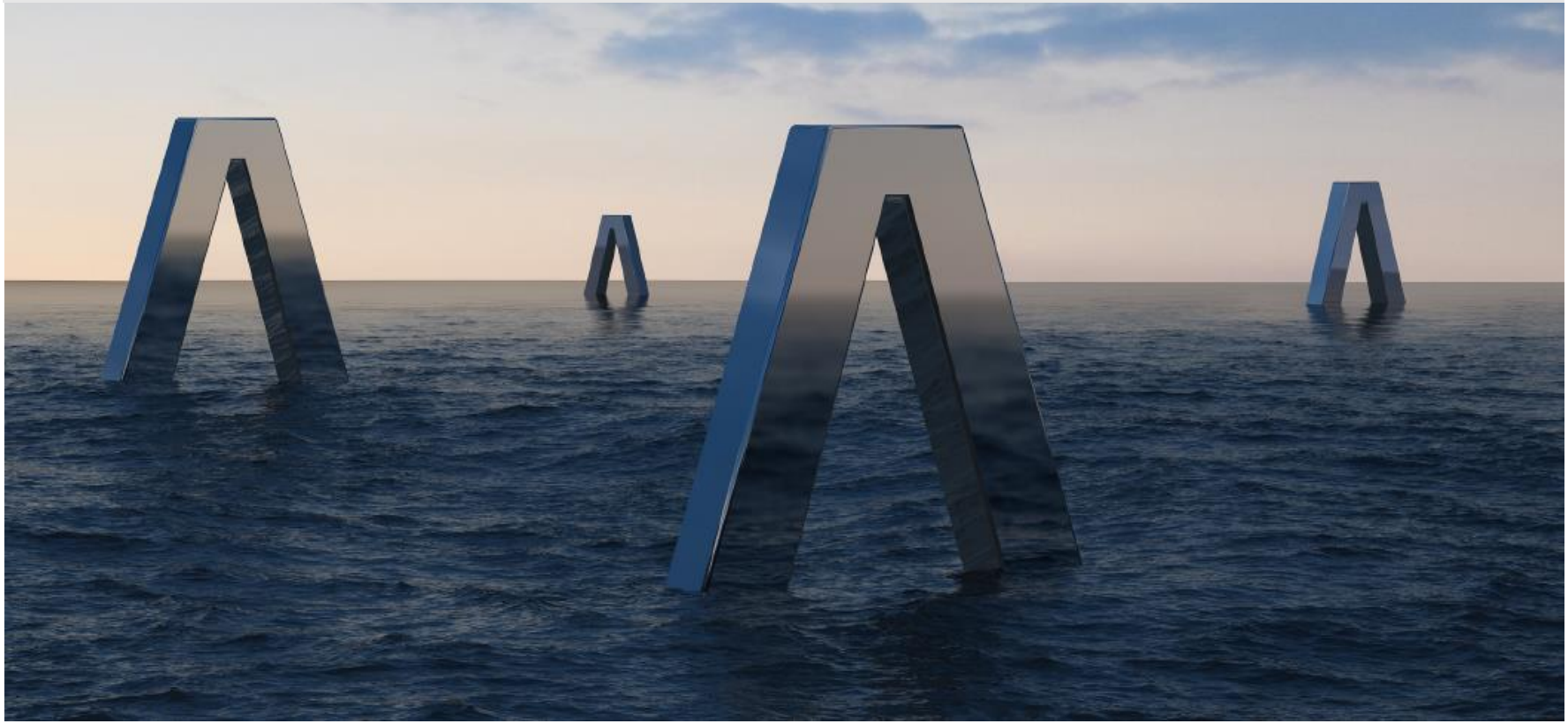
Understanding risk perspectives of Integrity

Chasing a moving target!!!

Understanding Asset Integrity, May 05, 2015



Agenda

- Introduction: Apply Sørco
- Principles of Risk
- Integrity from maintenance perspective
- Risk Vs. Reliability
- A Business Case
- Summary

APPLY – Upping the energy

FOCUS, GROWTH AND ENERGY TO IMPROVE

Apply Sørco AS
Apply Sørco Installasjon
Apply Sørco Driftspersonell
Apply Capnor
Apply Poland

NCS market presence.
International sourcing.
MMO frame agreements, modifications projects, (pre)operational support and engineering design studies.

Apply Leirvik AS
Apply Leirvik Int.
Apply Leirvik Emtunga
Apply Leirvik Reanco
Apply LQ Partner

Leading international independent provider of living quarters and helidecks.
Modular or single structure, steel or aluminum
Local content enabler

Apply Rig & Modules
Hanøytangen Rig Services

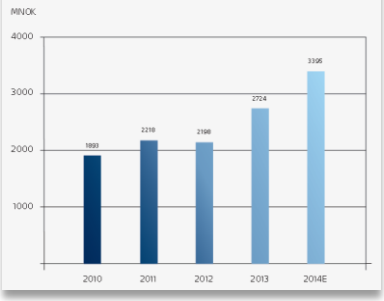
System packages for drilling rigs - drilling control systems.
Equipment containers.
HVAC under development, agreements in place.

