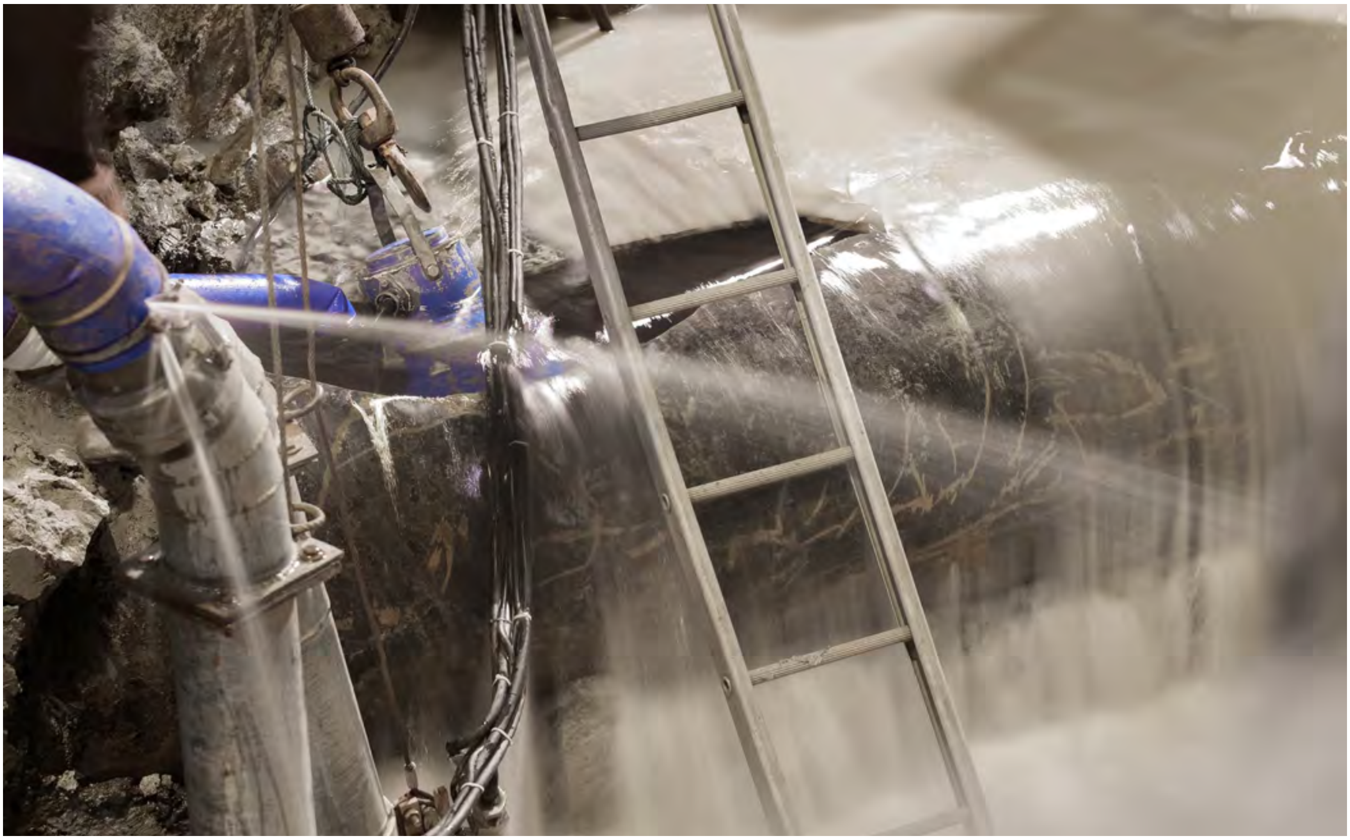

Proactive maintenance seeks to prevent problems before they occur and is 5 to 10 times cheaper than emergency repairs.
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HARNESSING DATA CAN HELP PRESERVE INFRASTRUCTURE MORE ECONOMICALLY

By **Ariel Stern**

The average age of Canada's four main classes of infrastructure was examined by an Investment and Capital Stock Division report in 2007. That survey, like its predecessors, showed that the country's infrastructure aged significantly between 1973 and 1999. The trend began to reverse slightly, beginning in the early 2000s, with a process of infrastructure "rejuvenation" due to increased investment, particularly in the provinces of Quebec and Ontario.

Waiting for infrastructure to fail is obviously an untenable strategy. Finding more intelligent ways to both prioritize backlogged repairs and direct limited maintenance capabilities is, therefore, the best means infrastructure managers have of managing its decay to maximize its useful life span.

