Inspection Scope Optimization for Turn Arounds

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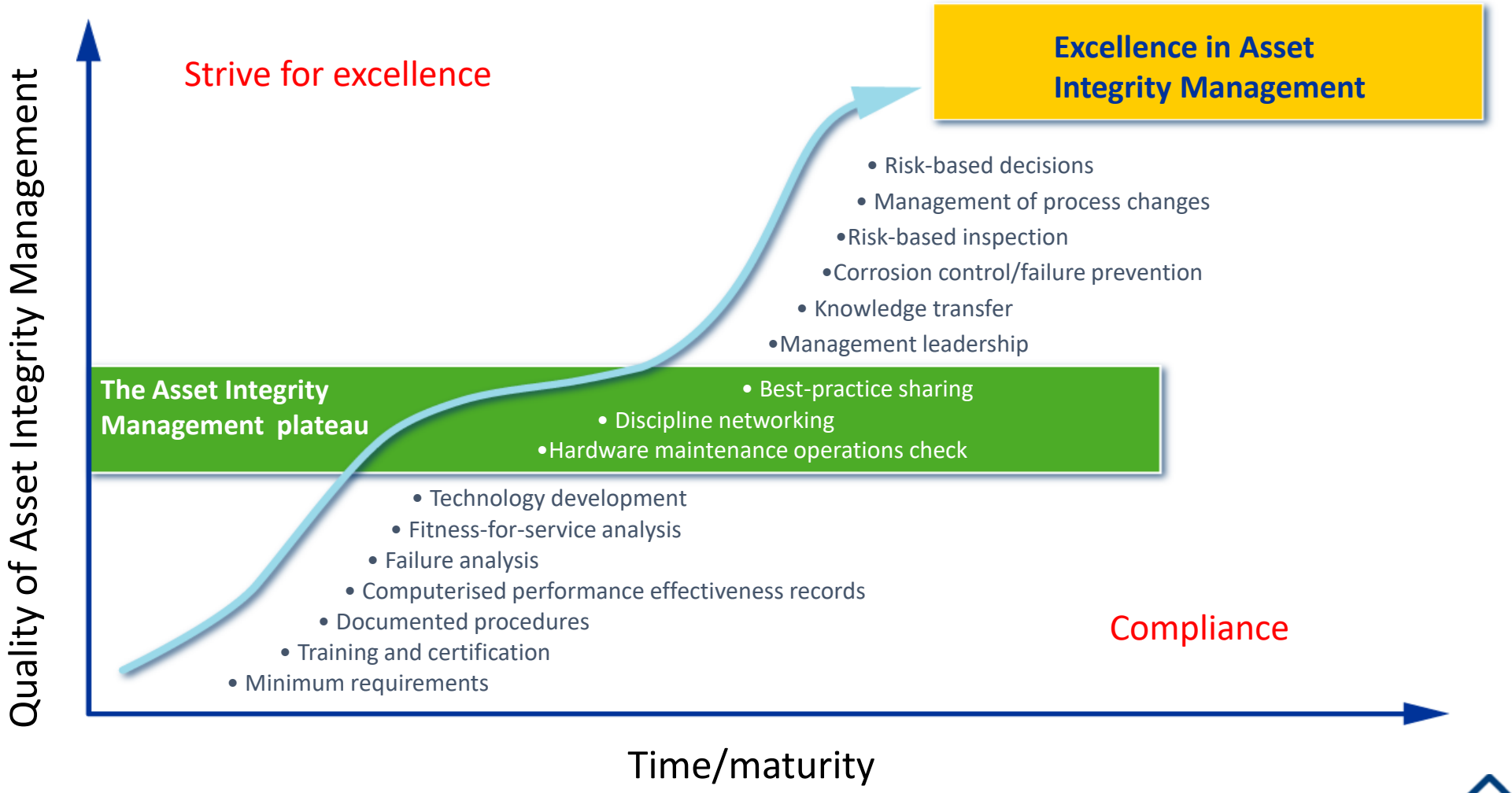
Agenda

- Introduction
- Minimum Intervention Strategy for Inspection
  - Value drivers: How to save cost
  - Risk Based Inspection: Minimize the intrusive scope
  - Use of robots for inspection: Optimize the execution
  - Non-Intrusive Inspection: Use alternatives
- Inspection strategy 4.0

Achieve Excellence in Asset Integrity



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Minimum Intervention Strategy for Inspection

Minimum Intervention Strategy for Inspection (MISI) is a methodology aimed at maturing an assets risk based inspection strategies in a structured manner

- Optimize the use of Risk Based Inspection (RBI)
- Improve your current RBI-strategy into a living program, deploy Corrosion Management and operate within Integrity Operating Windows
- Selection of alternative inspection methods such as Non Intrusive Inspection and robots for intrusive inspections

MISI aims at reducing the impact of inspection on:

- Turn Around scope and down-time of the installation
- Intervention costs for preparation of vessels
- HSSE impact of confined space entry