APPLY SUMMARY

> **Business Areas:**
- Upstream Facilities
- Living Quarters & Helidecks
- Rig & Modules

> **Turnover 2014E:** 3395 MNOK
> **EBITDA Margin 2013:** 5,8 %
> **No. of employees:** 1601

Revenue and growth profile



A partner from projects throughout operations

Preparations for Operations

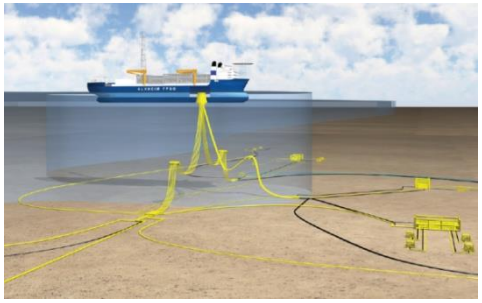
- Preparation of Maintenance Programs and Plans,
- Criticality Assessment & Analysis
- Barrier Evaluation & System Integrity
- Preparation of Operations Procedures
- Training Program, Material and Instruction

Handover & Start-up

- MC & Commissioning Support
- Project Follow-up suppory
- Company's Representatives
- Punch Lists handling and Punch out
- Start-up Advisers,

Operations Support

- Operators Capacity & Resources
- Crew Handling
- Spare Part Review & Warehouse
- Maintenance Optimisation
- Logistic support, Heli-booking



Integrated Operations

- Borderless Performance
- Integrated Operations
- Operation of Engineering Database
- Maintenance of 3D Model (incl. scanning)
- Weight Database, process models
- Structural models

M&M (Maintenance & Modifications)

- FEED Studies
- Detail Design
- Engineering Support & Resources
- Procurement
- Fabrication & Installation
- MC & Commissioning

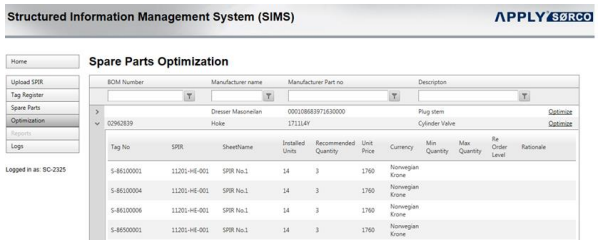
Modification Projects

- Concept Studies
- FEED Studies
- EPCIC Brownfield Modification Projects
- Subsea Tie-in Modification Projects
- Fabrication & Installation
- MC & Commissioning

Apply Sørco – Asset Integrity Services

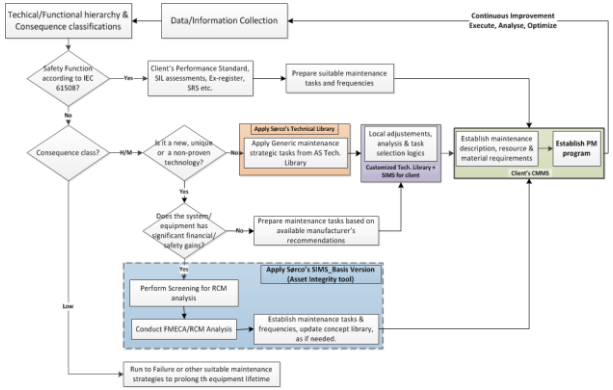
Div. Maintenance Engineering Support

- Establishing tag and functional hierarchies & criticality analysis
- Identification and quality checks for SCE and barrier-related tags (based on defined Performance Standards and regulatory requirements)
- Quality checks for SCE preventive maintenance (PM) programs as per regulatory requirements
- Quality checks for existing PM programs/strategies and tasks
- Establish checklists & PM routines i.e. detailed maintenance procedures etc.



Div. Maintenance Analyses

- Facilitating and assisting FMEA/FMECA analysis for the selected equipment
- Facilitating and assisting Reliability Centred Maintenance (RCM) analysis
- Develop RCM report with complete maintenance plan based
- Assist with developing Performance Standards (PS), covering the maintenance aspects



Spare Part Analysis

- Detailed analysis of commissioning & start-up, capital and operational spares
- Develop spare part list for all equipment grouped by vendors and identical items
- Prepare replenishment program: Determine max/min quantity, reorder level and warehouse location(s) for operational spares
- Identify minimum quantity of consumables
- SPIR follow-up, quality check, codification, BOM, procurement, receipt & warehouse services.

Continuous Performance Optimization

- Diverse GAP analyses to identify and remove nonconformities (e.g. spare parts and PM management work process etc.)
- Establishing system for KPIs for maintenance for continuous monitoring & follow-up
- Prepare Condition Monitoring (CM) routines and programs in CMMS
- Verification of Quality & Consistency of DFO deliveries based on Norsok standards & client requirements

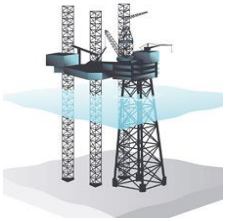
Apply – MMO Clients

Edvard Grieg

Lundin

Goliat

Eni



Valemon

Statoil

Brage

wintershall

Kvitebjørn

Statoil

Det norske. Ivar Aasen
Pre-Operation

Songa Offshore, all rigs
Maint. Engineering support

Teekay. Knarr
Operational Documentation

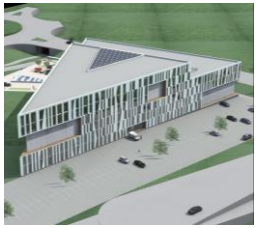
Shell, Draugen & Ormen Lange
Operational Readiness

BP Norway, Skarv Maintenance
Engineering Services

Dolphin Drilling AS, all rigs
Maint. Engineering support

Locations – competence & capacity

Stavanger (HQ)



- Corporate headquarter, new office building 2014
- Project management, multidiscipline engineering & design, brownfield development
- 410 engineers

Bergen

- MMO location, studies and modification projects
- Operations support services
- 100 engineers

Cracow, PLN

- Multidiscipline engineering services, support to ongoing projects in all phases – incl. study activities.
- Centre of excellence, asset visualization
- 150 engineers

Hammerfest

- New project location, Goliat FPSO M&M and Operations support
- Up to 50 engineers in 2015

Agenda

- Introduction: Apply Sørco
- Principles of Risk
- Integrity from maintenance perspective
- Risk Vs. Reliability
- A Business Case
- Summary

