



RIMAP



Risk Based Inspection and Maintenance Procedures for European Industry

EU-Funded Programme:

COMPETITIVE AND SUSTAINABLE GROWTH



4-04



RIMAP

- EU-funded project (GROWTH Programme)
- Budget: 3.6 mill € (EU: 1.7 mill €)
 - RTD: 2.8
 - Demo: 0.9
 - Network: 0.9
- Duration: March 2001 to March 2004
- Number of participants;
 - RTD and Demo: 16
 - Network: 30++



Partisipant

3

Det Norske Veritas (DNV)	Norway
Bureau Veritas (BV)	France
Staatliche Materialprüfungsanstalt (MPA)	Germany
VTT Manufacturing Technology	Finland
TÜV Engineering Service (TÜV)	Germany
TNO – INSTITUTE OF INDUSTRIAL TECHNOLOGY	Netherlands
Norsk Hydro (NH)	Netherlands
MITSUI BABCOCK ENERGY LIMITED (MBEL)	UK
ExxonMobil Chemical (Exxon)	UK
Energie Baden-Württemberg AG (EnBW)	Germany
Siemens AG (Siemens)	Germany
Electricity Supply Board (ESB)	Ireland
Corus	UK
The Dow Chemical Company (DOW)	Netherlands
Solvay	Belgium
Joint Research Centre of the European Communities (JRC)	Netherlands
	MANAGING RISK

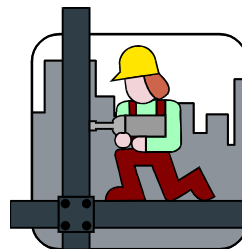
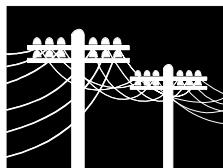
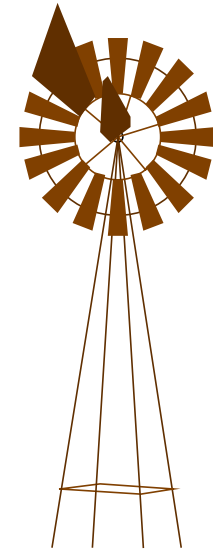


Type of industries

- petrochemical,
- chemical,
- (pulp & paper),
- steel works,
- power industry.