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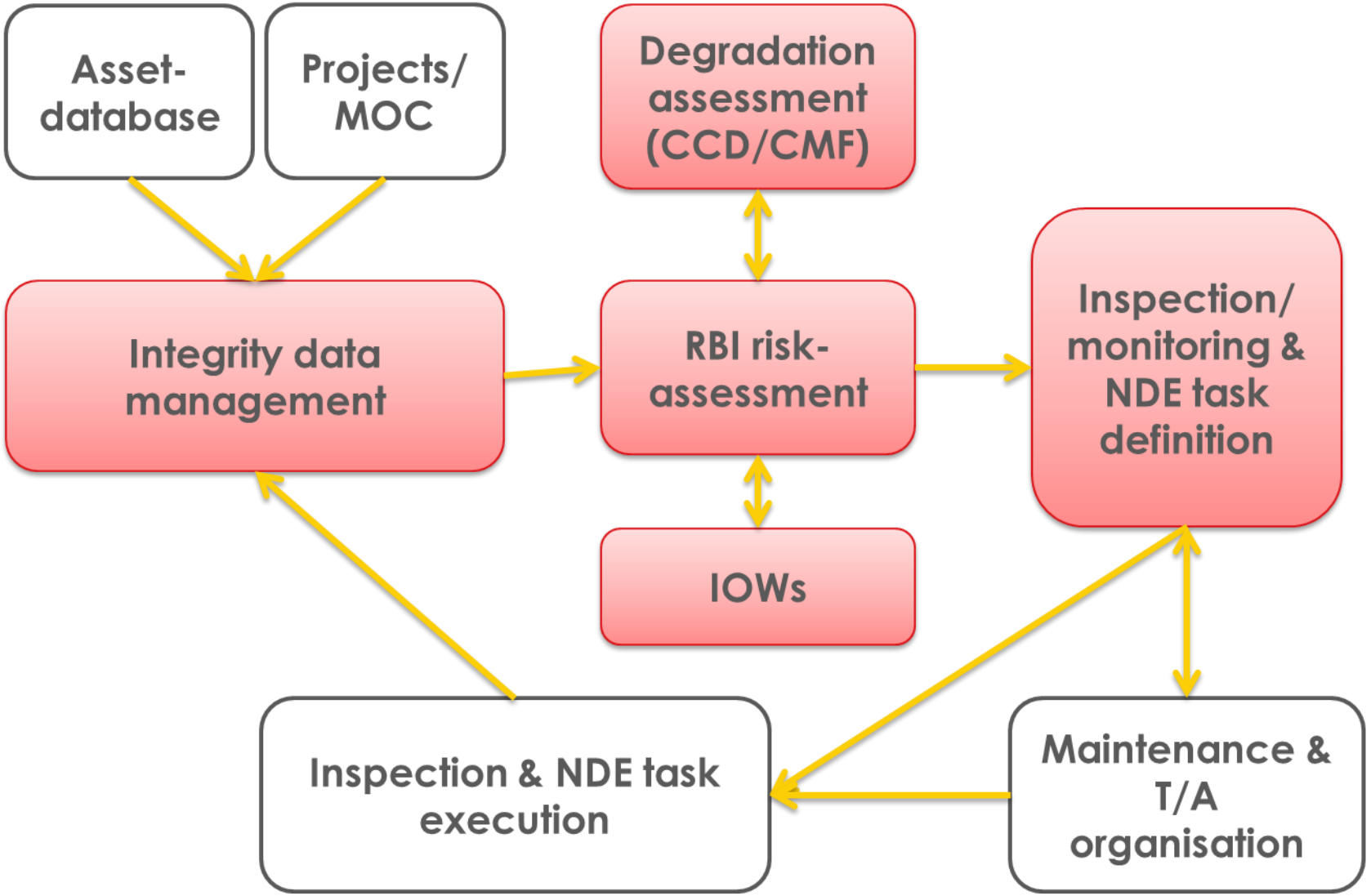
Inspection Optimization Key Elements



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MISI Value Drivers

HSE implications

Person on Board limitation

(Reduce deferment)

Direct preparatory costs

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MISI value drivers

Reduce Turn Around scope and down-time of the installation

- In Oil and Gas production and other facilities such as power generation
- Less people on board for execution during TA's

