

# Augmented Intelligence Applied to Natural Gas Ultrasonic Measurement

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## Abstract

We hear a great deal in the news about how Artificial Intelligence and the Internet of Things (IoT) is changing our lives, and how it will transform businesses across the globe. It's likely your business is already using some form of intelligence technology today. Research shows that on average nearly 80% of analysts' time is spent collecting and gathering data, while less than 20% of their time is spent analysing and communicating results to stakeholders. This paper explores the extent to which the application of Augmented Intelligence developed from continuously collected metering diagnostics can automate measurement analysis. The paper analyses the results of applying augmented intelligence methods to natural gas ultrasonic metering systems. The paper demonstrates that integrating augmented intelligence techniques into operations improves efficiency by 1) lowering the operator's time to resolve measurement issues, 2) lowering the number of adverse events 3) allowing for a greater focus on problematic stations. The result is that operators lowered their exposure to measurement error. The analysis indicates a steadily decreasing exposure to measurement error risk over time. After 4 years of implementation, the augmented intelligence methods were reducing risk by 1.3 Bcf/year (\$4M at \$3/Mscf) per 100 meter sites.

## 1. Introduction

Augmented Intelligence and Internet of Things are here and advancing business processes across the globe. It is estimated that by 2020, there will be around 30 billion IOT connected devices. These IOT devices generate vast amounts of data that can be difficult to effectively or efficiently understand. That's where augmented intelligence comes into play. Augmented Intelligence helps humans and machines come together to solve complex issues, reduce costs and achieve safer, faster results in a multitude of industries. In today's market, your business requires real-time awareness and data that AI provides, in turn, providing you with improved results and advanced decision making.

## 2. Time Spent on Data Analysis

Augmented intelligence systems make analysis more efficient and accurate by automating much of the work and decisions that analyst routinely perform. Figure 1 below illustrates current research breaking down how data analysts spend their time. The table shows that analyst spend less than 20% identifying insights and communicating these insights with stakeholders. They spend over 80% of their time gathering, cleaning, visualizing, selecting and applying analysis techniques.

Effective augmented intelligence automates much of this work [1].

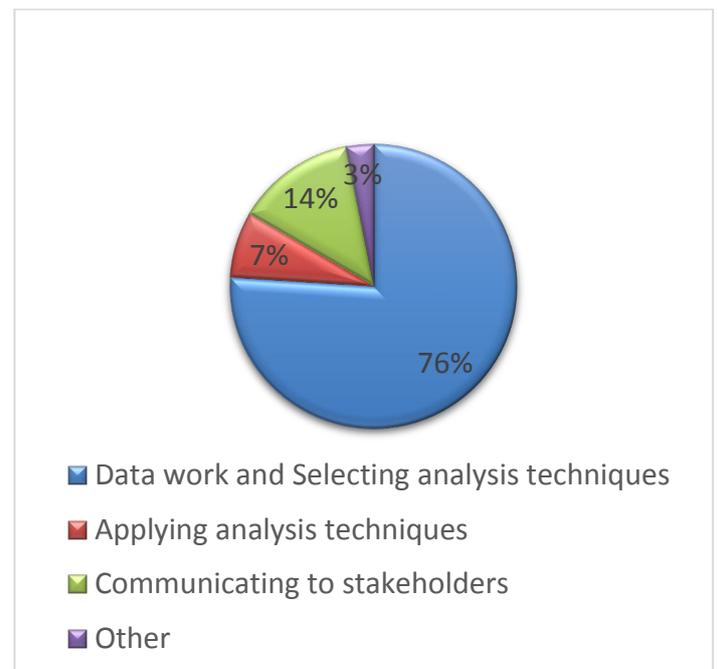


Figure 1: Time Data Analyst Spend on Job Task

### 3. Current State of Practical Machine Learning

News articles on augmented, or artificial, Intelligence tend to focus on cutting edge research using advance machine learning techniques such as Neural Networking and Deep Learning. However, current research shows that the most common techniques implemented by today's analysts are more mundane such as Regression and Time Series Analysis, Decision Trees, Rules, Visualization, Statistics, and Clustering [2]. Figure 2 illustrates the findings.

