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DIGITAL TECHNOLOGIES

A better data pipeline supports a better H_2 pipeline

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As the global focus on sustainability continues, an increasing interest in hydrogen (H_2) operations has emerged. Consequently, the world has become more focused on H_2 transportation methods to support those operations. In North America, hundreds of thousands of miles of existing pipelines are already designed and maintained to transport natural gas. In the coming years, some of these pipelines will start carrying blends of natural gas and H_2, while others may be converted to carry pure H_2. Moreover, as the popularity of H_2 increases, more pipelines will likely be built to support expanding operations globally.

As companies repurpose existing lines, retrofit them for H_2 operation or build new pipeline infrastructure, they must tactically employ new and existing technologies to handle the increased complexity of working with H_2. H_2 is more corrosive and difficult to contain than natural gas due to its small molecule size. Further increasing the complexity is H_2's high ignition potential, highlighting the safety, prediction and monitoring in any pipeline engineering operation.

In the face of these complexities, successfully designing, monitoring and monetizing pipelines for H_2 or blended product transmission will require a wide array of systems working together to safely deliver and track the products properly from end-to-end of the value chain. Today, many North American companies are working with various solutions linked via complex custom programming, or with unlinked solutions requiring manual transmission and data translation. However, the time and effort spent maintaining these complex architectures, or chasing data between siloed solutions, makes it difficult, if not impossible, to compete in an ever-expanding global marketplace.

Today's industry leaders are instead turning to software solutions that leverage automation[a]. These solutions are seamlessly integrated from end-to-end across the value chain, easily moving data from the intelligent field, through the edge and into the cloud, making it easier to monitor pipeline integrity and manage risk while also improving operations and operator preparedness through advanced modeling and commercial management software (**FIG. 1**).

Suitability of the pipeline. Implementing and operating new or retrofitted pipeline operations starts with design. As companies evaluate pipeline integrity and risk management, they must find ways to integrate data about pipeline design, whether that data is from a newly engineered network or historical design data. Managing that data typically happens offline in pipeline design software.

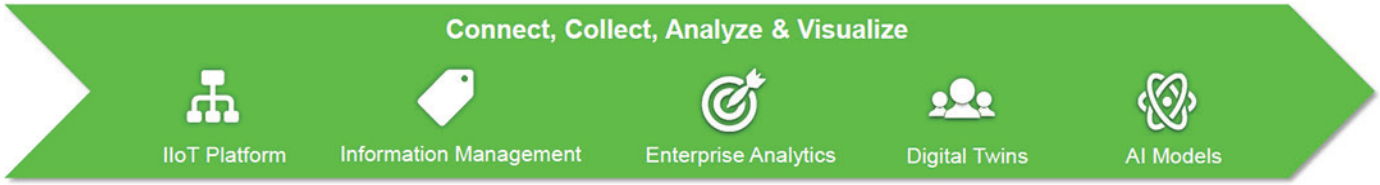

FIG. 1. H_2 operations efficiently monitor and manage risk using a seamlessly integrated software ecosystem.

First and foremost, engineers must evaluate the pipe material used in construction to ensure it can safely support H_2 transport. The most effective pipeline design software packages will consider this need, as they will be preconfigured with the most up-to-date H_2 regulations and standards. These packages will also automatically identify whether a selected pipe's material composition and welds can support the percentage of H_2 blended into the anticipated product.

For companies planning to repurpose existing networks, engineers must also combine pipeline design details with data from integrity assessments. As pipeline maintenance crews perform inspections, they will build extensive caches of historical data about potential wells, scratches, notches and wall loss throughout the pipeline network. This data is critical for identifying whether the pipeline is ready to support any amount of H_2 transport. Any areas with significant potential for welling and/or other issues can be targeted for modernization efforts to prepare the pipeline for H_2 transport.

In addition, the data from ongoing inspections can help pipeline operators track and trend the performance of specific areas of the network over time, providing insight into where recurring problems that had limited impact on natural gas might be more concerning with a more corrosive product.

Suitability of the environment. Most pipeline design and engineering teams are already using geographic information management software that identifies what pipeline elements exist and where they are located. Building or converting pipeline operations for H_2 will typically involve modifying elements, such as compressors, seals, valves and meters. Part of knowing how and when to modify these elements depends on their location, considering their accessibility and proximity to population centers, so the data in geographic information management software is of great value (**FIG. 2**).

To ensure the safety of the H_2 being transported, engineering teams must integrate condition information from inspection data with information about the operating environment to calculate risk. Risk evaluation can tell engineering teams where in the pipeline

FIG. 2. Integrity management software[a] enables H_2 operations to accurately assess risk along various sections of a pipeline.