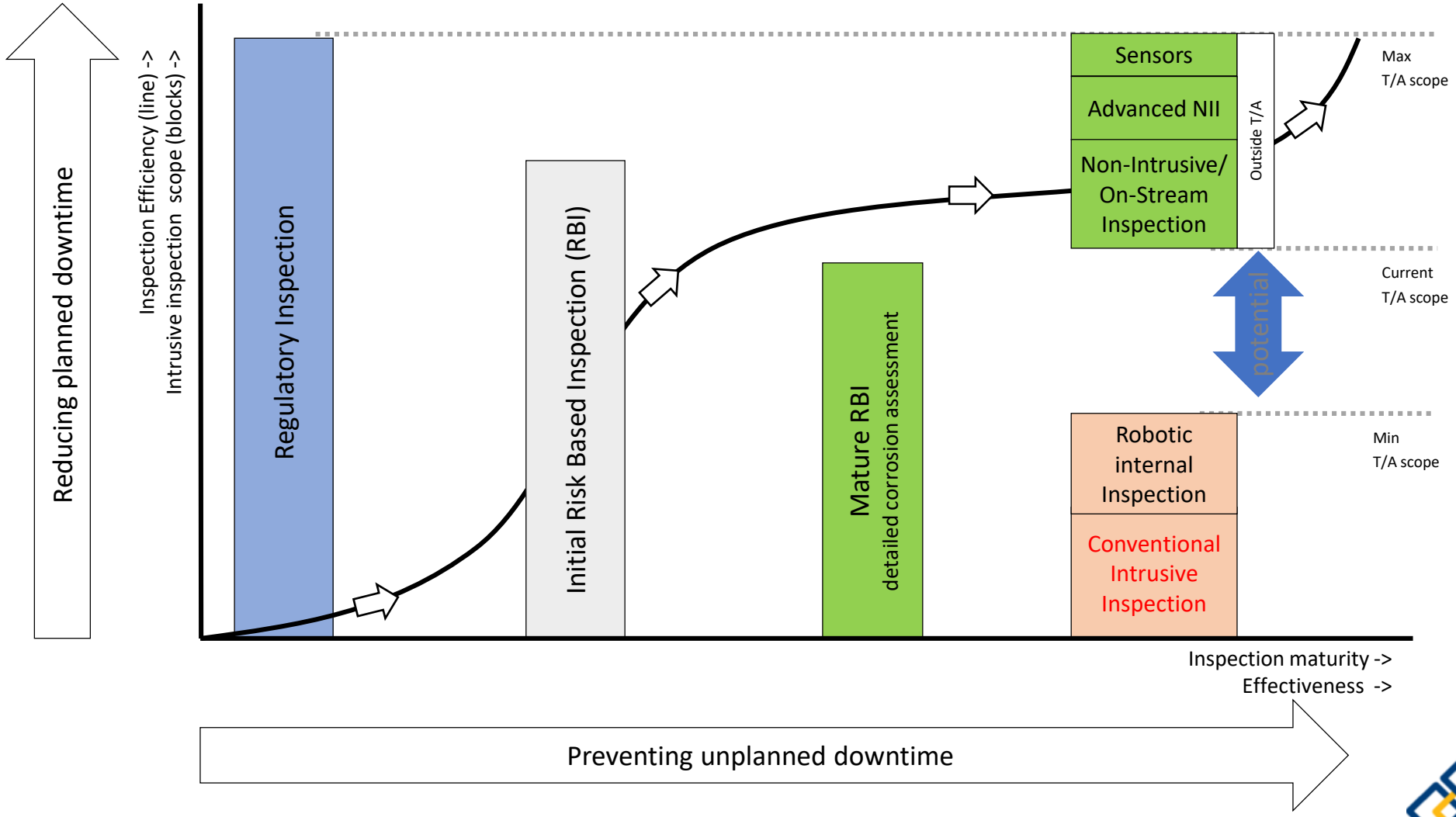
Less intervention costs for preparation of vessels

- Direct 'mechanical' cost
- 'Robots' require less isolation then human entries

HSSE impact of less confined space entries

- RBI analysis reduces risk and the need for internal inspection
- Reduced offshore travel for mechanical work/scaffolding/cleaning

Production optimization from an inspection point of view



Definition RBI

Risk Based Inspection (API recommended practice 580, Third edition, February 2016)

A risk assessment and Management process that is focused on loss of containment of pressurized equipment in processing facilities, due to material deterioration. These risks are managed primarily through equipment inspection.

Business impact of RBI

- A mature RBI assessment may result in a 2,5% increased availability over the life cycle of an installation
- An RBI quality review may reveal both inefficiencies and ineffective area's
- The impact can be assessed
  - Amount of TA days reduced
  - Direct cost reductions because of reduced inspection scope
  - Impact on HSE, less exposure hours and less confined space entries

