pulp waste streams
Structured Lignin (patent)	Paper Research
Fibrous Lignin	Agricultural waste, Biofuels
Lignin + Tall Oil, Pine Resins	Dust suppression NA
Drying Oils + biomaterial blends	Paint technology
Non food oil, Jatropha, Castor	Biofuels, lubricating oils
Polymerisation, Polyols	Bioplastics
Oils + Rosin+ catalysts	Sustainable pavements
Pozzolanas and Ashes	Roman Cement
Rice Husk Pozzolanas	Cambodian road trials
Other crop waste ashes	
Slags and Ashes	Construction industry

Work Flow of Creative Approach



Stabilisation

- **Crop Residue Pozzolanas**
  - Known Technology
  - Global potential 26 million tonnes from rice husk alone
  - By product of renewable energy, brick making etc
- **Lignin Sulphate and Sulphonate**
  - Waste products from the paper industry
  - Lignin is the second most abundant biopolymer on earth
  - Proven in USA: equal strength to asphalt concrete achievable
  - Needs sealing, lignin sulphonate is water soluble

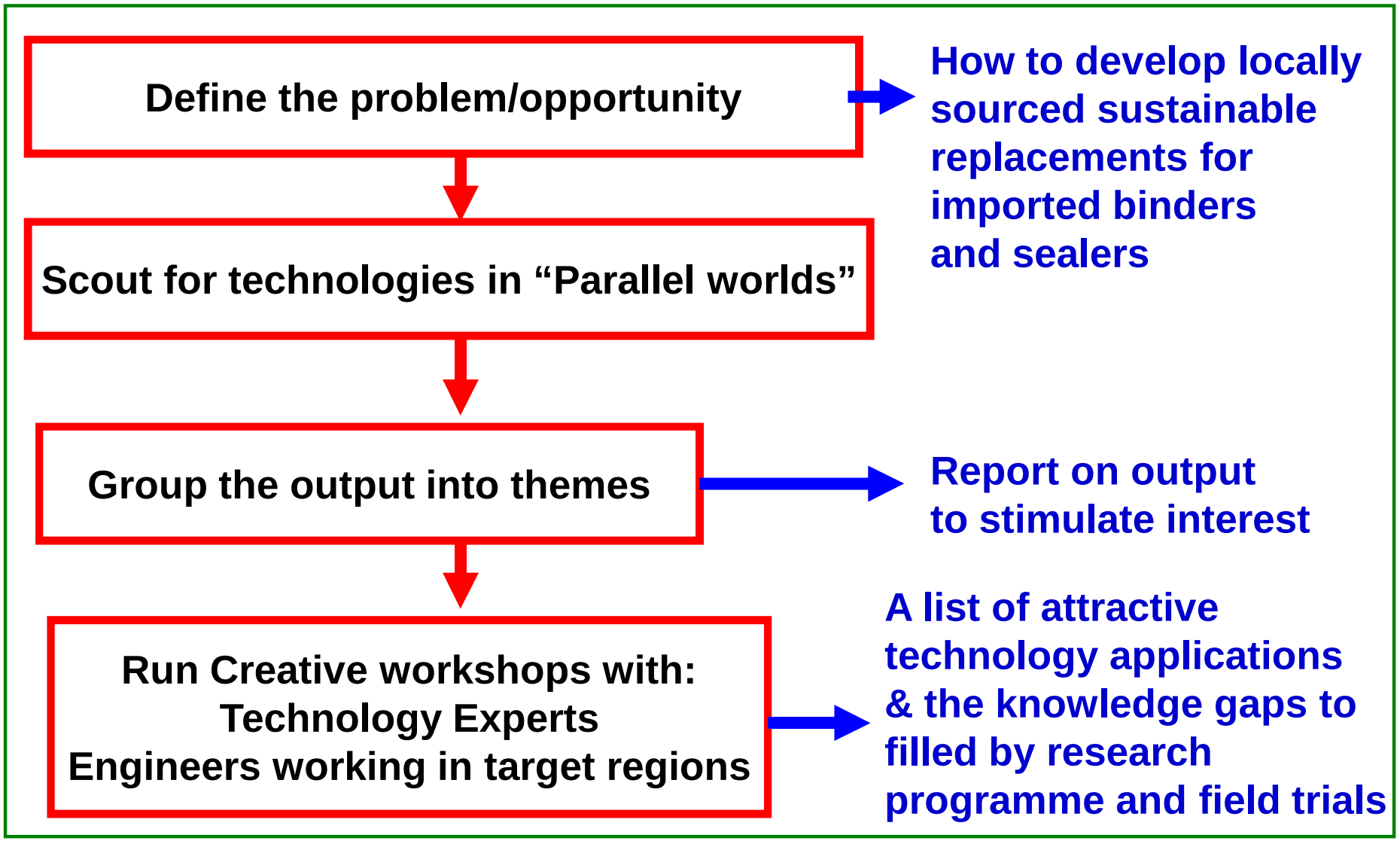
Stabilisation

- **Geotextiles from plants: Lignocellulose**
  - **Bamboo, Sisal, Coir, Bagasse, Hemp, Maize and Corn Stover all have potential for base or surface stabilisation**
  - **They contain fibres of the worlds most abundant natural raw material: 20,000,000,000 tonnes per annum**
  - **Natural fibre reinforcement of cement based mixes has been trialled in road structures and house building**
  - **Need to establish specification range and optimal combination with other materials**

Sealing

- **Polymerised plant oils**
  - Ideally non edible oils such as Jatropha and Castor
  - Grown on marginal land
  - Polymerisation (Paint) technology well understood
  - Adhesive strength/wear issues
- **Oil, resin and biomaterial blends**
  - Patent history of pitch, rosin and oil mixtures in waterproof pavements
  - Modern examples are Vegecol from Colas and Ecopave Australia
  - Challenges will be the use of low cost technology and local materials

Overview of Creative Approach



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Next Steps

- **Funding!**
  - To support a series of regional technology workshops which will generate ideas for road applications focussed on those regions
  - In order to fund the research and trials programmes which will bring pilot schemes for the applications into action
- **We need participation**
  - We need help from the road engineering community to join these creative sessions and help build the ideas and challenges for the future

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