Facets of Risk

- Combination of the **probability** and the **consequences** of the event (ISO 17776: 2000)
- Characterized by reference to potential events and consequences, expressed in terms of combination of **events** and the associated **likelihood of occurence** (NS-ISO 31000: 2009).
- Expected undesirable **consequence multiplied by its consequence** *(Verma and Verter, 2007)*
- **Expected loss** to a given element or a set of elements resulting from the **occurrence** of a natural phenomenon of a given magnitude *(Lirer et al., 2001).*
- *Risk* is a term covers 2 parameters, the **probability (or rate)** of a particular **event** and the **scale of consequence** (perhaps expressed in terms of fatalities). (Smith, 2011).
- Expected loss associated with an event, measured by **combining the magnitudes and probabilities** of all of the possible negative consequences *(Mandel, 2007).*
- Risk is the **probability of an undesirable event** (Campbell, 2005).

Practical Aspects of Risk: Integrity Perspective

Integrity tasks are performed to **reduce business risks** (HSE, Cost, Personnel, shutdowns etc.)

Maintenance personnel must have a good knowledge of underlying risks & reliability principles:

- During maintenance **planning & execution** phase
- In **dynamic operational environment**, changing maintenance frequencies, test & inspection intervals
- Management of **Change**
- For **continuous improvement** and dynamic risk reviews

Why…….

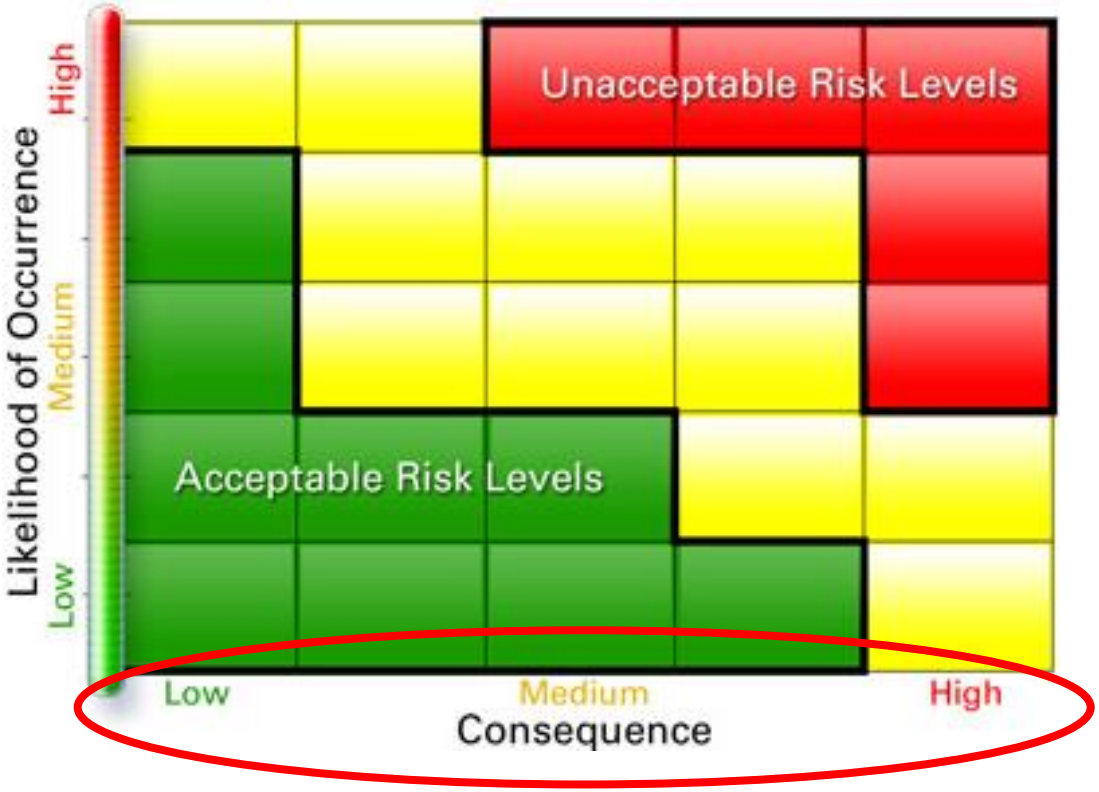
Because

It's a risky business!!!!!

Risk and Integrity

Variables in risk:

- Consequences
- Probability/likelihood



One of these variables is **FIXED**……??

Better understanding of Integrity is Better uderstanding of your Risks and Reliability issues

Agenda

- Introduction: Apply Sørco
- Principles of Risk
- Integrity from maintenance perspective
- Risk Vs. Reliability
- A Business Case
- Summary

Regulatory Requirements *(Ref. PSA Regulations www.ptil.no)*

Section 45
Maintenance

The responsible party shall ensure that facilities or parts thereof are maintained, so that they are capable of carrying out their intended functions in all phases of their lifetime.

Section 46
Classification

Facilities' systems and equipment shall be classified as regards the health, safety and environment consequences of potential functional failures.

For functional failures that can lead to serious consequences, the responsible party shall identify the various fault modes with associated failure causes and failure mechanisms, and predict the likelihood of failure for the individual fault mode.

The classification shall be used as a basis in choosing maintenance activities and maintenance frequencies, in prioritising between different maintenance activities and in evaluating the need for spare parts.

Section 47
Maintenance programme

Fault modes that may constitute a health, safety or environment risk, cf. Section 46, shall be systematically prevented through a maintenance programme.

This programme shall include activities for monitoring performance and technical condition, which ensure identification and correction of fault modes that are under development or have occurred.