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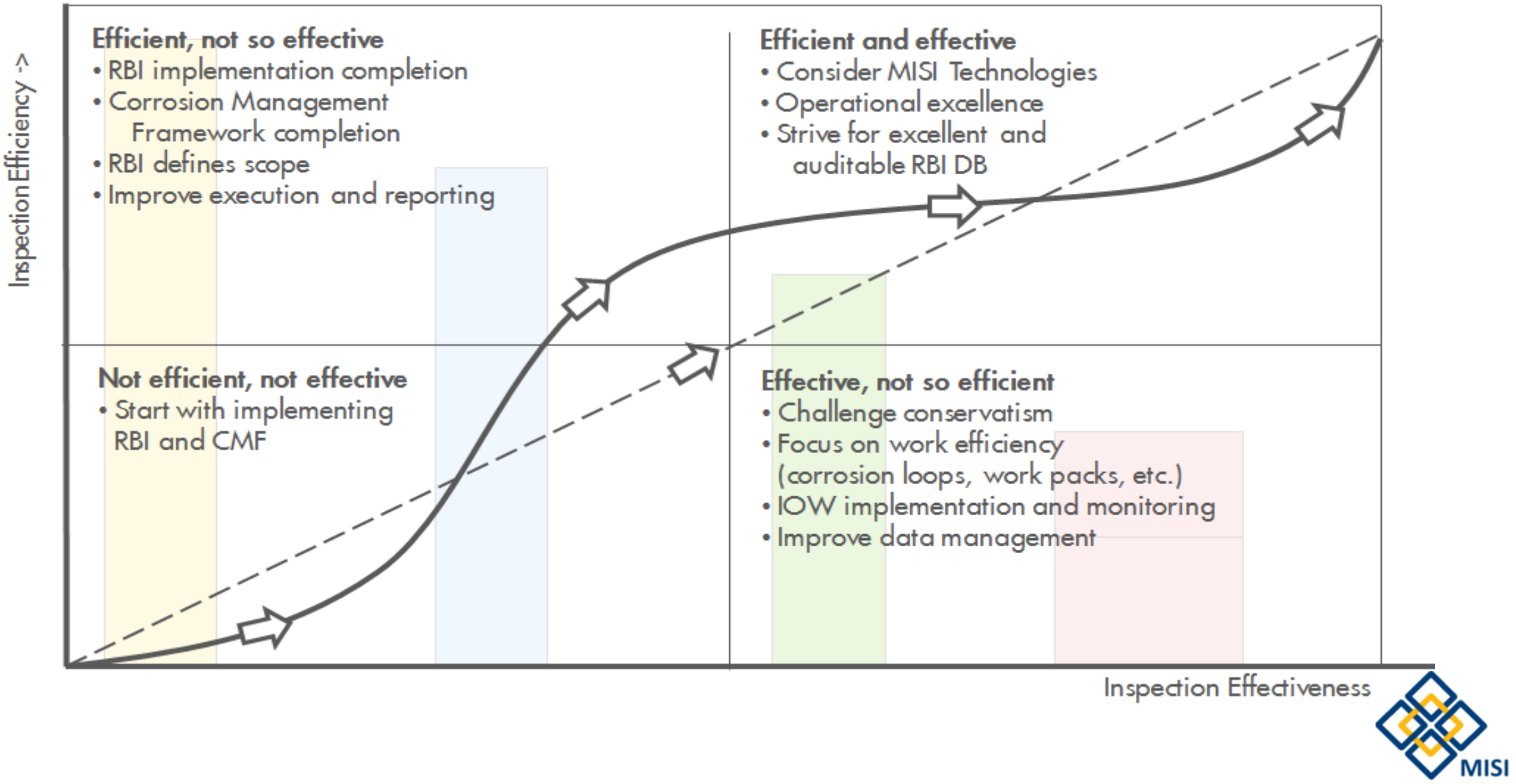
Optimize RBI



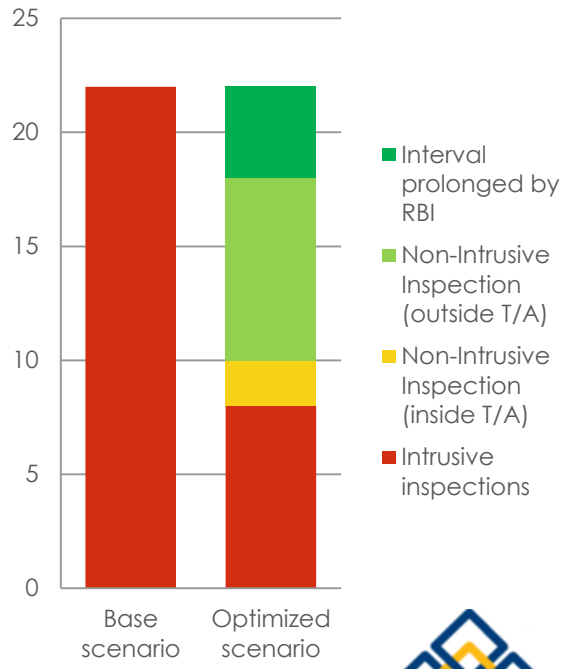
Example presentation of the impact of MISI

Minimum Intervention Strategies for Inspection Review targets:

- Review TA scope for **next** turnaround of a facility
- Risk Based Inspection (RBI) review of intrusive scope and screening for Non-Intrusive Inspection (NII) revealed opportunities for optimizing TA scope

Business Impact

- Original scope includes intrusive vessels inspections, extending the critical path
- All vessels analyzed
  - **X %** intrusive vessel inspections left in next TA
  - **X %** vessels removed from TA scope with NII / Robotics
  - **X %** vessels removed from next TA scope by extending intervals with RBI
- Savings estimated**: X man hours** removed from next TA scope
  - Potential saving ~X days TA duration
  - Cost for executing NII estimated at $ X over the next period
- **X confined space entries** avoided