H_2 transport might be a problem; however, this is only possible if the risk model has accurate data. The most advanced companies are feeding all this data into offline simulation tools to perform predictive studies to identify how well new operations will perform.

Integration brings more value to data. Pipeline design, inspection data, environmental factors and risk calculations provide a plethora of options for pipeline operators. Historically, this wide array of options has led pipeline companies to build a catalog of applications from many different vendors: this has resulted in siloed data, with critical information stored and managed in different systems across the organization.

If each application gathers data in its own proprietary format—or worse, if data is collected on paper records—bringing critical information together for multivariate analysis is extremely difficult. In the best case, companies manage to build a fragile network of complex connections among software packages; however, those networks require significant maintenance, especially when one software component must be updated while maintaining connectivity to the rest.

A better solution is to replace the company's array of disparate solutions with an end-to-end solution for pipeline design and management. Today's expert automation suppliers offer comprehensive, seamlessly integrated solutions for planning, executing and analyzing inspection results. These integrated packages include solutions for corrosion detection, geospatial location, pipe design and operation, soil conditions and land use, and population density evaluation (**FIG. 3**).

When pipeline design solutions seamlessly integrate, they help the company build toward an automation[a] vision for operation. Through that vision, built-for-purpose automation freely and easily moves data among systems to deliver more holistic