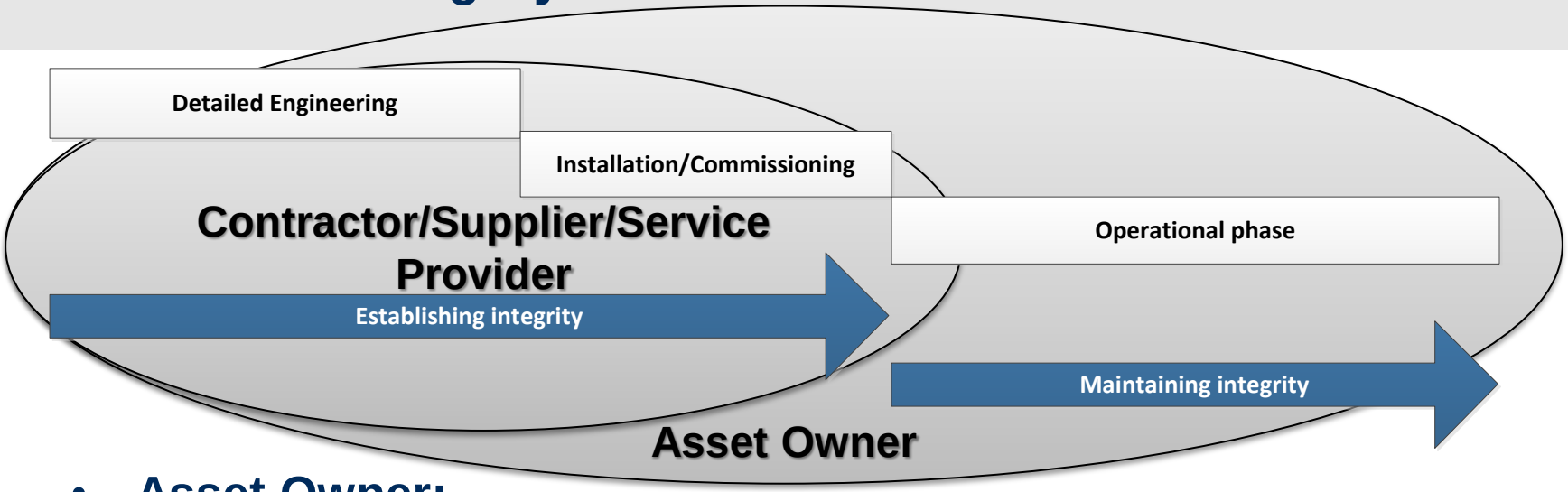
The programme shall also contain activities for monitoring and control of failure mechanisms that can lead to such fault modes.

Why Risk-Based Maintenance

- To comply with regulatory requirements
- It is engineers' contribution to risk of failures
- It provides an insight into the maintenance needs in all stages of life of an asset
- Identify consequences based on HSE, Cost, Production etc.
- Categorize equipment in High, Medium consequences classes
- Identify Safety Critical and Barrier equipment and test plans
- Systematic identification of PM activities, detailed procedures, spare parts analysis etc.
- Input to other extended reliability analysis such as RCM analysis, which is a reliability program

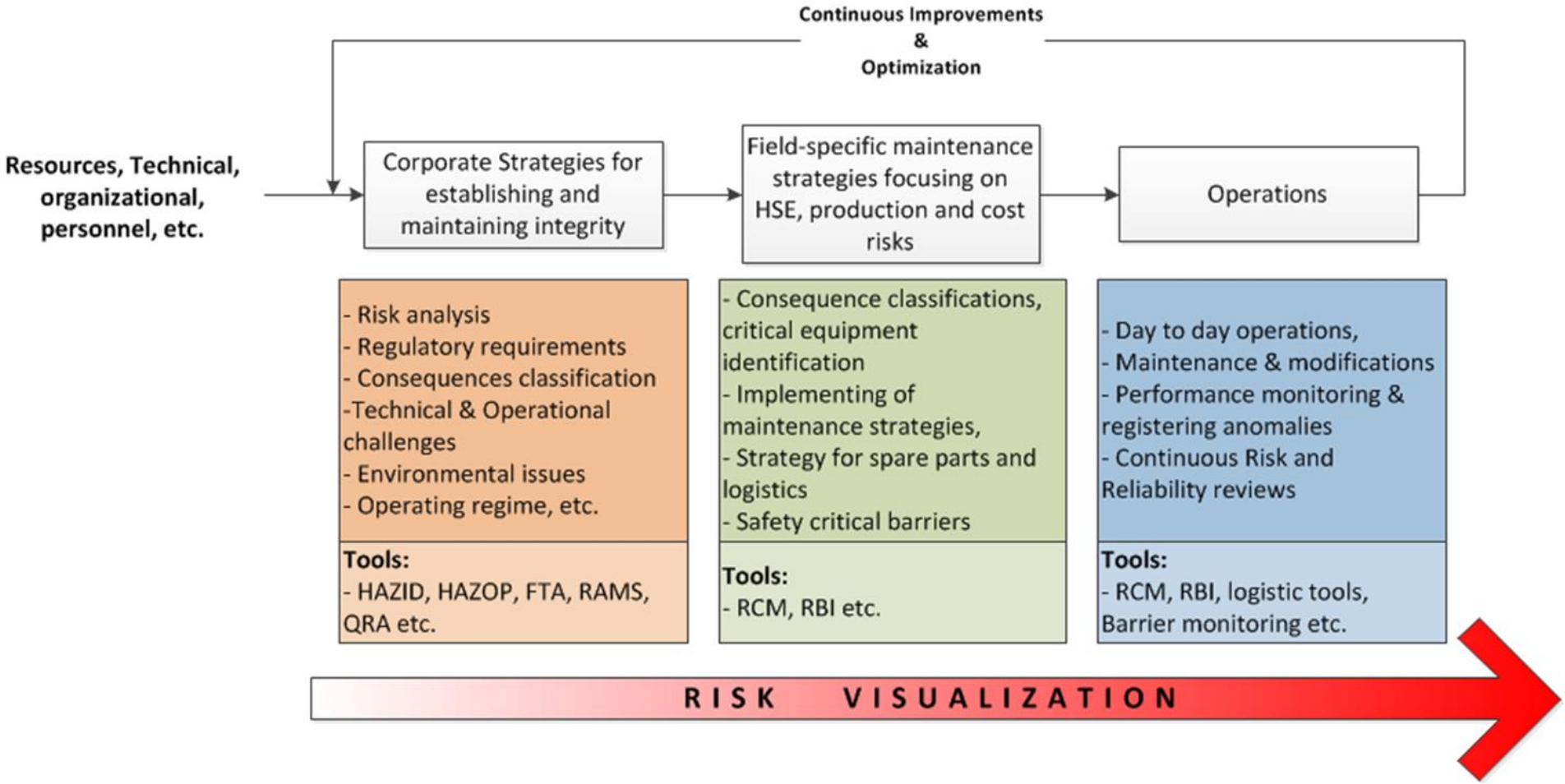
RBM is implemented in Computerized maintenance management system for maintenance planning, executing, logistics and continuous improvements

