INNOVATIVE TECHNOLOGIES FOR AGING INFRASTRUCTURE

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Water Research Foundation
Infrastructure facilities are intrinsically linked to economic performance

- The aggregate needs for investment in water mains through 2050 exceed $1.7 trillion (AWWA 2012)
- Water scarcity
- Changing trend in industry (moving from capital to O&M)
- There is a growing gap between required and projected financing of water infrastructure due to unviable water pricing
Implementation of Advanced Asset Management is Warranted

- Traditional reactive maintenance programs are no longer adequate
- Imbalance between capital and O&M investments
- Many water assets are distributed over large distances, with different ages, material type, and operating conditions
- Degradation of long-term planning for future asset enhancement and greater financial burdens
Prognostic asset management offers an attractive solution.
Project Objectives

- Review of available and emerging technologies
- Detailed technical assessment of the applicability of these technologies specifically to water industry
- Guidance to manage assets
Project Participants

- 29 Water Utilities/Agencies around the globe
- 16 Solution/Equipment Providers
- 3 Academics
Research Approach

Task 1: Literature Review
Task 2: State of the Industry Survey
Task 3: Interview with Technology Providers
Task 4: Case Studies
Task 5: Final Report
Progress Results
Based on our survey of 54 respondents globally.
Where are the needs for asset condition assessment?

Based on our survey of 54 respondents globally.
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### Major concerns related to asset classes

<table>
<thead>
<tr>
<th>Type of Assets</th>
<th>Surface deterioration</th>
<th>Mechanical issues</th>
<th>Electrical issues</th>
<th>Software/hardware issues</th>
<th>Data management issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmission and distribution systems</td>
<td>65</td>
<td>10</td>
<td>0</td>
<td>2</td>
<td>24</td>
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<tr>
<td>Rotating equipment</td>
<td>7</td>
<td>44</td>
<td>32</td>
<td>6</td>
<td>12</td>
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<tr>
<td>Storage</td>
<td>75</td>
<td>6</td>
<td>2</td>
<td>0</td>
<td>17</td>
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<tr>
<td>Control &amp; communication (SCADA)</td>
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<td>3</td>
<td>22</td>
<td>39</td>
<td>35</td>
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<tr>
<td>Physical &amp; digital security</td>
<td>3</td>
<td>1</td>
<td>10</td>
<td>43</td>
<td>43</td>
</tr>
</tbody>
</table>

Based on our survey of 54 respondents globally
Condition Assessment Technologies: Literature Review

Robot inspection system

Distributed fiber optic sensors

Sonar technology for subaqueous Imaging

Remote Field Testing (RFT) technology

Acoustic sensor-based in-line leak detector

Electromagnetic flux leakage technology for corrosion detection
Technologies Distribution

- CCTV inspection
- Acoustic leak detection system (external)
- Enterprise asset management software
- Robotics technology (ROV)
- In-line leak detector (acoustic)
- Advanced metering infrastructure (AMI)
- Electromagnetic/electromagnetic flux leakage...
- Eddy Current Testing (ECT)/Remote Field Testing...
- Broadband electromagnetic (BEM)
- Sonar technology for leak detection
- Visualization of big data analytics
- Wireless sensor technologies
- Smart wet infrastructure modeling and...
- Acoustic guided wave inspection
- Acoustic fiber optics (AFO)
Where are these technologies applied?

- Robotic technology
- Electric/electromagnetic-based
- Remote monitoring & data solutions
- Acoustic-based
- Sonic/Ultrasonic-based
- Fiber optics

North America: 40% Robotic, 30% Electric, 15% Remote, 10% Sonic, 20% Acoustic, 5% Fiber

Europe: 45% Robotic, 35% Electric, 15% Remote, 10% Sonic, 20% Acoustic, 5% Fiber

Australia: 30% Robotic, 25% Electric, 20% Remote, 15% Sonic, 20% Acoustic, 5% Fiber

Middle East: 20% Robotic, 30% Electric, 20% Remote, 20% Sonic, 20% Acoustic, 5% Fiber
Emerging Technologies for Linear Assets

Distributed fiber optic sensors

- Used mostly in Oil & Gas, Transportation, Power Transmission, Bridge structures, etc.
- Can be used for detecting multiple attributes including:
  - Leak detection
  - Strain measurement/deformation
  - Mechanical failures/detecting breaks in prestressed tendons
  - Temperature changes
  - Encroachment/unauthorized access

Source: Sensorland.com
Emerging Technologies for Linear Assets

Pipe-in-a-pipe solution to install fiber optic sensor

The Atlantis Hydrotec® Solution - Benefitting cities and communities

Source: Craley
Emerging Technologies for Linear Assets

Ultrasonic Guided Wave Testing (GWUT)

- Used for internal/external corrosion detection /wall thickness variations in pipe wall
- Detect delineation of the internal CML coating
- Detection of defects in weld connections

Source: Stantec Project (City of Hamilton)
Spot repair using fiberglass wrap while pipe is in operation (180 psi)
Emerging Technologies for Vertical Assets

Magnetic Flux Leakage (MFL)

• To accurately detect corrosion and pitting in steel structures
• Mostly for pipeline application, but can be used for storage tanks
• Can detect corrosion through detection of magnetic field “leaks” from the steel
• Tanks need to be emptied and cleaned

Pipeline application (Pure Technologies)

Tank floor assessment (Eddify Technologies)
Emerging Technologies for Vertical Assets

Distributed fiber optic sensors for vertical assets

- Combining optical sensors, fiber optic cables and advanced algorithms.
- For leak detection, water level, and temperature monitoring.

Source: Rizzolo et al., Scientific Reports, Nature, 2017
Emerging Technologies for Vertical Assets

Vibration and Ultrasonic Sensor for Rotating Equipment

Data collected can be analyzed and viewed in real time using built-in analytics

Source: Augury
Use of Data Management Software

Not implementing data management software:
- Reactive: 28%
- Preventive: 28%
- Proactive: 28%
- Predictive: 16%

Implementing data management software:
- Preventive: 33%
- Reactive: 23%
- Proactive: 25%
- Predictive: 19%
Top 3 Challenges in Asset Management

**Small-Size Organization**

1. Lack of financial resources to evaluate new technologies
2. Lack of time/resources to collect data
3. Lack of integrated effort within the organization

**Large-Size Organization**

1. Lack of time/resources to collect data
2. Lack of integrated effort within the organization
3. Lack of financial resources to evaluate new technologies
Top 3 Benefits of Asset Management Implementation

**Small-Size Organization**
1. Improved efficiency of daily operation
2. Extended service life of physical assets
3. Improved asset performance visibility

**Large-Size Organization**
1. Cost savings
2. Improved troubleshooting, response time and maintenance planning
3. Extended service life of physical assets
What are we missing?

- Learning from other industries about effective applicable technologies
- Case studies about success stories
Case Studies

Fiber optic sensors for strain, temperature, and vibration

Advanced Asset Management

Emerging rehabilitation technologies (e.g., SippTec, Automatic Leak Repair)

Vibrational & Ultrasonic sensors for rotating equipment

Advanced ultrasonic technologies

Other advanced condition assessment technologies

P-CAT™
How to Get Involved

• If you would like to participate in the project by providing information about other emerging technologies and/or case studies/pilot projects, please contact us after this meeting:

  Erez Allouche: erez.allouche@stantec.com

  Ayu Sari: ayu.sari@stantec.com

• We would request documents related the project(s) that you want to highlight

• We would also request a short call with you to discuss about the project. We will prepare a summary and send it back to you for review.