- the techniques can be extended and used in other industry sectors

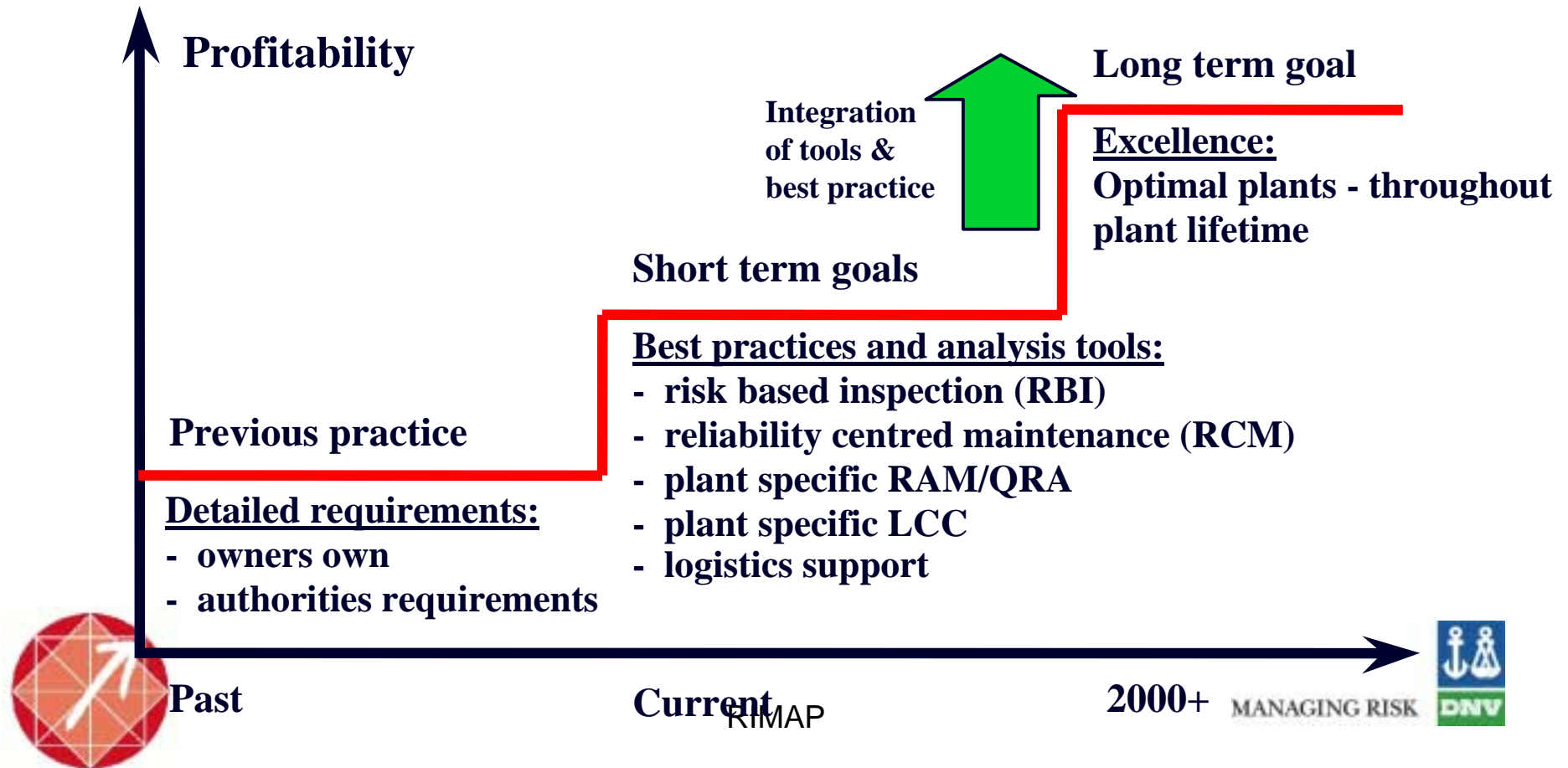


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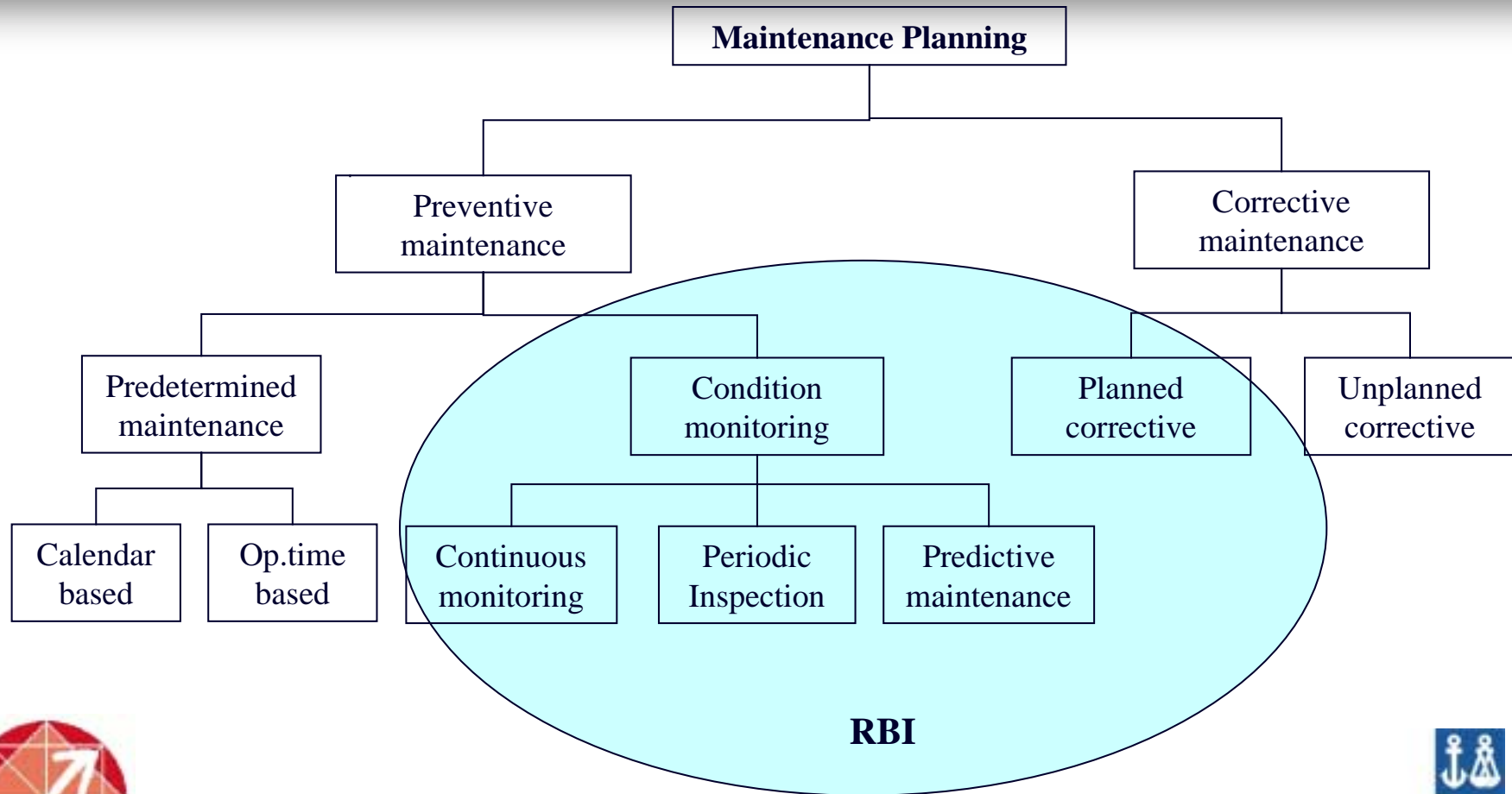
MANAGING RISK