Who Owns Integrity-Related Risks…?



- **Asset Owner:**
  - Owns the risk in all phases of its asset
  - Responsible for keep risk minimum throughout asset's lifetime
- **Contractor/Supplier/Service provider:**
  - Establishes integrity based on Asset Owner's risk criteria
  - Implement integrity tasks
  - Follow up/feedback in the initial phase
  - Assist asset owner in maintaining integrity in operational phase, if required by the Asset Owner

Visualization of Risks in Practice



Dynamic operating environment, equipment failures, unwanted events, changing maintenance intervals, may affect your risks and integrity

Mitigating Risks….

Risk mitigating measures:

- Minimizing business risk through effective maintenance strategies
- Risk inherent to PM activities can be reduced by sound procedures, checklists, guidelines, strategies etc.
- Thorough safety analysis prior to job execution
- Continuous focus on cost/safety/unwanted outputs
- Quantified risks related to the probability and consequence of events
- Preventive programs that help reducing high consequence events from occurring

Tools used (Not limited to..):

- RCM, RBI, FMECA, FTA, ETA, HAZOP, HAZID etc.

Risk….A Moving Target?

Type and nature of risks is variable in Asset's lifecycle:

- Integrity regime to continuously focus on minimizing business risks, keeping up risk and reliability objectives
- Dynamic situation, operational scenario, market, cost etc.
- Optimizing existing maintenance regime may affect overall risk picture
- More qualitative risk aspects are considered, sometimes under-estimated or overkill
- Reliability parameters such as failure rates, faults, PM intervals, costs (shutdown, MTTR etc.) affecting dynamic risk picture

Quantitative risks relate to probability and consequences, whereas Qualitative risks are complex and more difficult to resolve

Industry Understanding of Integrity-Related Risks

Some challenges…

- More qualitative risk assessments, experience-driven assessments
- Lack of understanding of uncertainties in general decision making
- Decision making, based on individual understanding of risks, due to background, responsibilities in an organization
- Reliability issues, cost, shutdowns becomes more critical in operations
- Lack of visualization of risk in different phases of operation, maintenance and modifications
- Better understanding required about theoretical aspects of risks & reliability

In general, industry needs to better understand risk, reliability and integrity issues and factors affecting these in dynamic operational environment

Agenda

- Introduction: Apply Sørco
- Principles of Risk
- Integrity from maintenance perspective
- Risk Vs. Reliability
- A Business Case
- Summary

Risk Vs. Reliability

Risk…

Qualitative and/or quantitative analysis performed on a corporate (Company) level for different purposes, identify catastrophic events, potential hazards and their likelihood

Note that….in Practice….

Essence of life cycle costing, Hazards are always present in a plant or facility, likelihood is always finite….can be reduced but *never be eliminated!!!!!*

