An Integrated Asset Management Approach to Unconventional Oil Natural Assets

(Venezuela Case Study)

José Luís Ortiz Volcán

Landmark

Drilling and Evaluation Division

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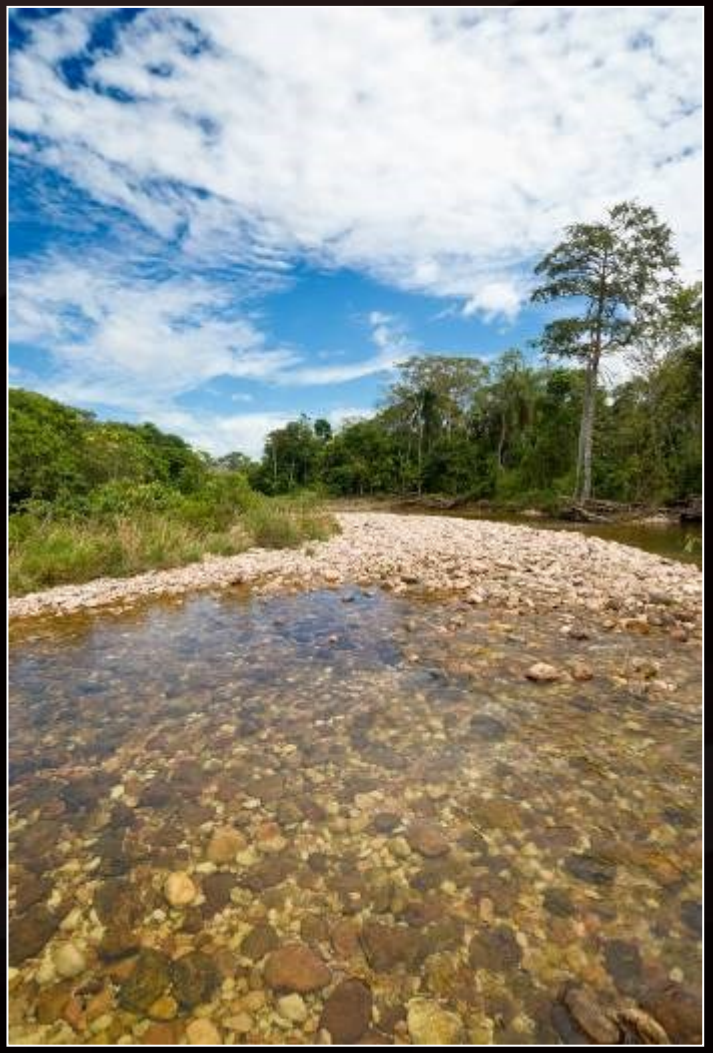
Agenda

- Life-Cycle Perspective
- Economics and Deliverability Challenges
- Existing Complexities and Risks
- Green Asset Operations and Products
- Supply Chain
- Closing Remarks



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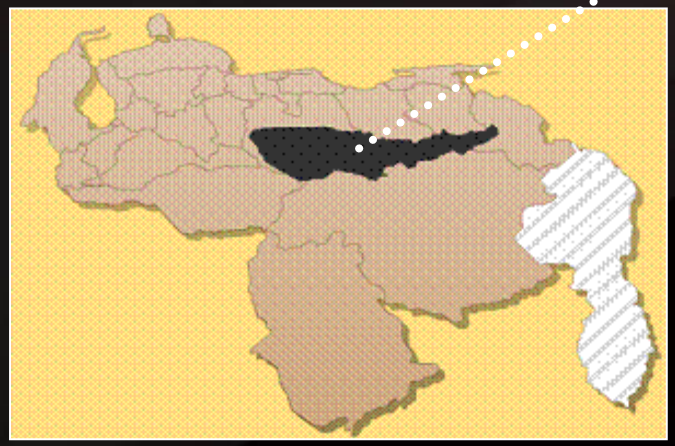
Life Cycle Perspective

Reservoir Characteristics - Oil Properties

1.3 Trillion Bbl OOIP
216 Billion Bbl Reserves
(undergoing reserves certification)



Orinoco Oil Belt (OOB)