RBMI towards Excellence



Maintenance Planning

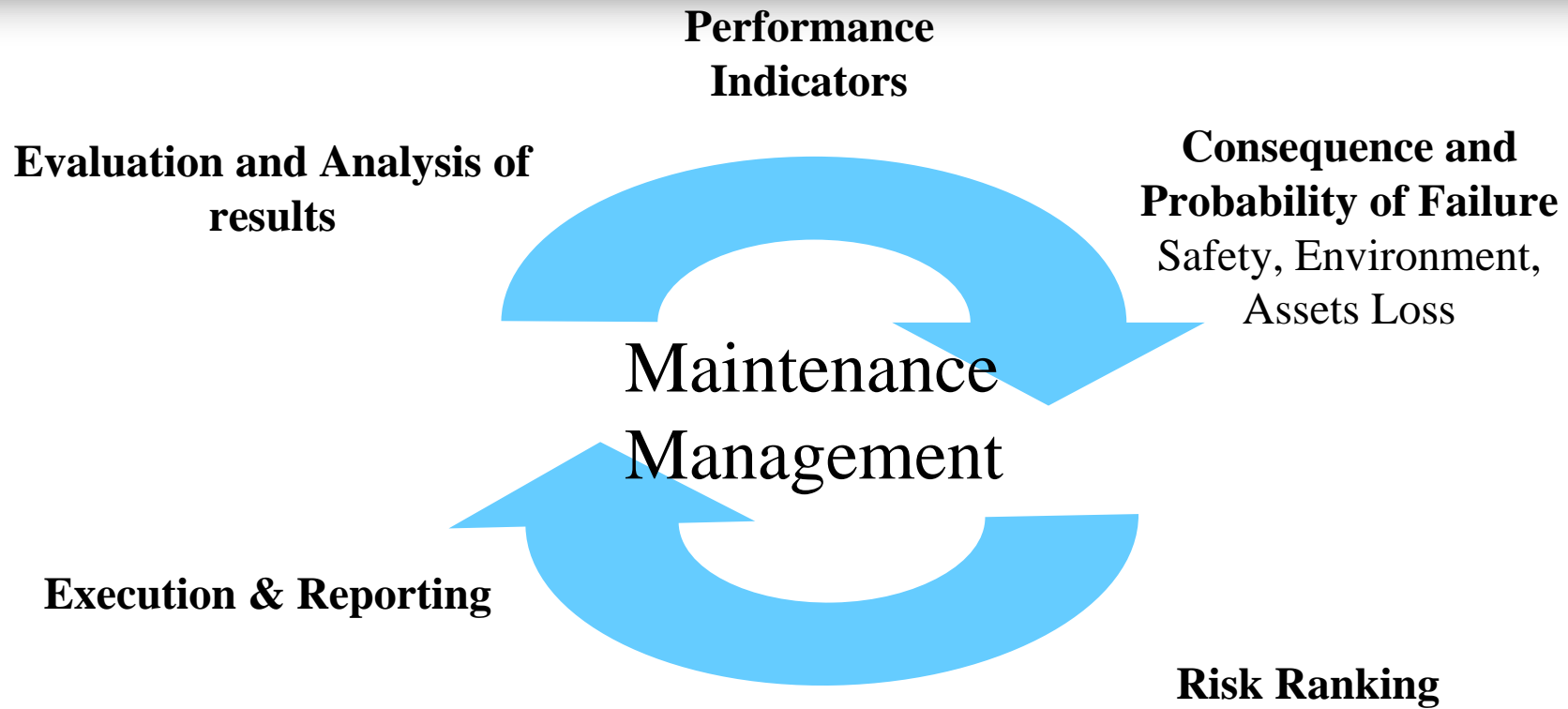


RBI

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RBMI Philosophy

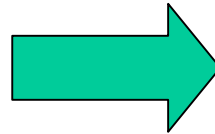


Inspection & Maintenance Programme
RIMAP



Background

**Prescriptive
legislation**



**Goal setting
standards**

- *But the industry don't know how to do this?!*
- *Large variety in quality of assessments*
- *No basis for audits by legislative bodies*



Objective (1)

- to define a unified approach to making risk based decisions within the field of inspection and maintenance
- safety/environment constraints
- cost-optimised

a technical framework for a European standard

Risk = Probability *
consequence

Consequence :

- personnel safety,
- quality of product,
- environmental damage,
- economic loss



Objectives (2)

- Developing a unified approach to risk based maintenance and inspection planning
- Setting requirements to the contents of an analysis, personnel qualifications and tools
- Forming the basis for a future standardisation in this area.

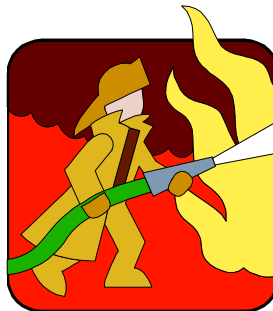
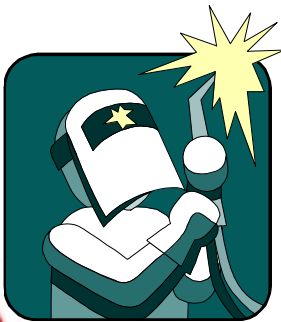


Risk

=Consequence of failure X Probability for failure

- Personnel
- Environment
- Economic
- Quality

- Failure mode,
- Material/Environment; degradation; type & rate,....
- Damage tolerance