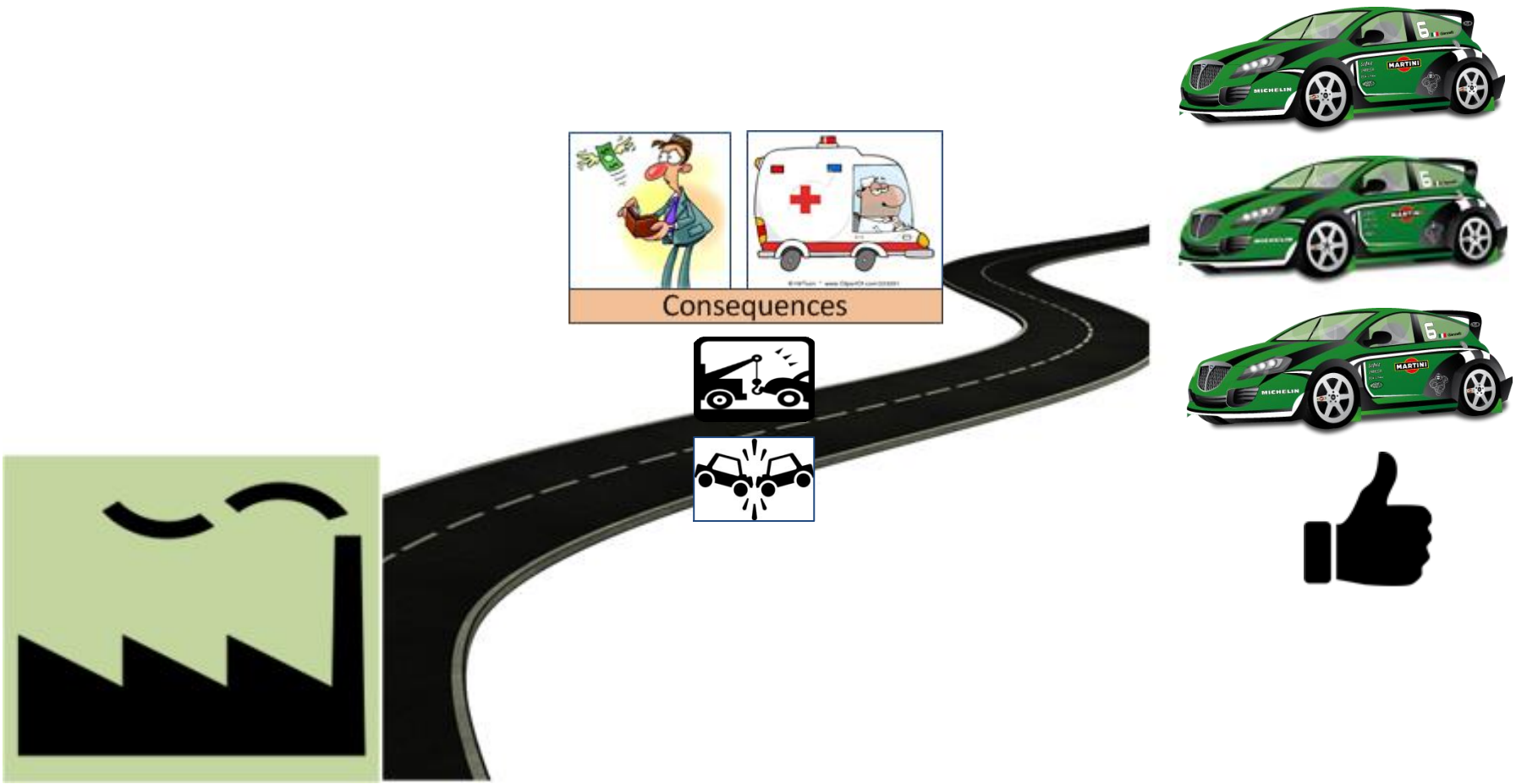
Reliability…

Ability of an item to perform a required function under given conditions for a given time interval (ISO 14224, NORSOK Z-008)

Note that….in Practice….

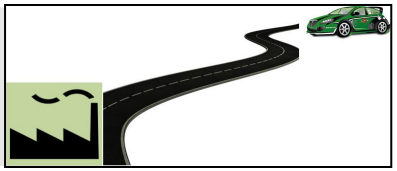
Reliability is more focused toward cost (up-times, down-times), system complexity, component reliability, customer satisfaction

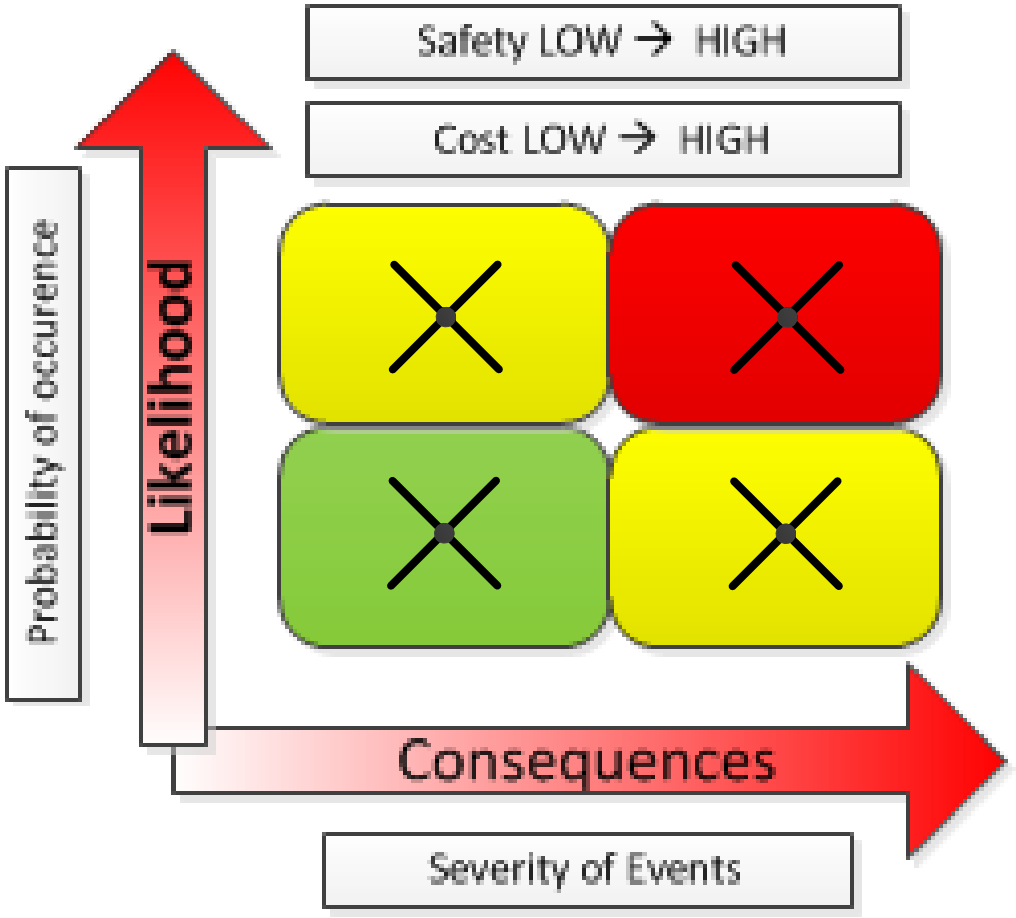
Driving to Work: Consequences, Risks and Reliability



Redundancy improves your system's reliabilty, not necessary reduces criticality or risk!!!