So far <u>all</u> MISI reviews carried out on 20+ installations have identified and realized scope- and cost savings of 10-50%

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MISI: Business impact

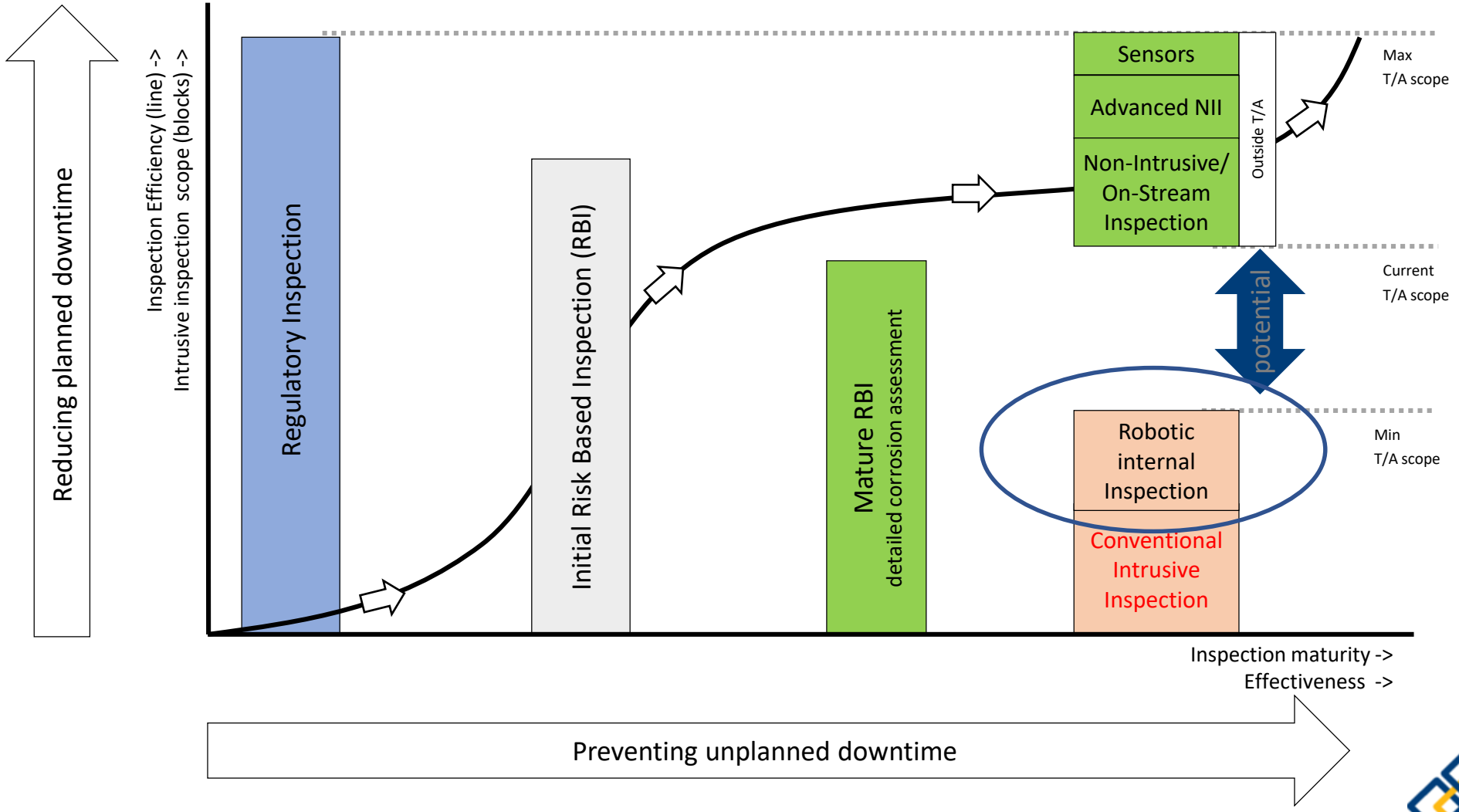
300 vessels reviewed on 7 Oil- and Gas production installations

- Intrusive inspections were reduced by 30% applying RBI
- A reduction of about 20% by applying NII
- For 10% robots could be used to avoid human entry

Result

- 35 less Turn-Around days
- Significant cost savings, up to 50%
- 100+ reduction of confined space entries

Inspection optimization: Use Robots



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Manually operated camera systems

- Non-robotic arm with video scope or a camera mounted on pole for visual inspection
- Access from small nozzles
- Quick low cost visual inspection, less stability, no NDT tools possible
- Commercially available on market
- ATEX certified solutions are available