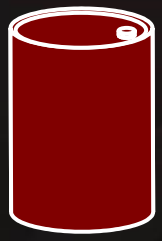
Depth, ft	1,000 – 3,500
Sand Thick., ft	50 – 300
Porosity, %	30
Permeability, Darcy	5 – 20
Temperature, °F	110 – 130
API Gravity	7.8 – 9.8
Viscosity, cst. a 122 °F	2,000 – 10,000
Vanadium, ppm	300 – 500
Nickel, ppm	120
Sulfur, %w	3.5 – 4.0

Sources: 1) http://www.camarapetrolera.org/eventos/presentaciones_crudos_pesados_2008/12_02_08/luis_vierma.zip, 2) 7th UNITAR Conference, Beijing, October 1998 – I. Layrisse and J. Chacín: The Impact of Technology in the Development of the Orinoco Belt. Results and Future Trends

Life Cycle Perspective

Unique Business Model: The Planned Energy Complex

55,314 Km²
4 Areas - 28 Blocks
Companies from 21 Countries



Raw Oil + Water Molecular Transformation → **Synthetic Crude**

34,000 Jobs by 2012

Energy

- Refining products
- Synthetic gas
- Super-clean fuels
- Green Chemicals
- Power Plants

Industrial Infrastructure Goods and Services

- Housing and Roads
- Agriculture and Food
- Construction and Engineering
- Schools and Universities
- Hospitals
- Sports and Culture

Source: Adapted from PDVSA presentations – 1) http://www.camarapetrolera.org/luis_pulido_pdvsa_industrial_150408.zip & 2) http://www.camarapetrolera.org/eventos/presentaciones_crudos_pesados_2008/13_02_08/eulogio_del_pino.pdf

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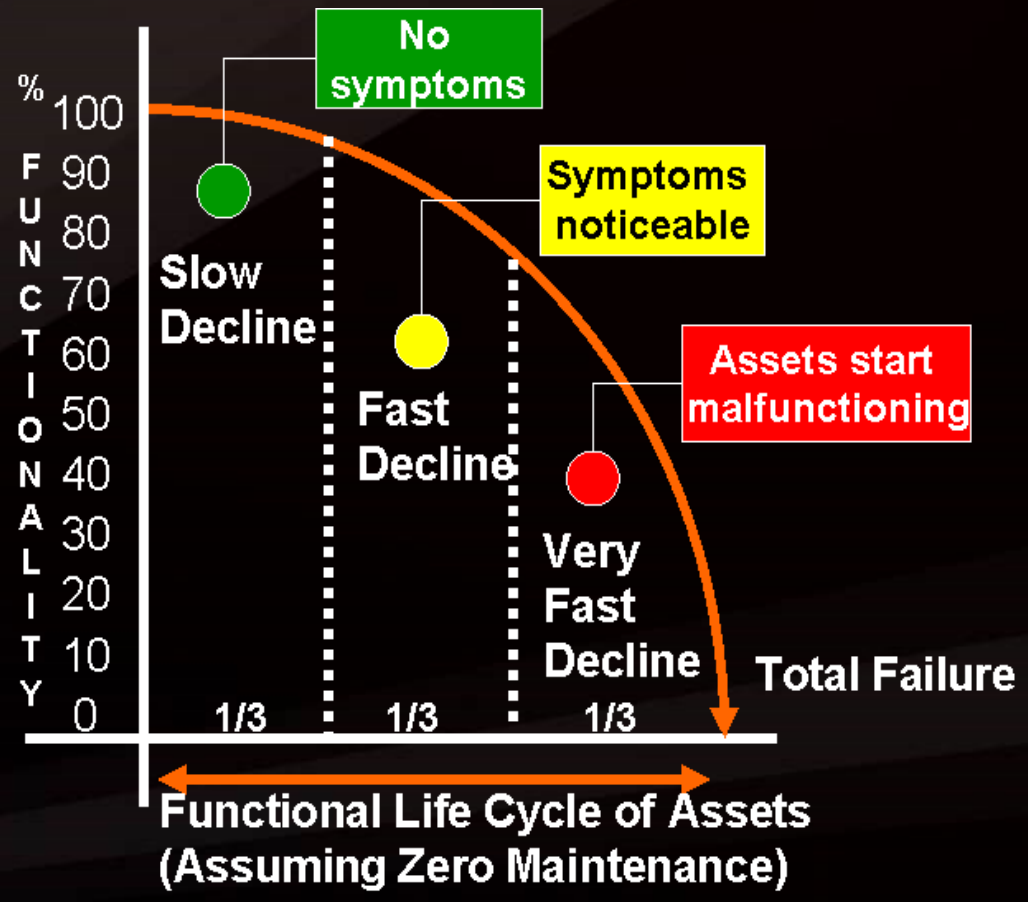
Life Cycle Perspective