Driving to Work: Evaluating Risks





Scenario 1

Car doesn't start/broken
Consequence: Losing salary / Repairs(Cost)

Scenario 2

Road Accident
Consequence: Injury & Losing salary (Safety & Cost)

Likelihood of the event is main driving factor for risk management, control and mitigation

Agenda

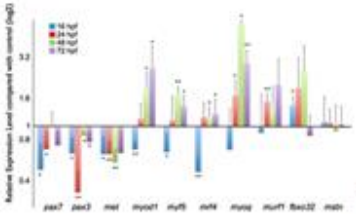
- Introduction: Apply Sørco
- Principles of Risk
- Integrity from maintenance perspective
- Risk Vs. Reliability
- A Business Case
- Summary

A Business Case: RBM Project

- A new operator on NCS
- Contract won in Dec.2013. Start-up RBM Jan. 2014.

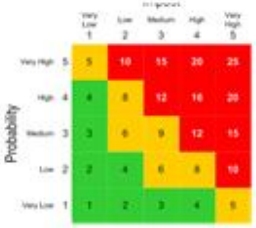
Detailed Maintenance Procedures

Maintenance analysis



Spare Parts Analysis

Consequence Classification

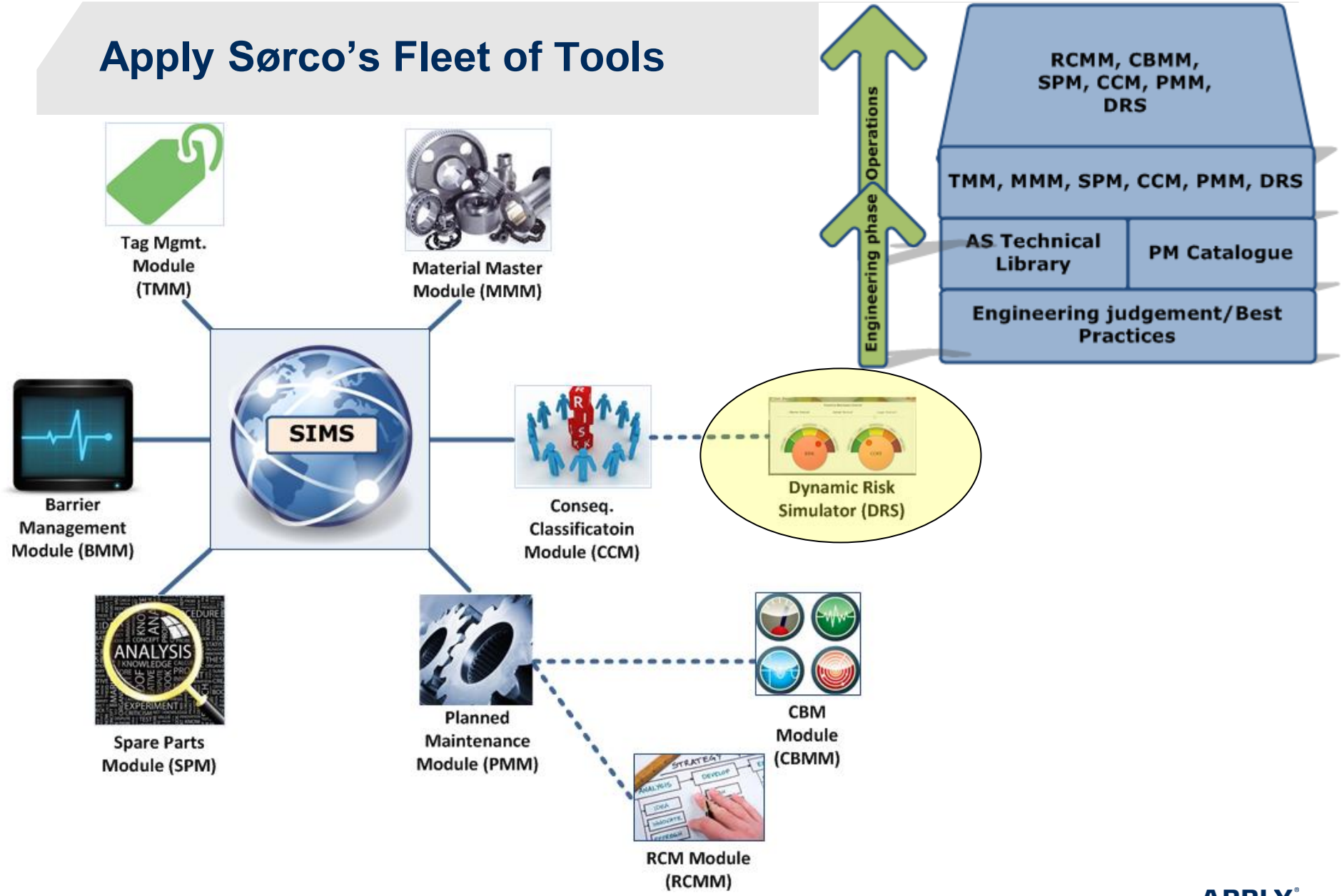


Equipment-Specific Technical Library

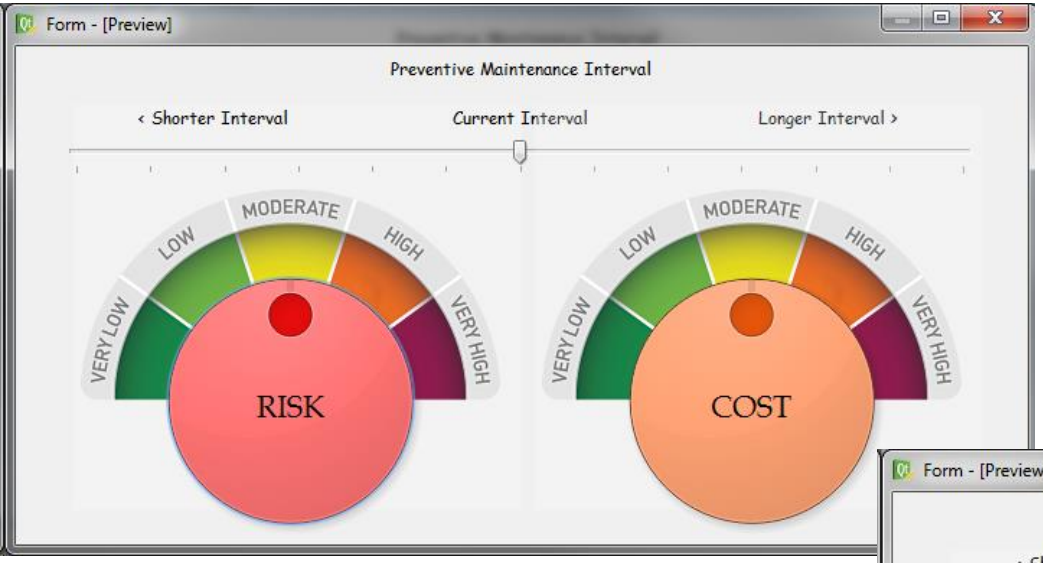
Implementation of RBM in CMMS

Complete integrity system, linked up strategies on tag levels, auditable trail for decisions, dynamic consequence evaluations and their impacts

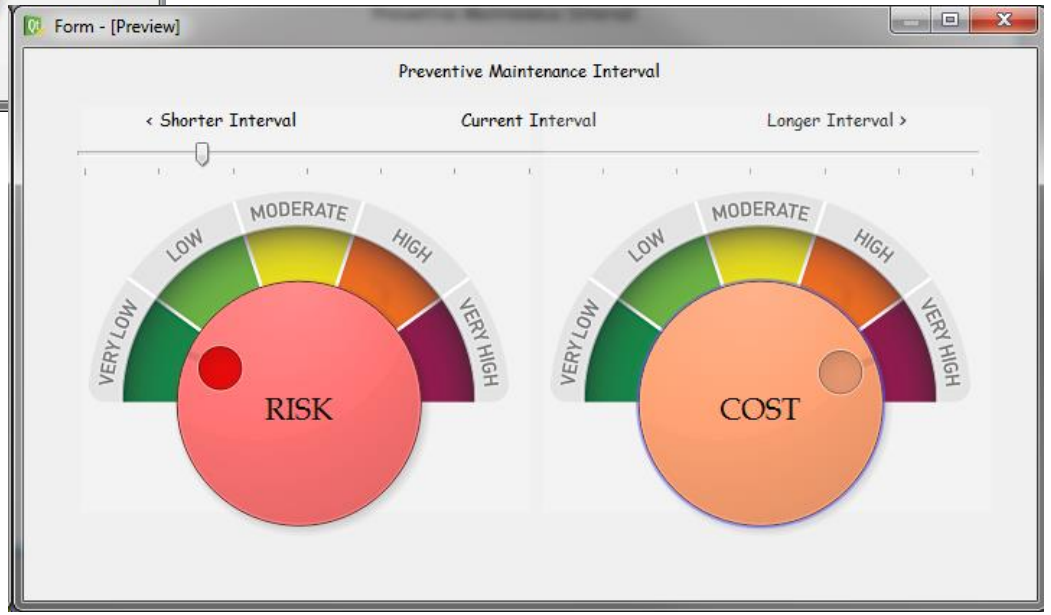
Apply Sørco's Fleet of Tools



Dynamic Visualization of Risks: DRS



Visualization of Risks (Cost and Safety) due to dynamically changing test/PM intervals



Means to visualize continuously changing risk aspects

Agenda

- Introduction: Apply Sørco
- Principles of Risk
- Integrity from maintenance perspective
- Risk Vs. Reliability
- Business Case
- Summary

Summary

- Consequences, risks, criticality, reliability…..All are linked
- Differentiate what drives your risks & reliability issues