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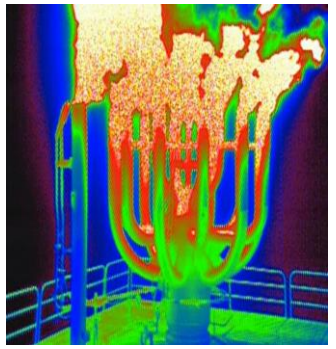
ROAV Applications: Drones

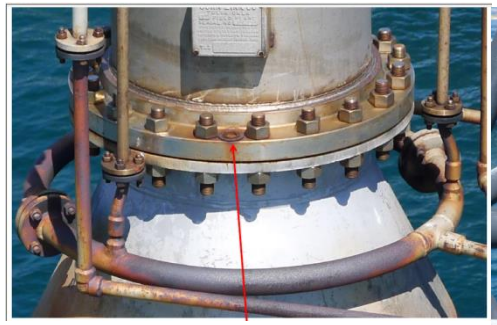

Deployment and operation


Flare inspection



Vent stack inspection




Structural inspection

Chimney inspection

Applications (not exhaustive!)

Flares including “live flare” inspection
Chimneys, Vent stacks
Communication masts
Waste heat boiler ducting
Geomatics – aerial surveys
Emergency response to situations

Geological studies

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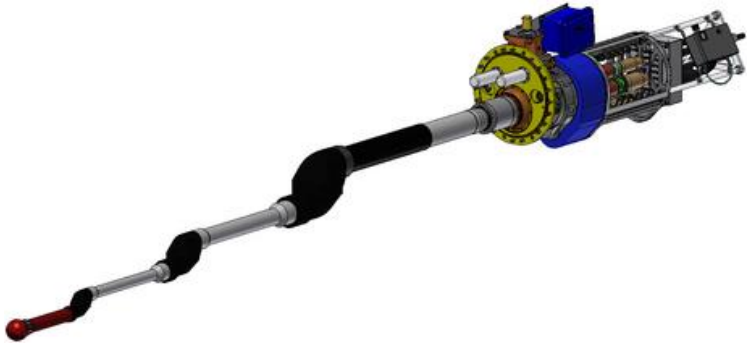
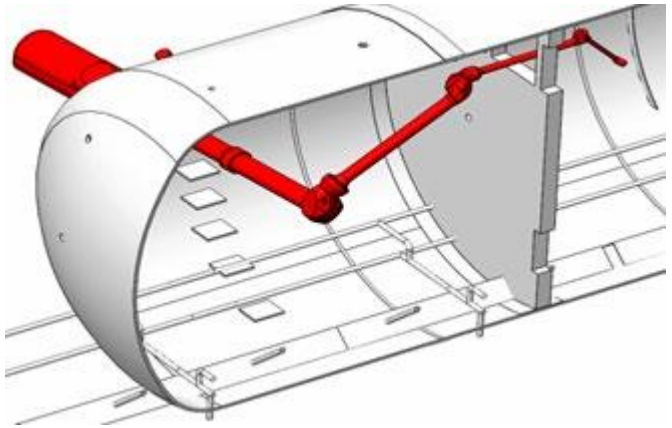
Large stand-off type robotic arms

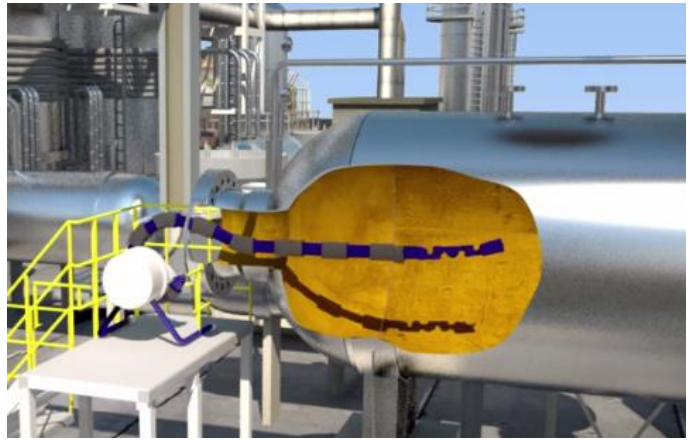
- Deployed first in Norway in 2012
- Adapted to O&G in Demo-2000 Joint Industry Project in Norway
- Heavy but stable deployments
  - Extensive preparations needed
- ATEX certified solutions available
- Cleaning and visual inspection tools





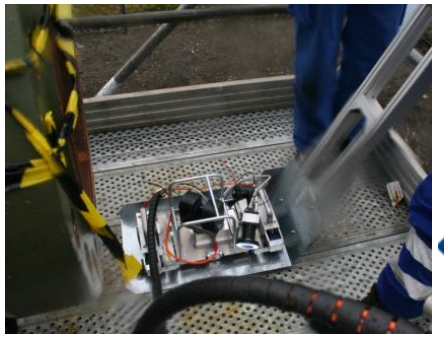
Smaller flexible arm type robots

- Lightweight retractable snake arm developed by OC Robotics under the Petrobot program
- Deployments require less preparation (no manhole adaptor), still require hoisting
- ATEX zone 1 certification capable
- Quick intrusive inspection with visual, UT, EC sensors