Reliability – Key to Future OOB Developments

Design for high reliability performance



Source: Adapted from KC Leong, 2004 – The Essence of Asset Management – A Guide – UNDP Malaysia, EAROPH & APIGAM

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Life Cycle Perspective

25 Years of Upstream Technology Innovations

Year	Technologies	Barrels/Day/Well
1980-1985	Vertical Wells Pumping Optimization	100-400
1990-2000	1,500-ft Horizontal Well ESP, PCP and Multiphase Pumps, Multilateral Wells	600-2,500
2005	Well Construction and Fluids Optimization	2,000-3,500

Up to 12% Recovery

Source: http://www.camarapetrolera.org/eventos/presentaciones_crudos_pesados_2008/13_02_08/hercilio_rivas_intevep.pdf

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Life Cycle Perspective

Technology Life Cycle – Many Options

Technology	Life Cycle Phase	Impact	Local Experience
Steam flooding	Mature	RF 30% to 50%	Yes
Steam Assisted Gravity Drainage	Commercial	RF 60% or more	Yes
In-Situ Combustion	Commercial	RF 55% to 65%	Yes
Solvent Assisted Gravity Drainage	Pilot	RF 60% or more	Yes
Downhole Heating with Electricity	Commercial	Productivity	Yes
Multilaterals	Commercial	Productivity	Yes
Pressure Pulsing Technology	Commercial	Productivity	No
Cold Heavy Oil Production with Sand	Commercial	RF up to 20%	No

Source: Adapted from NPC Global Oil and Gas Study - (www.npc.org)

Economics and Deliverability Challenges

Upstream, Midstream and Downstream

- Achieve recovery factors 20% or above and higher well productivity
- Sustain oil production for 30+ years and optimize life-cycle cost (CAPEX + OPEX)
- Lower operating costs without compromising safety and reliability
- Develop highly efficient upgrading and refinery processes