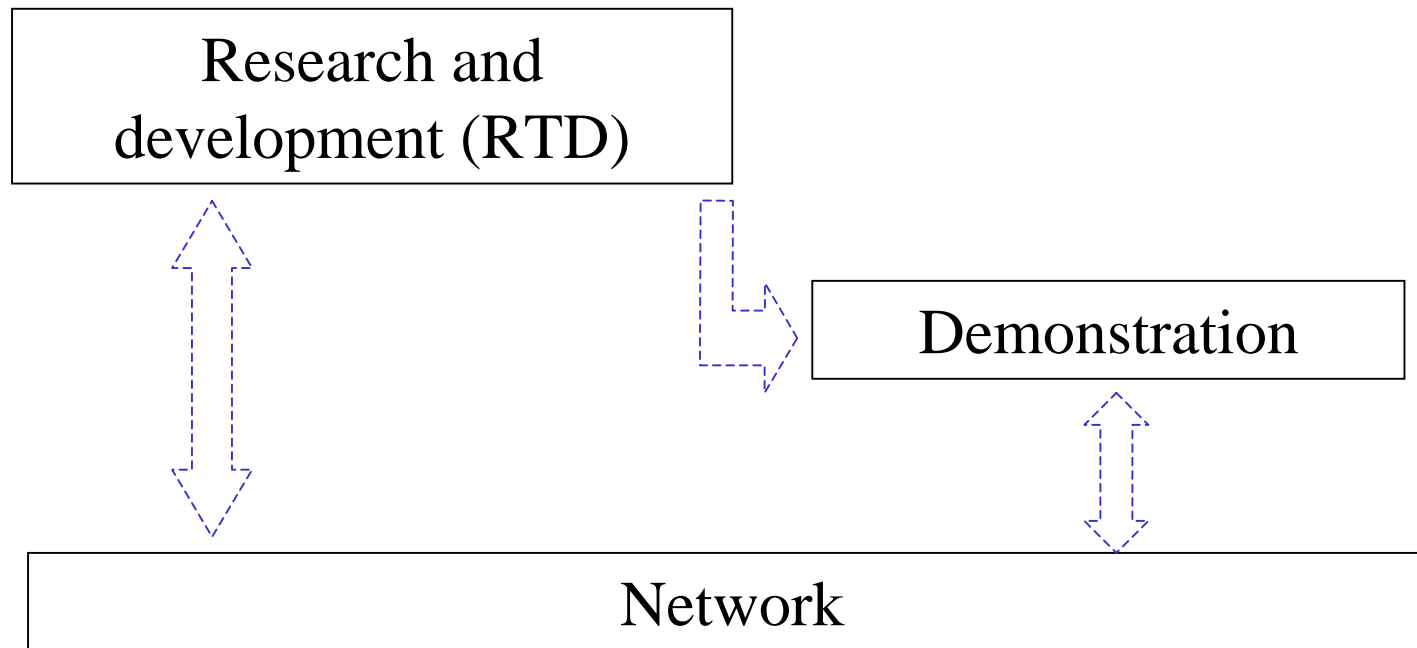


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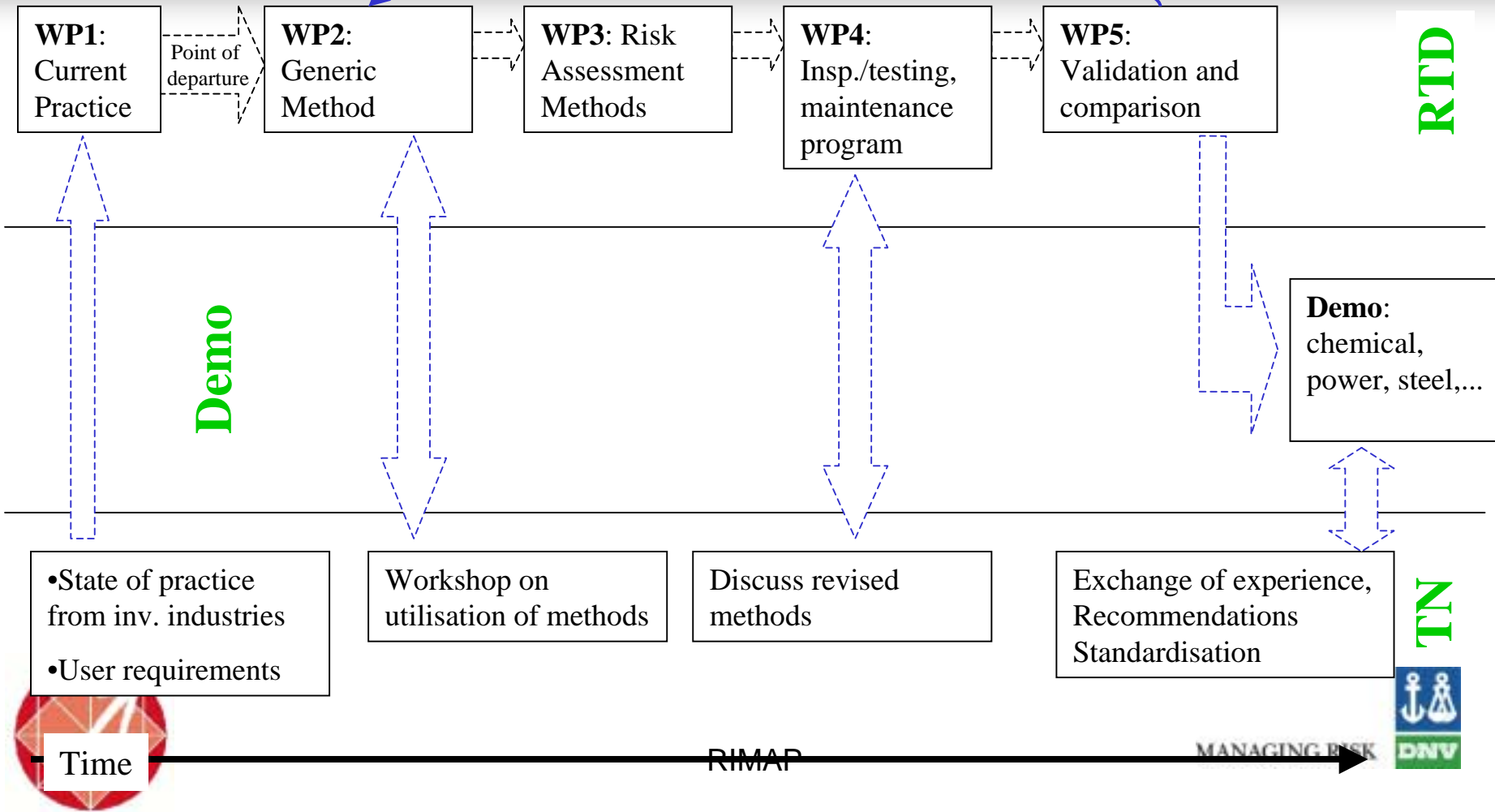