- Visualization of dynamically changing operational scenario is important for safe and secure operations
- Understand the «moving targets» for your asset's integrity
- Better understand theoretical aspects of risk & reliability for your asset
- Asset integrity can be improved through better understanding of underlying risks, reliability and associated factors
- Integrity-related tasks reduce the «risk» of unwanted events or their magnitude, the consequences may however remain unchanged

Better asset decisions, risk-mitigating actions & optimization depends on how better you understand what are the driving factors!!

References

1. NORSOK Z-008. Risk based maintenance and consequence classification - Rev. 3, June 2011
2. ISO 14224. Petroleum, petrochemical and natural gas industries -- Collection and exchange of reliability and maintenance data for equipment
3. ISO 17776 (2000) Petroleum and natural gas industries -- Offshore production installations -- Guidelines on tools and techniques for hazard identification and risk assessment
4. Narayan V (2012). Effective Maintenance Managemet: Risk and Reliability Strategies for Optimizing Performance. 2nd Edition. Industrial Press Inc. New York, USA.
5. Dhillon B.S. (2006) Maintainability, Maintenance, and Reliability for Engineers. CRC Press, USA.
6. Smith, D. J. (2011). Reliability, Maintainability and Risk. Practical methods for Engineers. Eighth Edition. Elsevier.

Thank you

Contacts:
Dr. Jawad Raza
(jawad.raza@applysorco.no)

Kristian Helland
Business Manager Asset Integrity
(kristian.helland@applysorco.no)