infraPLAN Ask the Experts! #5_2

You may be underestimating how soon your water pipes will break

if pipes that have been abandoned are not included in the break prediction analysis.

Let's first illustrate our point with an example.

Imagine we want to predict what the condition of a 55-yr old pipe will be 25 years from now, at 80. We consider the behavior of all similar pipes that ever reached 80, those still active and those abandoned. However, pipes that degrade in a similar fashion, are not exactly similar: some are better; some are worse; some are younger; some are older.

Furthermore, utilities tend to replace pipes that are older and in worse condition. The table below illustrates that fact at a mid-size utility. It shows the length, average age and yearly break rate for pipes that were abandoned or are still in service. Abandoned pipes on average were older (80 years old at the time they were abandoned, as opposed to 55 at the present time for those still in service). They were also in worse condition with a break rate nine times higher than for those still in service.

	Abandoned pipes	Active pipes	Ratio Abandoned/Active
Length (mi.)	98	997	9.80%
Average yearly break rate (number of breaks/mi./yr.)	0.35	0.051	8.8
Age	80	55	1.5

Let's imagine that there are pipes similar to the ones abandoned that are still in service but in much better condition. If we did not have access to the abandoned

pipes data, we would be predicting the behavior of the 55-year-olds in 25 years (that, on another end, still include good and bad pipes) based on the behavior of the 80-year-olds that are left, which are the best ones. This would create a bias: the 55-year-old pipes will be predicted to be in better condition at 80. As a result, the utility may not properly budget R&R investment, and may face service disruptions at an unanticipated level.

We could even imagine a scenario in which budgeting would not be possible at all if abandoned data are not available. For example, after years of efficient abandonment, the pipes left may, for a while, experience very few breaks (but will certainly start breaking in the future). What would the engineers rely on to plan the R&R of the pipes for the next 20 years if no data exist for the pipes that have been abandoned, and the ones left had few breaks? How will they justify their budget requests?

Let's borrow from public health to illustrate this point further.

Would it make sense to predict human longevity by including health data solely on the living or on the healthy population? Would we know about the risk factors of a disease if, in our study, we only included the individuals who recovered or never got sick; and ignored the ones who died?

Statistical analyses of pipes degradation borrow heavily from public health. Both fields study a population (pipes in the water industry; individuals in public health) over a set period of time, and look for a specific occurrence (break; disease) pertaining to their physical condition. It is obvious that data from the deceased population enhance the accuracy of predicting human life expectancy; it is vital to apply the same principle to pipes experiencing breaks.

In other words, for optimal pipe failure forecasting analyses, all pipes in service during the whole or part of the period of breaks observation should be taken into account, including pipes no longer active.

Does your failure forecasting approach include abandoned pipes?

The good news (when it comes to analytics) is that, to date, most U.S. utilities have only replaced a small percentage of their original stock of pipes. As a result, missing abandoned pipes data has had limited impact on the accuracy of pipe failure forecasting. However, as utilities start replacing more pipes, the percentage of abandoned pipes will only grow, and the negative consequence of missing those pipes in the analysis will also worsen.

Part 3 of this Data Series will show how to start collecting that data and how to organize it for integration into an advanced pipe failure forecasting model that can be used right away, and accurately.

Part 1 describes the datathat is necessary to conduct a machine learning-powered failure forecasting analysis **(Article 5_1)**

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