Crawler types with magnetic wheels

- Magnetic wheel robots
- BIKE and FAST developed by AIR as a part of Petrobot JIP
- ATEX is a challenge
- Low cost intrusive inspections, hand carried
- Equipped with visual, EC, UT, visual and cleaning tools



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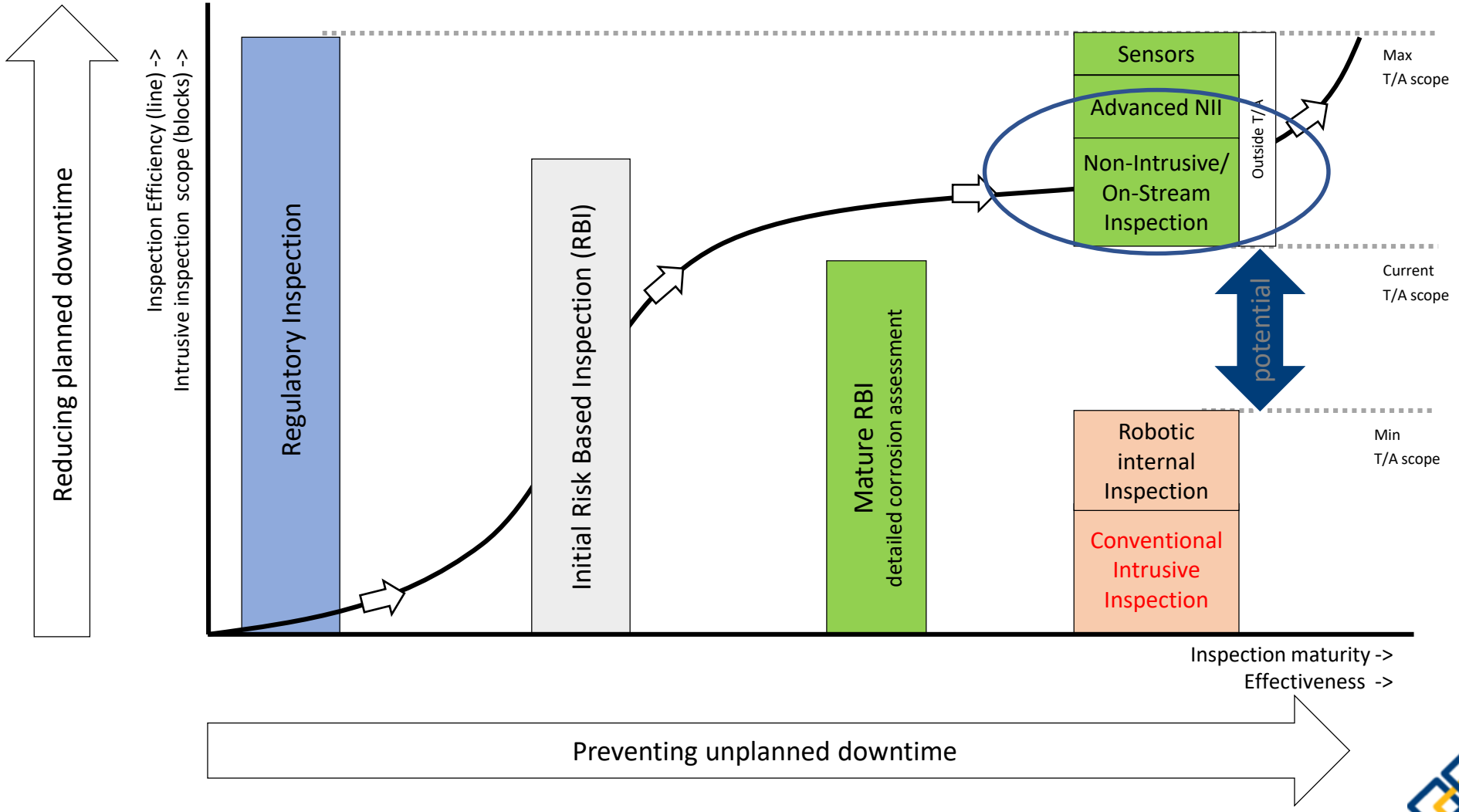
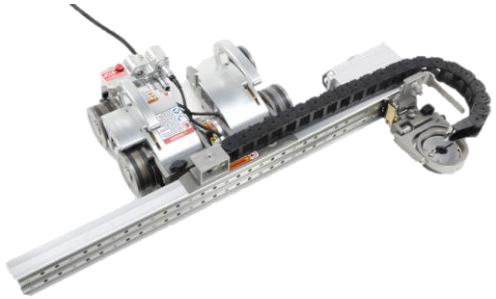
Inspection optimization: NII



Pre-stop corrosion mapping with crawler

Actual Case

- Tower 40m Height, 60°C
- Corrosion mapping strip 500mm width, full height, 4 wind directions



Main advantage:

- Required inspection results before TA
- No need for huge scaffold during TA, (scafolding expensive + large footprint)
- Less interventions during TA

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Precisely Right.