RIMAP Work packages



RIMAP WP-relations

Update on RBMI



WP1: State of art

- Define terminology
- Document state of art/practice in different industry sectors
 - inspection planning
 - maintenance planning
 - evaluate pro/con
- Establish user requirements
- Identify available SW & tools
- Local and EU legislation limitations



WP2: RBMI Framework

Generic framework for RBMI decision

- risk based
- linked to overall safety/ environmental criteria
- combine qualitative & quantitative assessment
- data requirements
- regulatory aspects

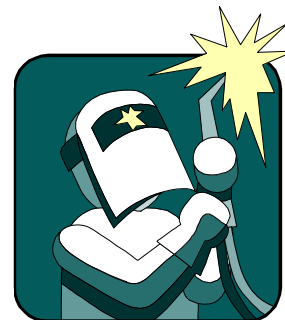
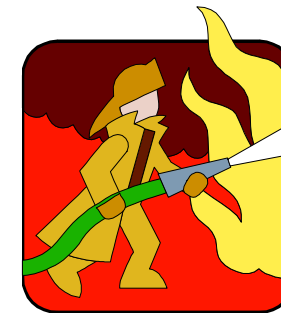
Applied to:

- Pressure containing equipment
- facilities; electrical, rotating, instrument
- Safeguarding (protective) devices