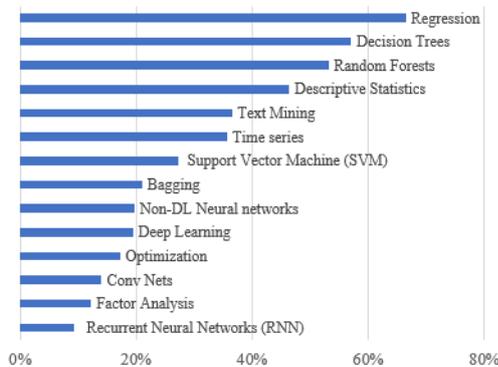


Figure 2: Respondents use of machine learning techniques [2]

Modern natural gas ultrasonic metering equipment produce tremendous amounts of diagnostic data. The question is, can current machine learning techniques be applied to the diagnostics to make measurement analysis more efficient?

### 4. Analysis of Augmented Intelligence Methods

This paper analyzes results from four years of augmented intelligence methods applied to natural gas ultrasonic metering systems. The data set from CEESmaRT includes a diverse array of metering equipment (meter sizes, brands, and geometries; flow computer brands; chromatograph brands; temperature and pressure transmitters; etc.).

The data was normalized to express the results per 100 meter stations. Of the total events detected by the augmented intelligence:

- 46% of the events detected included sufficient diagnostics information to estimate an error and provide maintenance recommendations, such as replacement of ultrasonic meter transducers, meter cleaning and/or removing debris from in front of the flow conditioners, or various flow computer, chromatograph,

pressure and temperature transmitter failures. Uncertainty estimates were developed from data sets collected at an ISO 17025 laboratory [3].

- 52% of the events detected contained sufficient information to identify preventative maintenance or non-critical equipment failures that did not cause an appreciable increase in uncertainty such as degradation in a ultrasonic meter transducer performance, ultrasonic noise effecting the meter, chromatographs in hold mode or not auto-calibrating, and pressure or transducer drift.
- 2% of the events detected identified a problem, but the failure was such that there was not sufficient diagnostic information to reasonably estimate an error or an increase in uncertainty such as total equipment failures.

The events were divided into 5 major categories: 1) UFM transducer and electronics issues, 2) Flow Computer issues, 3) Contamination and/or debris in the meter tube, 4) Pressure and Temperature measurement issues, and 5) Chromatograph issues. Figure 3 illustrates the average results for the entire four-year period.

Issue	% of sites	Events per Year	Resolution days (avg)	Impact (Mscf)
USM Transducers & Electronics	21%	37	70	608,734
Flow Computer	7%	8	38	375,681
USM Dirty/Debris	13%	21	78	164,070
P&T Transmitters	9%	12	46	73,188
Chromatographs	30%	44	49	170,950
	55%	123	59	1,854,556

Figure 3: Average Event Detection Results

For each of the categories the table illustrates the percentage of sites where an event was detected, the average number of events, the average time required to resolve an event, and the impact of the event (error or increased uncertainty given in units of Mscf).

#### 4.1 Analysis of Response Time

For the four-year period, the number of days it took to correct an issue averaged 59 days. This response time includes several factors: 1) prioritizing the event, 2) ordering parts as needed, 3) scheduling the equipment and resources need to perform the work, 4) and making operational arrangements to perform the work, for example scheduling a shutdown for maintenance.

Figure 4 below shows that over the four-year period, the response time decreased by 34%. The result suggests continual improvement as operators learn to trust and use augmented intelligence.

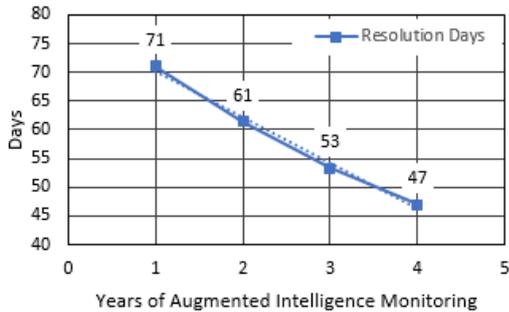


Figure 4: Average Response Time Per Year

#### 4.2 Analysis of the Detected Events

Over the same four-year period, on average 123 events were detected per year. Figure 5 below illustrates the trend over the four-year period.