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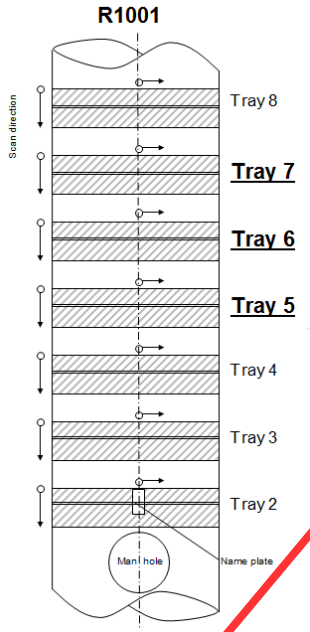
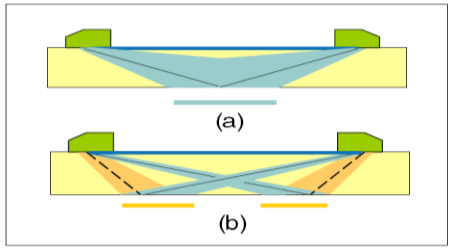
Rapid Screening TOF on heavy wall vessel

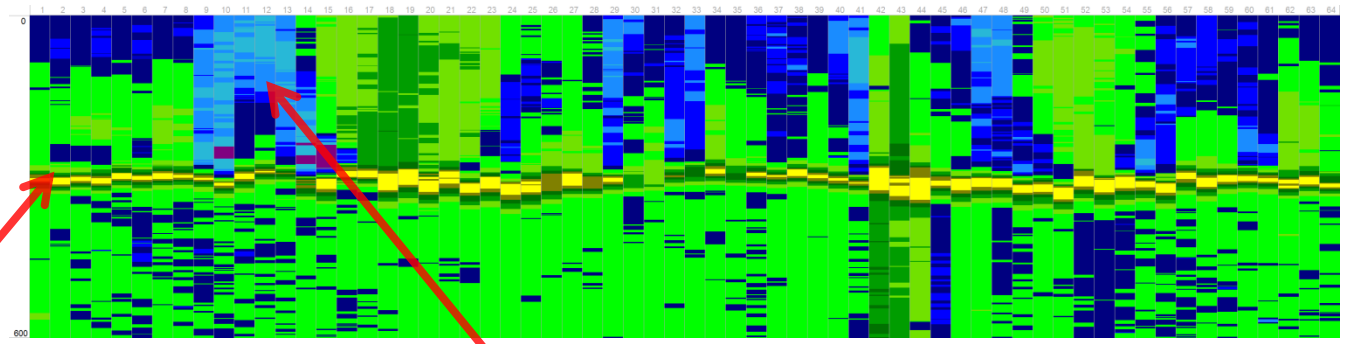
- Wall thickness: 104mm
- Material: C-Steel



- Monitoring accuracy: <0.5mm



TRAY 6



- Circumferential weld

Affected areas

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Inspection Strategy 4.0

Strategic developments

- Focus on minimal interventions, maximize uptime
- Design for non-intrusive inspection: nozzles, access, use of robots
- Maximize operational control, process conditions, integrity operating windows
- Compliance demonstration of Integrity Performance Standards
- 3D visualization & trending of integrity status of major equipment

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Visual Pressure Vessel Inspection

Inspector in the Vessel

- confined space entry
- preparation for human entry
- manual reporting
+ “human intelligence”

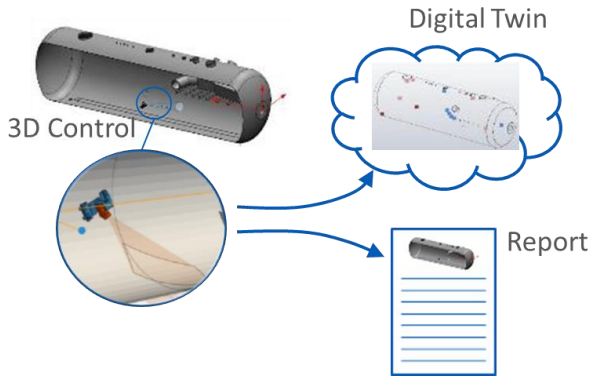
Camera on a Stick

+ NO confined space entry
- limited access / reach
- manual operation
- manual reporting

Robotic Visual Inspection

+ NO confined space entry
+ NO blinding, scaffolding . . .
+ full access / reach
- manual operation
- manual reporting

Robotics & Digital



+ NO confined space entry
+ NO blinding, scaffolding . . .
+ full access / reach
+ automatic operation
+ automatic reporting

www.inspection-robotics.com

From the Physical Asset …

… to a Digital Twin

Example 3D visualization

Thank you for your attention

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