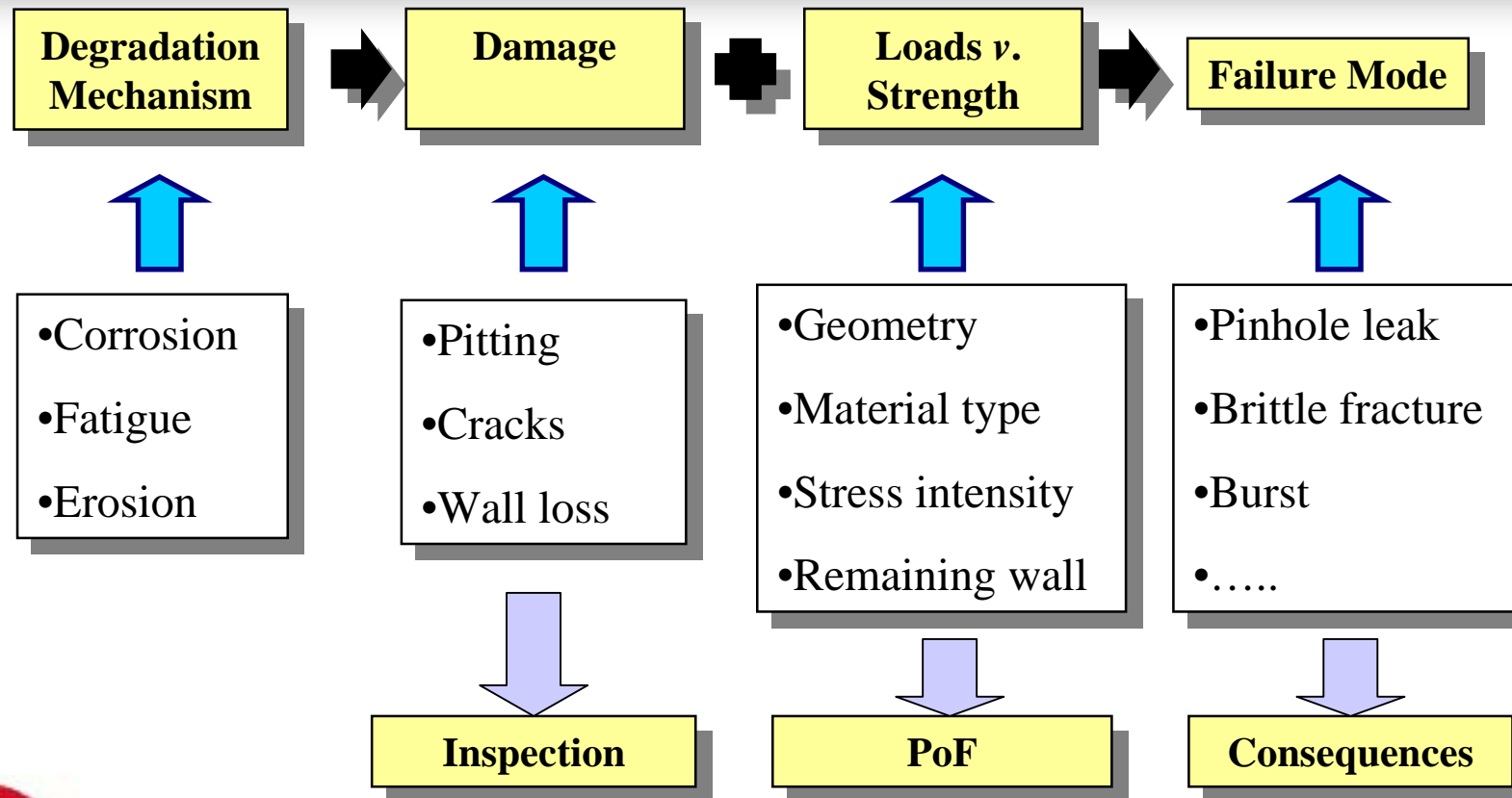


WP3: Risk Assessment methods

- 1: Probability of failure assessment
 - damage mechanisms
 - lifetime estimation
- 2: Consequence of failure assessment
- 3: Inspection/monitoring efficiency
- 4: Human aspects
- 5: Risk aggregation



Calculation of PoF



Knowledge of Materials Tells Us What Failure Mode to Expect

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WP4: RIMAP Application workbooks

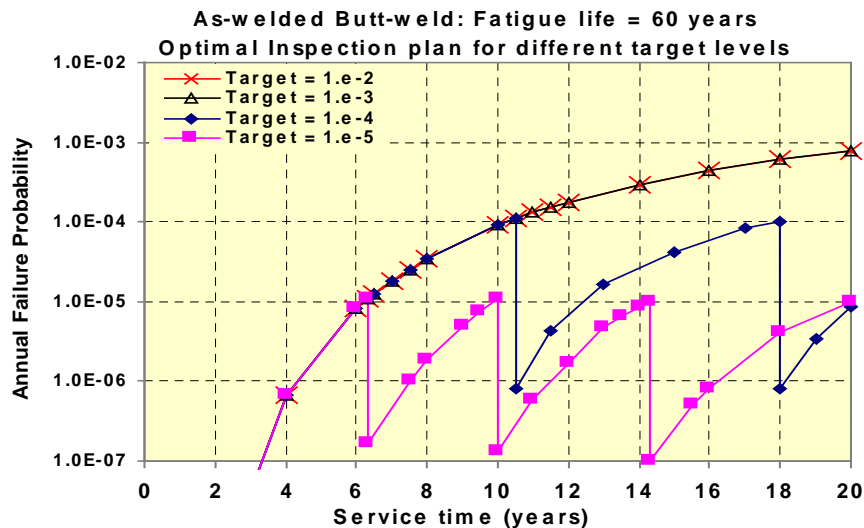
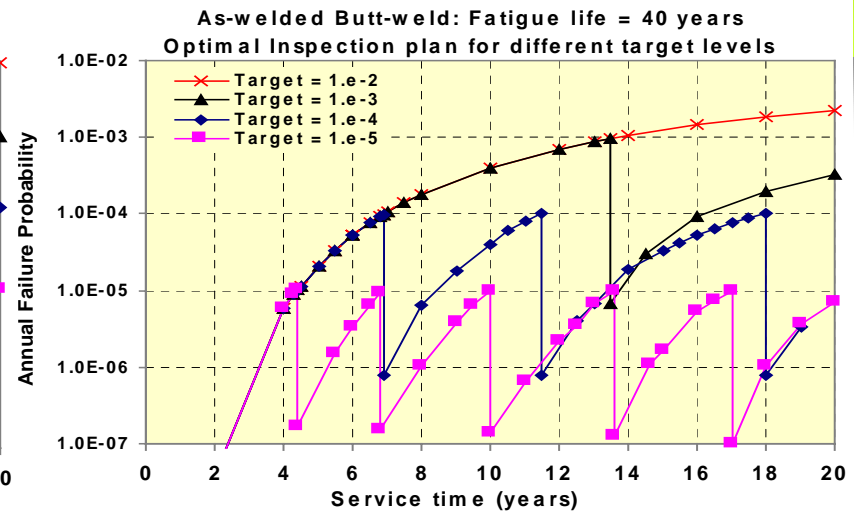
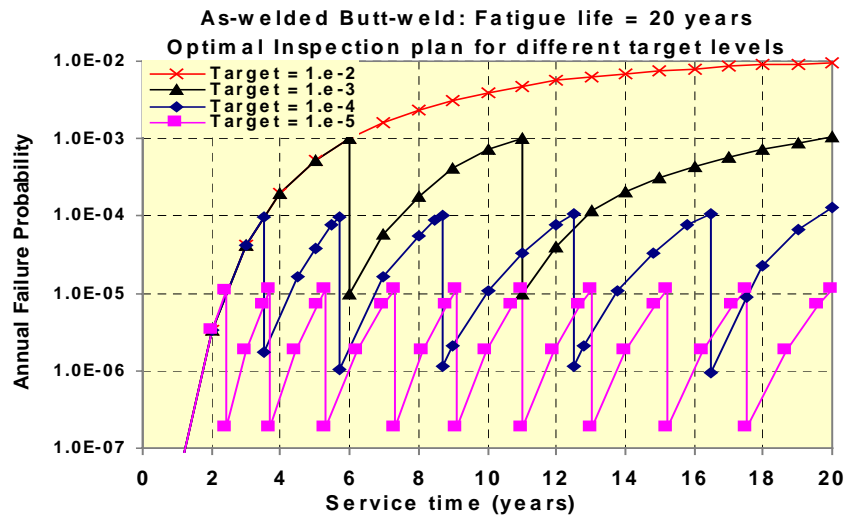
- 1: Working process for the development of inspection/maintenance programme
 - How, when, why
- 2: Risk reduction
- 3: Optimisation methods
 - safety/environment
 - cost-benefit