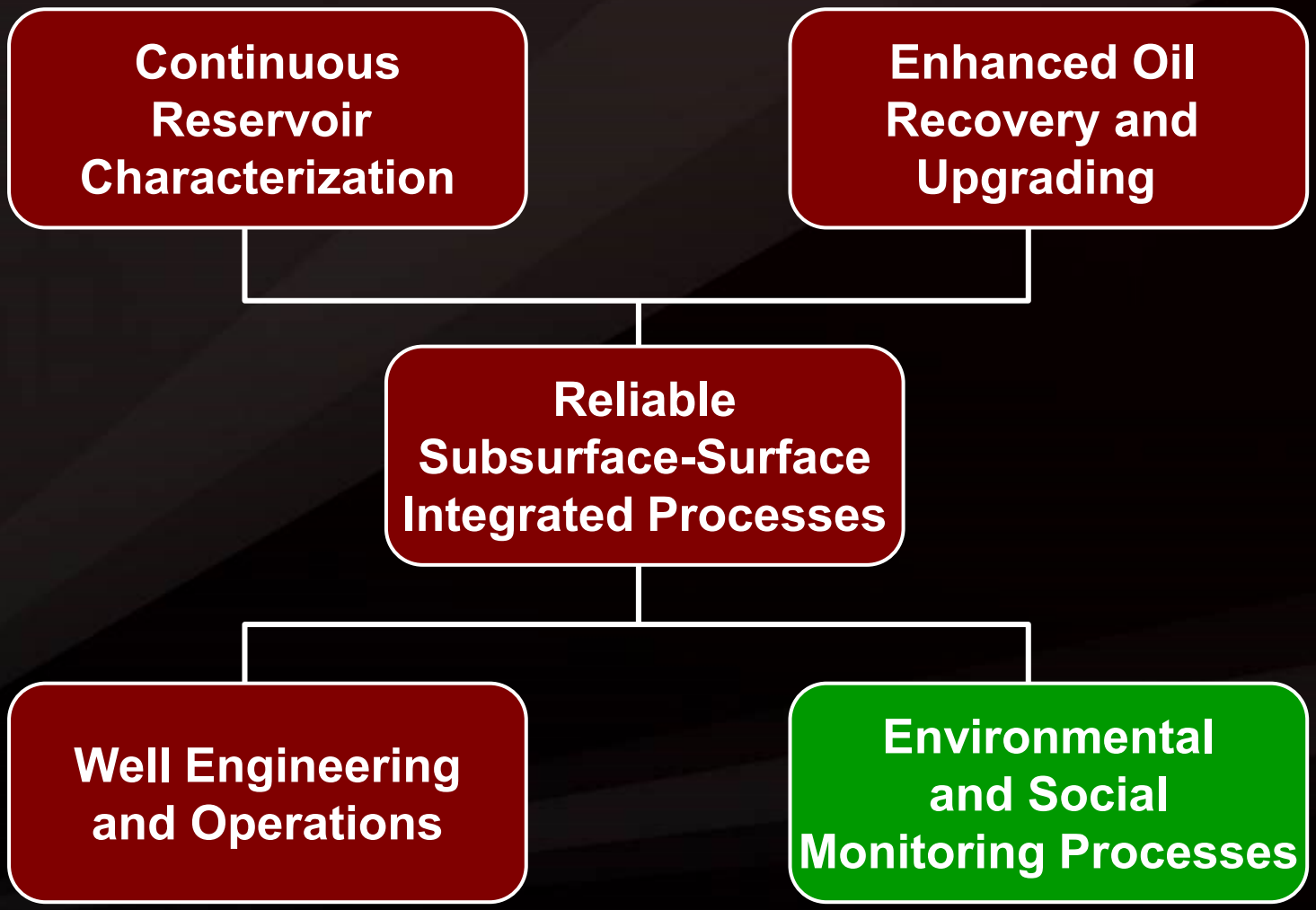
Economics and Deliverability Challenges

Upstream, Midstream and Downstream

- Creation of a cycle where carbon dioxide is sequestered for oil enhanced recovery
- Use gasified coal instead of natural gas
- Development of key competencies