TRADITIONAL APPROACHES

Reactive maintenance, also known as run-to-fail (RTF), means simply allowing infrastructure to run to the point of breaking before it is repaired. This may be an acceptable strategy for replacing household light bulbs, but is obviously unsuitable for public infrastructure.

Proactive maintenance is an approach that seeks to prevent problems before they occur and it's 5 to 10 times cheaper than emergency repairs. It breaks down into preventative and predictive maintenance.

Preventative maintenance is triggered by a condition that dictates that the infrastructure be fixed to prevent its impending failure (e.g., a low battery rate that, if not remedied, will lead to a sensor's outage); a fixed time schedule; or readings from a sensor in an adjoining system (e.g., adjusting a sewer's configuration in response to rising water levels that, unchecked, could result in a sewer overflow event).

Predictive maintenance could be regarded as a higher form of proactive maintenance, comprising systems that use intelligent analysis to attempt to predict equipment failures before there are any direct indications they are on course to occur.

EVOLUTION OF MAINTENANCE APPROACHES

Proactive maintenance represents a significant advance over reactive maintenance. However, its adoption has been severely hindered by the difficulties in deploying sufficiently wide remote monitoring sensor networks to overcome the limitations of monitoring by taking manual "field readings".

Traditional telemetry solutions for remote monitoring were expensive, cumbersome, lacked communications redundancy, and often worked only on external power sources. This, in turn, created a physical limitation as to how far along a network's edge they could be deployed.

Even if such a remote monitoring network could be deployed to a sufficient scale, the lack of advanced data analytics platforms could overwhelm SCADA engineers with a flood of unmanageable information, burying actionable insights amidst unnecessary network noise.

The arrival of remote monitoring was, in itself, a sizeable advance over the initial model of proactive maintenance. This was sending teams into the field to take readings from legacy, handheld sensor equipment. However, its current implementation still falls far short of what would be optimal to best maintain infrastructure. Because of these difficulties, sensor deployments tended to be partial at best.

Also, the combination of irregular field visits and limited information from the network edge (through the remote monitoring of infrastructure) did little to ensure comprehensive awareness of an infrastructure network's state.

A HYBRID APPROACH IS KEY

Data is the lifeblood of both preventative and predictive maintenance and, finally, the times are changing. The Industrial Internet of Things (IIoT) is quickly gaining momentum. Telecommunications operators are launching dedicated, power-efficient networks specifically designed for IIoT requirements. NB-IoT is at an advanced planning stage, and the unlicensed LP-WAN family of networks (including LoRa and Sigfox) are already in active use.

IoT communications gateways, no larger than a landline telephone, now are capable of doing the same job as outdated telemetry cabinets and at a fraction of the cost. This new breed of ultra-low-power IoT networks utilizes either existing telecommunications infrastructure, or proprietary transmission systems and can be located virtually anywhere.

In tandem, the emerging field of edge analytics is seeing ambitious hardware engineers cram powerful offline-operable data analytics software aboard these compact devices. Data is crunched in situ on the network edge and relays only pre-analyzed information to human eyes in SCADA control rooms.

The first key to improving maintenance strategies used to keep the vast stock of public infrastructure in good health is deploying these widespread smart networks as quickly and aggressively as possible. The next step for utilities is to develop digital systems based on the tried-and-trusted techniques of old, using electronic scorecard systems to prioritize

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repairs by urgency and importance.

In the interim, it is still impossible to maintain all infrastructure elements at all times. But, the availability of cost-effective, smart infrastructure monitoring and powerful analytics capabilities means that an intelligent program of proactive maintenance can be realistically undertaken by utility managers for the first time.

This could come, for example, in the form of proactive strain monitoring which could help avert catastrophes. The incident at the Oroville Dam in California earlier this year is a striking example of how dangerous compromised infrastructure can be. Nearly 200,000 downstream residents were advised to evacuate after workers noticed the dam's emergency spillway was severely damaged, leading to fears part of the dam might fail.

Assets exhibiting or predicting a state of disrepair can be afforded priority attention by repair crews, saving overall resources and improving network efficiency. Infrastructure aging at an expectable rate can be safely ignored for as long as it is safe to do so.

Repair work being done on the damaged Lake Oroville Dam flood control spillway.
Photo by Kelly M. Grow/ California Department of Water Resources

Ariel Stern is CEO of Ayyeka. For more information, email: info@ayyeka.com