Deliverables:

- General workbook
- Workbooks per industry sector



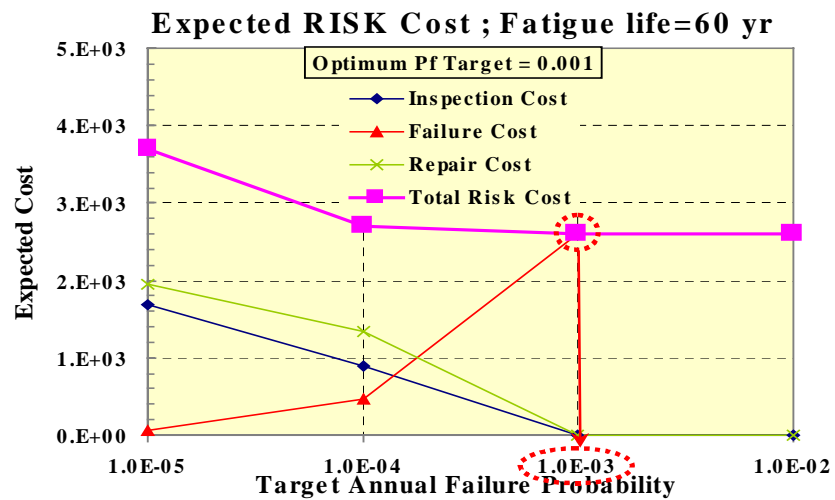
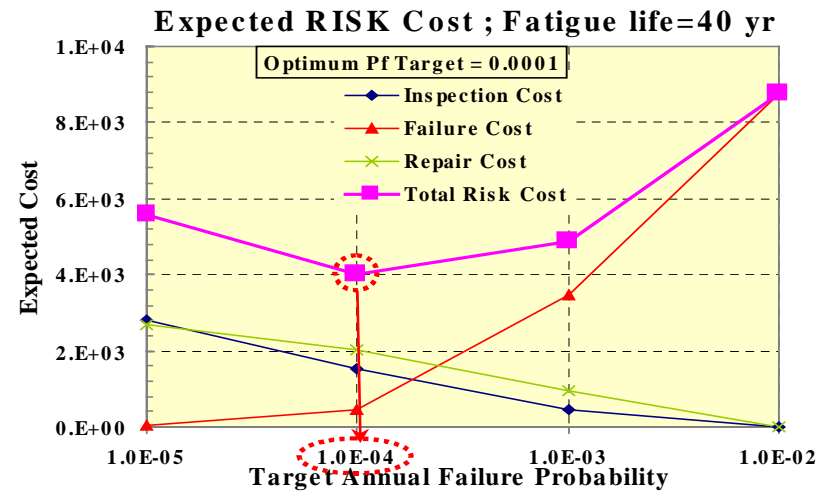
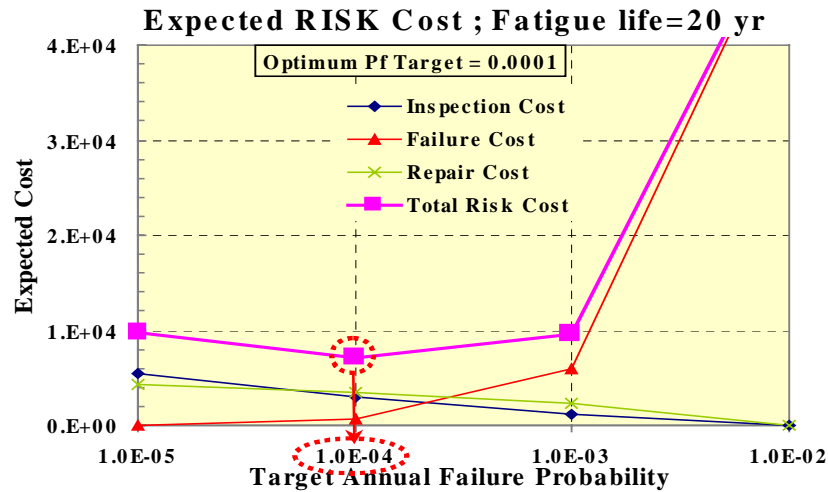
Selection of inspection scheduling programme - Example



Cost terms:

- Expected Failure cost $1.44 \cdot 10^6$ NOK
- Expected Inspection cost 1000 NOK
- Expected Repair Cost 10000 NOK
- Discount rate: 6%

Selection of inspection scheduling programme - Example



Number of inspection as function of target failure probability and fatigue life

Target Pf	Fatigue life (years)		
	20	40	60
1.0E-05	9	5	3
1.0E-04	5	3	2
1.0E-03	2	1	0
1.0E-02	0	0	0