Economics and Deliverability Challenges

Subsurface-Surface Integrated Processes



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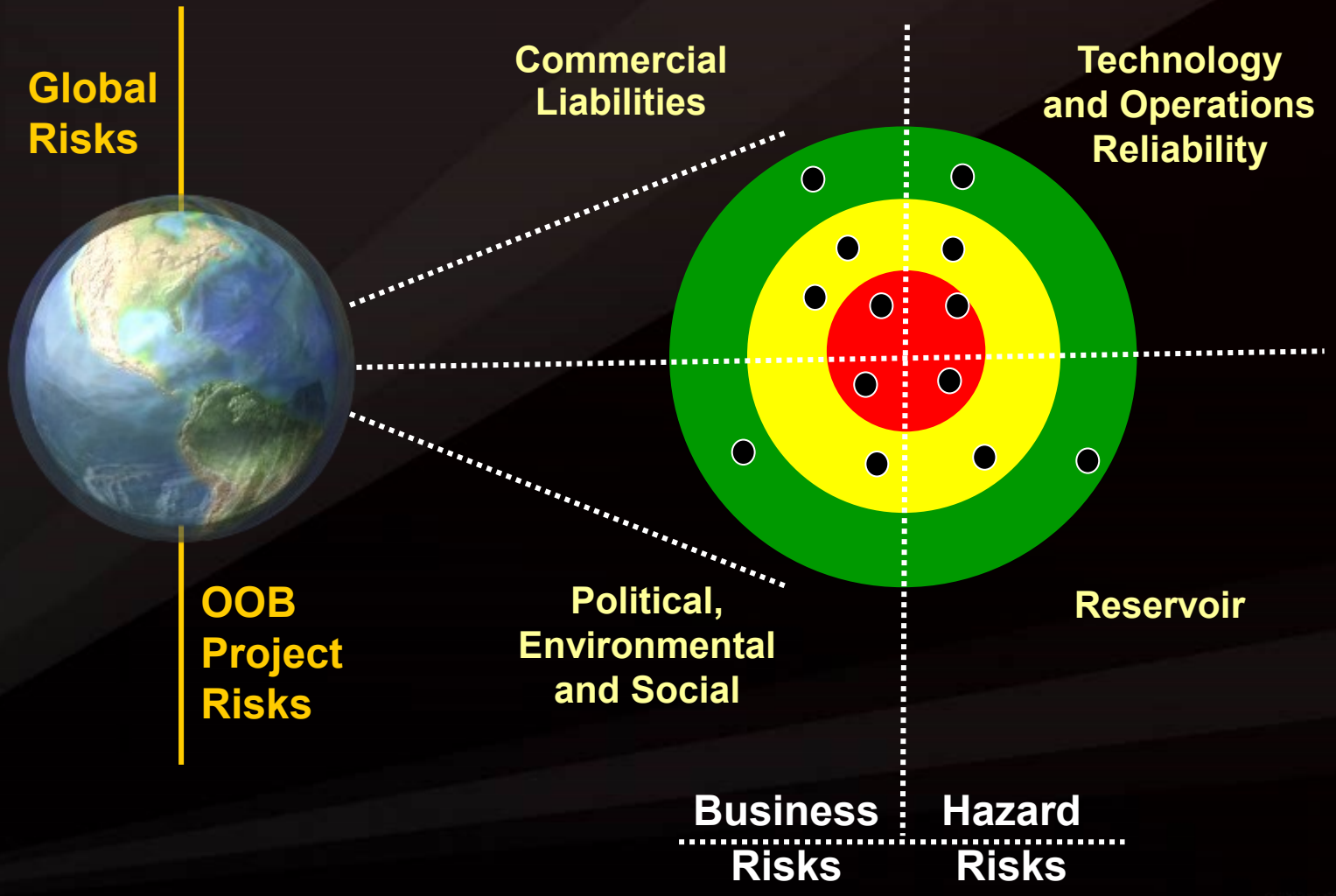
Existing Complexities and Risks

Risk Management Systems Needed



Sources: Adapted from Prakash & Shimpi – Integrating Corporate Risk Management

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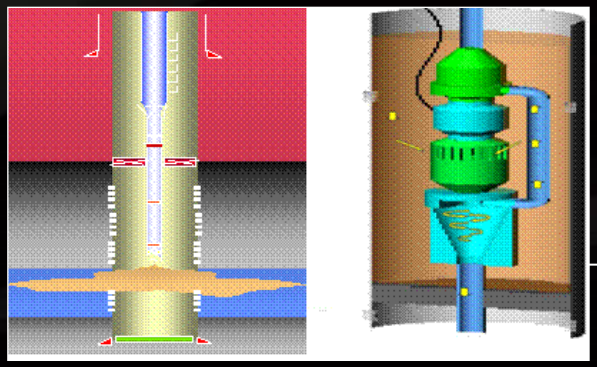
Green Asset Operations and Products