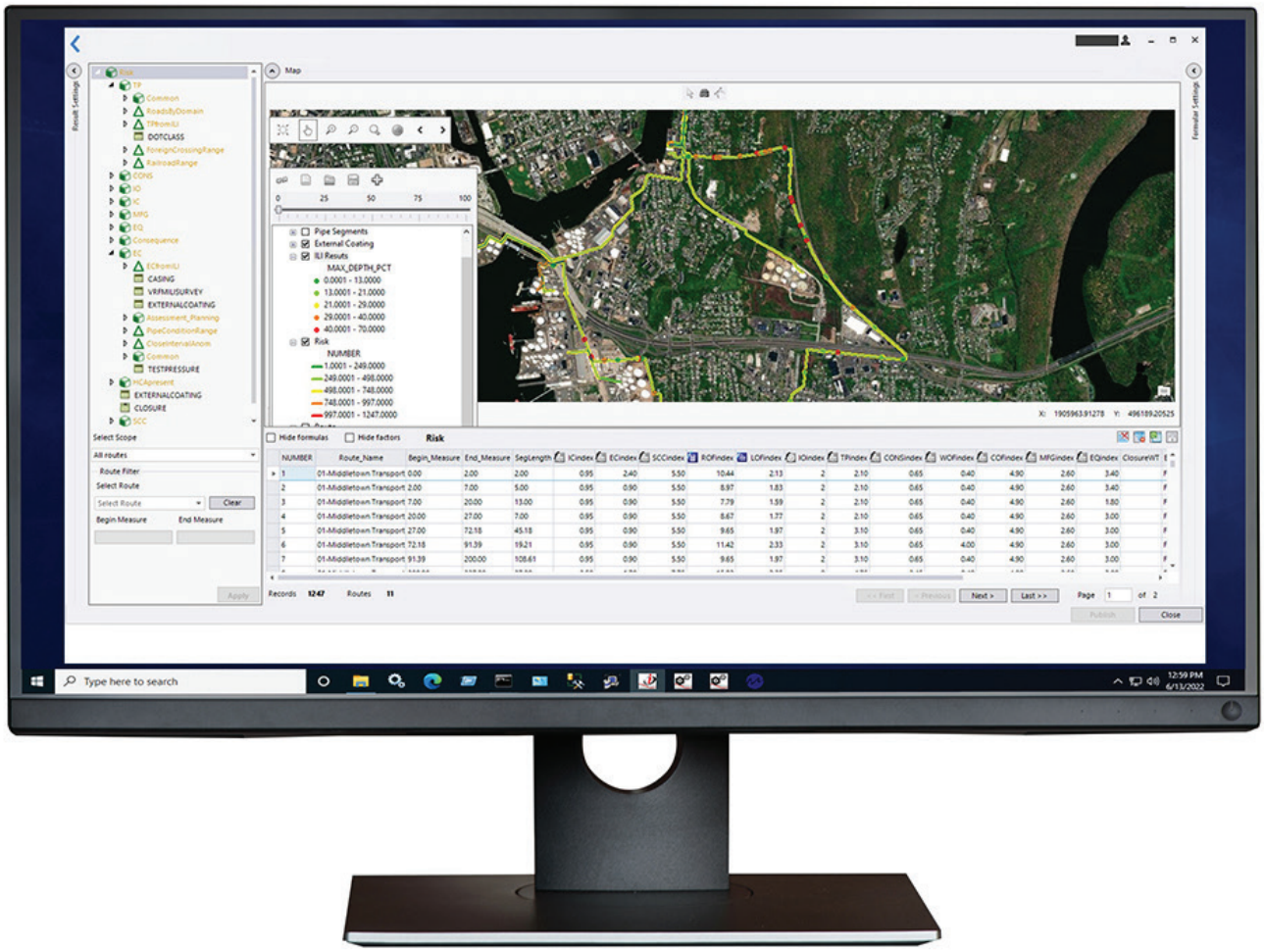

FIG. 3. Software tools for geospatial mapping can integrate with pipeline design and other simulation tools to create a cohesive risk management environment.

operations across the enterprise. Instead of looking at each element of pipeline operation as a separate piece, operations can bring data together into high-level tools to predict and test operational changes, like the ones necessary to transition toward safer, more efficient H_2 transport.

For example, if a company's pipeline design application integrates seamlessly with integrity assessment, geospatial mapping and other risk management tools, operations can easily move that data into similarly-integrated simulation tools to perform predictive studies offline. They can test changes to the pipeline and determine how those changes will impact operations as a whole. However, such high-level predictive simulation is only possible when the underlying data is easily accessible—a task best accomplished with tools that are intentionally designed to work together.

Moreover, the same offline models used to design pipelines for less common operations can be transferred into real-time simulation tools in the control room, providing operators with decision support to run the pipeline at the peak of safety, efficiency and sustainability.

Real-time simulation. Pipeline management software can also be seamlessly integrated with key pipeline technology that companies already have in place as they transition to H_2 operations. These technologies collect real-time data on flows, pressure and other measurements along the pipeline, and compare the data against optimum performance models. Using the data gathered from this comparison, operators are empowered to better ensure the pipeline is running to specification during normal operation.

FIG. 4. H_2 operations monitored using real-time modeling software[a] can capitalize on notification and visualization to identify pipeline leaks more rapidly.

Real-time modeling also provides additional benefits essential to H_2 operations. Leak detection and product tracking are by-products of modeling. The simulation softwarea contrasts what the model predicts vs. what is being measured and can identify and alert when disparities suggest leaks in the pipeline (**FIG. 4**).

Many operators transporting natural gas, crude and other refined products are already using this software in their operations—with the increased explosive and corrosive properties of H_2, real-time modeling will be even more important with the transition to H_2 and H_2 blends. As companies evaluate simulation software, they should keep this future need in mind, opting for software that already supports the modeling of H_2 operations.

Operations can also use simulation tools to perform predictive and look-ahead modeling to identify the benefits and drawbacks of tasks, such as changing supply setpoints or taking compressors offline. The results of these simulations will tell the operators how effects will cascade down the line, all the way to customer delivery, allowing them to better plan maintenance activities, outages or adjustments for power savings, while still meeting demand.

The same tools can also be used to train operators offline. Operators of any experience level can practice control strategies on simulated systems that replicate what they will see in the control room. They can learn how to manage complex but infrequent operations, such as how to ramp up flow and open valves when starting the pipeline, or practice emergency scenarios, such as how to operate the pipeline if a station fails or communications are lost.

Connected commerce. The benefits of seamlessly connected systems even extend to commercial applications, improving activities from nominations to invoicing and reporting. If data can be passed easily and seamlessly into pipeline transportation software, companies can eliminate the need for manual steps to bill and provide documentation to customers, relying instead on the systems to automatically generate all required electronic paperwork and invoices. If customers have questions or concerns about invoicing, seamlessly integrated systems provide a clear audit trail across the entirety of the value chain, making it easier to resolve discrepancies.

Unlocking more effective operations. While the future of H_2 operations presents many unknowns, one thing is certain: competition will be fierce. Companies participating in the emerging H_2 economy must operate at the peak of efficiency, sustainability and safety. The only way to accomplish those optimal operations will be to generate, contextualize, store and manage data efficiently and effectively, a task that is nearly impossible with a complex web of disparate systems.

The most-effective companies are already taking steps to navigate this complexity by transitioning to software solutions that are seamlessly integrated across the H_2 value chain by design. In doing so, they are discovering ways to improve operational excellence at every step of H_2 transport, while also unlocking better visibility across operations, both key catalysts to capturing and securing competitive advantage. H2T

NOTE

[a] Emerson's Boundless Automation

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