Optimal Target = 10^{-4}
=> Scheduling program



RIMAP Demo: Demonstration

Per industry group:

- Petrochemical industry (Exxon & DNV)
- Power Industry (MPA, EnBW, Siemens, ESB)
- Steel works (Corus)
- Chemical industry (Dow, Solvay, Hydro)

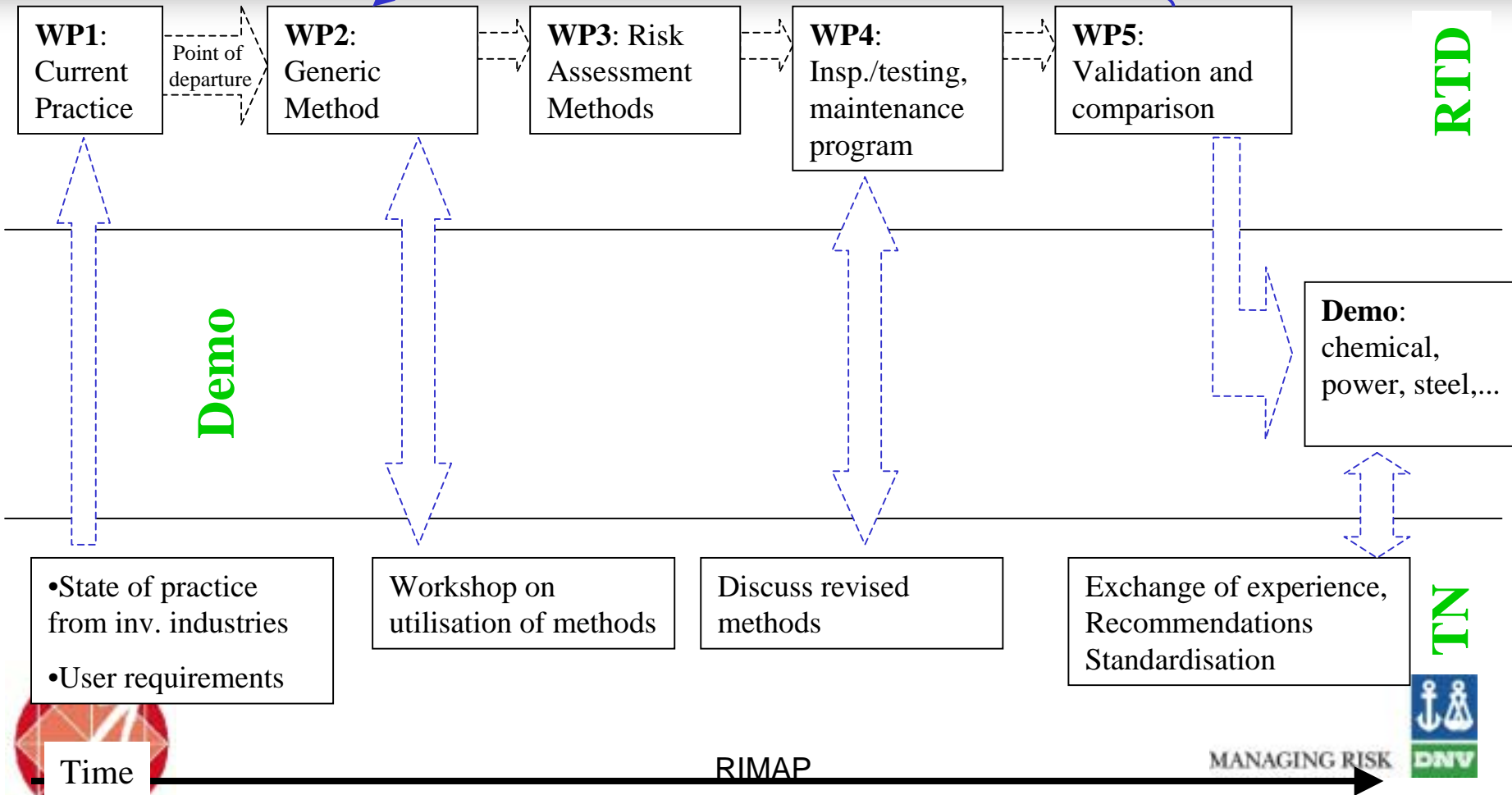


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RIMAP WP-relations

Update on RBMI



RIMAP Innovation

- The integration of maintenance (RCM) and inspection (RBI) into a uniform decision process
- The use of probabilistic decision analysis for process systems
- Combining the theoretical modelling of plant failure ("hard" knowledge) with plant experience ("soft" knowledge)
- Technology transfer between industry sectors, i.e..



Goals & Benefits

For the plants/end-users:

- reduced operational and failure costs.
- a clear philosophy for planning

For the inspection companies:

- Tailoring of tools and methods
- know limitations

Regulators:

- basis to set proper requirements
- basis for standardisation

Consultants:

- enhanced services for the industry in particular during plant-networking and outsourcing.



RIMAP; Risk Based Maintenance and Inspection

- **Improved control of high risk failures - more attention to high risk components.**
- **Improve cost effectiveness of inspection resources**
- **Balance focus on safety and economical risk - current practice tends to focus on safety only.**
- **Documented and traceable program.**
- **Systematic use of experience data - basis for:**

CONTINUOUS IMPROVEMENT



RIMAP

