Proactive & Predictive Waterfront Asset Management
Port of Rotterdam Experience

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January – Montreal, Qc
General Port Management Context

Business
- Meet bottom line expectations
- Maximize ROI over an extensive, expensive and diverse asset portfolio
- Generate revenues to cover the cost of capital in a competitive, dynamic and difficult to forecast marketplace
- In a very cautious private capital marketplace

Public
- Serve as responsible steward of public resources
- Generate jobs and economic opportunity
- Meet additional ad hoc demands
- In a public capital environment short on funds
General Status of Assets

- Aging infrastructure
- Growing deferred maintenance costs
- Inadequate capital allocation process
- Deficient data
- Run-to-failure maintenance program
- Inspections based on random observations, accident reports, intuition
- Seniors retire/leave, loss of “institutional knowledge”
- Uncertain level-of-service requirements
- Loss of competitive edge and productivity
- Safety/Security concerns
Asset Management Challenges

- **Corporate Culture**
  - “If it ain’t broke...”

- **Goals & Objectives**
  - “What do we want?”
  - “Where do we start?”

- **Other Priorities**
  - “…but we’re all too busy to take on something else!”
  - “Yes, it’s on the front burner...”

- **Budget**
  - “We can’t afford this, especially this year!”
Asset Management Reality

- AM issues will not go away
- Solutions will not be easier or cheaper over time
- Pick a goal and get started
A Comprehensive Approach

Pre-Design  Design  Construction  Maintenance  Rehabilitation  Recycling

Cumulative Damage

Time

WITHOUT INTERVENTION

CURRENT CONDITION

REPAIR

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Unified Facilities Guide Specifications (UFGS)

- New Facilities 2012-2015 - $2.6 B
- Results in cost avoidance: $168 million per year
- 25% life extension of the facilities
Waterfront Structure Management System (WSMS)
Port of Rotterdam

- Largest port of Europe
- 4th largest in the world
- 80 km of quay walls
- 200 km of banks
- Invested capital: €2.9 billion ($3.75B)
- Yearly maintenance budget: €70M ($90M)
WSMS Trigger

C-Level questions:

- What will happen if the proposed budget is NOT granted?
- Can you even out the budget over the years?

The problem for the asset manager:

- Which assets do I put the money on?
- What risks do I incur if I postpone maintenance interventions?
- In the long run, how does this influence the remaining life?
Asset Management

ASSET MANAGEMENT MATURITY

- INNOCENCE: Repairs are as good as before
- AWARENESS: Reactive – fix it when it breaks
- UNDERSTANDING: Systems are a valuable tool – information as an asset
- COMPETENCE: Repairs are as good as NEW
- EXCELLENCE: Maintenance is part of the supply chain

Attitude shift from cost focus to value focus

Focus is on lifecycle & reliability
Optimized decision-making

MAINTENANCE COSTS
COSTS GO DOWN
MAINTENANCE IS AN EXPENSE

RELIABILITY & PERFORMANCE
WHILE VALUE & PERFORMANCE INCREASE
MAINTENANCE IS AN INVESTMENT
WSMS Objectives

Objectives:

- Manage inspections (3 types of inspections)
  - Visual Inspection
  - Technical Inspection
  - Lifetime Inspection
- Manage maintenance budget
- Manage repairs
WSMS Process Flow

LEGACY SYSTEM

Data Analysis
- Next Intervention
- Immediate Repairs
- Prioritization of Repairs

Technical Inspection (Field Measurement)
- Next Intervention

Lifetime Inspection (Deg. Curves)

Residual life & Optimum Repair & Maintenance
- Risk Analysis

Visual Inspection

LCCA

CONSEQUENCES
- Likelihood
  - Atmosphere: Minor, Major
  - Major: Major, Significant

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Inventory Database

STEP 1

Inspection Request

Concrete → Coring → Full Analysis Chemical Analysis

Steel → Visual Inspection

Coring → Cathodic Protection

Corrosion Measurements
STADIUM® Expert System

Degradation Analysis per Zone and Element
Evaluate Degradation with STADIUM®

Post Treatment Analysis

For each Zone/Element combination
Select the most critical Zone/Element combination

Schedule Next Inspection
Close Monitoring Required
Repair

Critical Year (Trigger/Intervention)
Maintenance Proposal
Graph for harbour "Hartelhaven" and section "H-L-N-MV-047-KAD-004-A" (150101/49)

**Portlandite analysis**
Source: SIMCO Technologies

- **Front of Portlandite @ 35.686 g/kg**

**Input Data**
- Initial Portlandite Content: 39.7 g/kg
- Portlandite Content Dissolution Threshold (90% Initial Content): 36.7 g/kg
- Position Threshold Zone Factor: 90%
- Red Flag Position (Concrete Cover): 60 mm

**Analysis Data**
- **Portlandite Dissolution Depth**
  - Inspection Year: 35.2 mm
  - End of Contract Year: 54.1 mm
- **Portlandite Content at Yellow Flag Position**
  - Inspection Year: 43.8 g/kg

**Flags**
- Yellow Flag Reached In: 2028
- Red Flag Reached In: 2035
STADIUM® Expert System

Evaluation Order "150057" on Section "H-L-H-MV-037-KAD-003-B"

<table>
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<th>Current Analysis Year</th>
<th>2011</th>
<th>Inspection Date Year</th>
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Evaluation Order "150057" on Section "H-L-H-MV-037-KAD-003-B"

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<th>Comission Scale</th>
<th>2.692</th>
<th>Construction Year</th>
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Steel analysis
Source: SIMCO Technologies

Alert 0

|---------------|---------------|-------|------------------|-------|------------|-------|------------|-------|

1st hole
Strength
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Ground
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Critical Zone
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|        |

Year Trigger
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|        |

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Risk Calculation & Prioritizing
From Risk Analysis to Prioritization of the Maintenance Plan

Generic risk analysis (FMECA/RCM)

Determine generic risk effect, financial risk and probability

Combine asset & generic risk for a specific risk factor

One factor to express the economic added value of an asset

Prioritization of the maintenance plan based on the risk factor and business value
Risk Calculation & Prioritizing
From Risk Analysis to Prioritization of the Maintenance Plan

The risk matrix to determine the risk effect is constructed out of three levels:

Level 3: Risk effects, determining the risk factor

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<th>Sustainability (points)</th>
<th>Reputation &amp; aesthetics (points)</th>
<th>Availability (points)</th>
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Level 2:

Level 1:
Prioritization
## Prioritization

### Task Description

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WSMS Benefits

- **Short term:**
  - Transparency in annual budget for maintenance

- **Mid - Long Term:**
  - Insight on residual service life and maintenance costs per structure
  - Insight on total port concrete and steel costs
  - “Just in time” inspections
  - Proactive, prioritized and risk-based maintenance
  - Save $$$
KMS - Awards

At the iMaintain Infrastructure Congress that took place in November 2012, by the Dutch Association for Effective Maintenance (NVDO), Port of Rotterdam’s KMS system is awarded “Project of the Year 2012”.

At the 2013 ACEC Engineering Excellence Awards, Port of Rotterdam’s Quaywall Modeling System (KMS) receives the 2013 ACEC New York Gold Award.
Thank You

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