Near Zero Environmental Impact

Minimizing Impact on Land Use

Biological Bacterial Phenol and Sulfur Removal



Downhole Oil Water Separation and Simultaneous Injection

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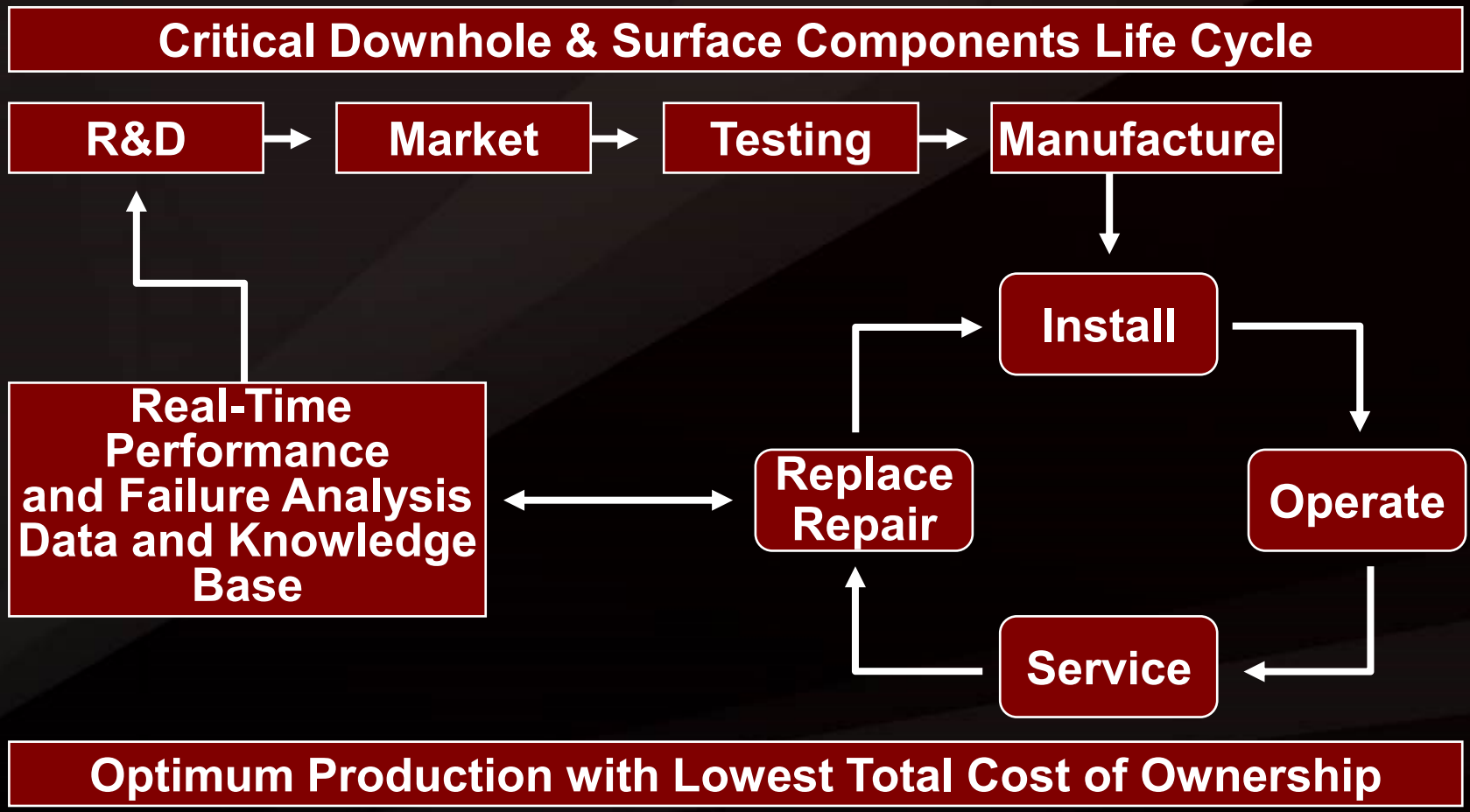
Supply Chain

Increasing Reliability of Critical Components



Source: Adapted from Ortiz-Volcan JL & Saveth Ken - SPE ATW A Field Life Cycle Perspective to Artificial Lift Asset Systems – Cartagena, Colombia, February 2007

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Lessons Learned in the 1990s – Valid Today

- Long-term planning should balance short-term social and environmental realities
- Regional capabilities key to getting optimum conditions for OOB projects
- Upstream projects should be tied to the country's development strategy
- Handling of cultural differences improves business process

Closing Remarks

Next 10 Years – Overcoming Mental Inertia

Shall Orinoco Oil Belt require a reliable system of physical and human assets supported by carbon-free processing technologies?

"Treat the earth well. It was not given to you by your parents. It was loaned to you by your children."
Kenyan Proverb