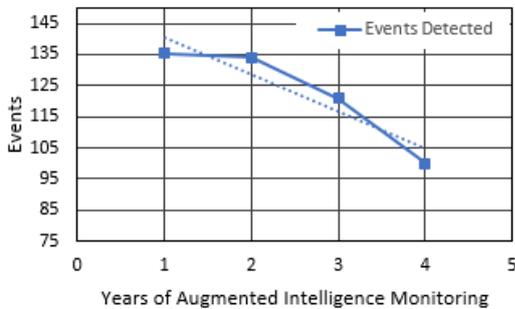


Figure 5: Average Number of Events Per Year

Like the resolution time, the trend also decreased (26% over the period), again suggesting that continued use and familiarity with the augmented intelligence had a positive impact on measurement operations.

The analysis also showed that the percentage of sites where augmented intelligence detected issues decreased by 44% over the four-year period. Figure 6 below illustrates the trend.

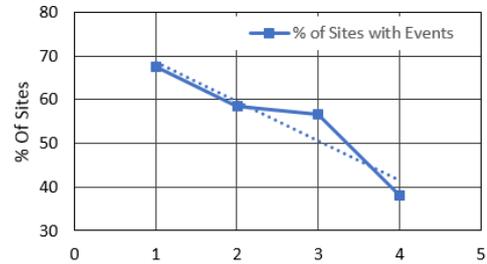


Figure 6: Average Number of Sites with Events Per Year

Combining the previous two findings shows that over time the events are concentrated at particular sites, allowing operation teams to focus their resources on problematic sites. Figure 7 below illustrates this. Over the four-year period the number of events per year at sites with an event increased by 30% (on average from 2 to 3 events per year).

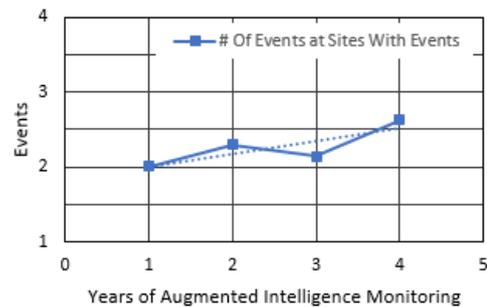


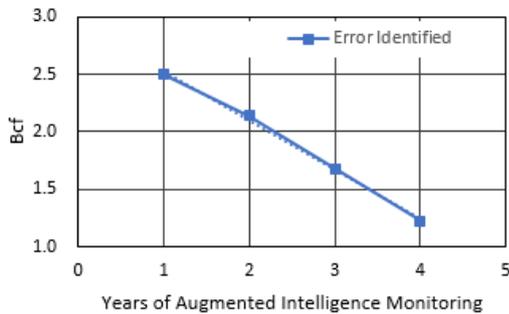
Figure 7: Average Number of Events at Sites with Identified Events

#### 4.3 Analysis of the Impact

Thus far, the analysis shows that as augmented intelligence methods are trusted and integrated into operations, the results are:

- A decrease in event resolution time.
- A decrease in the number of events.
- A greater focus on problematic stations.

Figure 8 below illustrates the final impact of augmented intelligence. The downward trend shows that the operator's exposure to measurement risk.



**Figure 8:** Impact of augmented intelligence.

Figure 8 shows that in the initial year of the implementation of augmented intelligence monitoring, 2.5 Bcf of error were identified. By year 4 the amount had been reduced to 1.2 Bcf. Therefore, in year 4 the augmented intelligence methods reduced measurement error exposure by 1.3 Bcf (\$4M at \$3/Mscf).

## 5. Conclusion

The analysis shows that application of augmented intelligence can significantly improve the efficiency of measurement analysis. The analysis shows that as operators integrate these techniques into their operations, they lower the number of measurement events, decrease the resolution time, and can focus their resources on problematic sites, resulting in a reduction in exposure to lost and unaccounted for gas. The analysis indicates a steadily decreasing exposure to measurement error risk over time. After 4 years of implementation, the augmented intelligence methods were reducing risk by 1.3 Bcf/year (\$4M at \$3/Mscf) per 100 meter sites.

## References

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- [3] Randy Miller, Ed Hanks, "A History Of Naffmc Installation Effects Testing Including Current Testing"