ABB ABILITY INDUSTRIAL ANALYTICS AND AI SUITE

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Strategic decision making in industrial operations leading to differentiating performance is challenging: all data may not be available, some of it may be inaccurate or outdated, and optimization requires complex algorithms. In addition, the human mind tends to make errors and apply cognitive biases.

Data-driven operations can improve decision making and today's technology can help personnel in accessing, cleaning and combining data. Industrial information modeling can help derive information from data. This information must be presented in a meaningful way to the different profiles in the organization and assist in decision making by applying AI and machine learning. Today's industrial analytics platforms, such as ABB Ability Genix Industrial Analytics and AI Suite have these capabilities and can contribute to lower cost and risk, improve return on assets, improve sustainability and profitability.

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VISION, EXPERIENCE, ANSWERS FOR INDUSTRY

CONTENTS

Executive Summary

Whether a company's overarching strategy is cost competitiveness, client intimacy, product performance, added value through services or combinations thereof, it experiences the pressure to be resource-efficient, sustainable, flexible and agile, and its assets must be safe, long-lived and reliable. Reaching a few of those objectives is a challenge, but reaching all of them at the same time represents truly differentiating performance.

Strategic decision making in industrial operations leading to differentiating performance is challenging: all data may not be available, some of it may be inaccurate or outdated, and optimization requires complex algorithms. In addition, the human mind tends to make errors and apply cognitive biases. Data-driven operations can improve decision making and today's technology can help personnel in accessing, cleaning and combining data. Industrial information modeling can help derive information from data. This information must be presented in a meaningful way to the different profiles in the organization and assist in decision making by applying AI and machine learning. Today's cloud-based industrial analytics software, such as ABB Ability Genix Industrial Analytics and AI Suite have these capabilities and can contribute to lower cost and risk, improve return on assets, improve sustainability and profitability.

In some cases, not all variables can be optimized independently so we should not be naïve about the potential of optimization and intuition about this can be wrong; it could be either overly optimistic or overly pessimistic. Most of us would not have guessed what research has shown to be possible: to lower maintenance cost while improving reliability (Laurens and van der Molen, 2009). The study reports reliabilities of 95 to 98 percent are reached even in older facilities, by increasing the proportion of predictive maintenance relative to reactive maintenance jobs. Operational excellence was improved by focusing personnel on value-adding activities and optimizing production processes. Depending on the industry sector, and the pressures it may be subject to in a particular period, the impact of these factors may vary somewhat. What remains is that these factors can be managed when the right information is presented to the right people in the right time, to base their decisions upon.

We should also recognize that intuition can be realistic and accurate if it is properly trained, but we need to build in checks and aids, because it is not trivial to know when intuition is right or wrong (Kahneman, 2011). Therefore, decision support must provide accurate, contextualized information, enriched with analytics and predictive capabilities rooted in domain knowledge and science. It should include information on capacity

utilization, asset integrity, health, performance and reliability, and provide assistance in managing and optimizing performance and remediating risks.

A step towards improved operation and improved decision making is getting access to information based on accurate data. Today, data sources are ubiquitous. Enterprises can mine their operational, maintenance, engineering, supply chain-related, lab- and quality-related, client- and vendor-related, safety-related and business-related data sources. The potential of combining these data sources is enormous. Strategic planning, maintenance, process and reliability engineering, and many more functions become far easier if personnel can look up facts, find root causes, compare implications, run optimizations, etc. This potential is conditioned by two main factors. First, data need to be contextualized to make sense when analyzing them. To provide context, data must be organized according to uniform, ideally standardized information models; that is, organized according to asset hiearchy at a minimum, and possibly also according to process (phase), transaction, material and people manipulating products or processes. Second, to be exploitable, data quality and integrity are essential: data must be consistent, accurate and up to date. This requires human intervention that can be assisted by technology.

When the basis of accurate and up-to-date information is in place, information must be presented in a way that is meaningful at a glance for different roles such as operators, supervisors, managers, experts and executives. Ideally, companies need easy-to-configure dashboard components and reports, that can be used in a self-service mode, but also provide standardized, uniform views for sharing information and best practices across the enterprise and beyond. Given that these dashboards and reports can provide additional context and insight by combining information categories as described above, the value of these fact-based views is potentially very high in themselves. They will improve the quality and timeliness of decision making and thereby impact the bottom line. However, the lack of quality data and information creates considerable risk in making inaccurate operational and maintenance decisions.

Ultimately, to optimize operations and respond to industry pressures, companies require tools that can make optimizations that individuals cannot make themselves. Important areas that can benefit from such support are:

- Industrial operational excellence and performance management
- Asset integrity and performance management, including risk mitigation

- Safety and sustainability, including energy efficiency
- Supply chain optimization

Optimization may require a combination of data mining, additional data contextualization, categorization, machine learning, mathematical optimization or application of artificial intelligence routines. These must be informed by domain knowledge and science. The quality of the optimization results further relies on data completeness, quality and integrity. The added value of those functions is not only that they are likely to provide an optimum for the next time window or period, but also that they are free of the cognitive biases that humans suffer from, as we discussed earlier.

Improving Operational Decision Making

Modern operations are highly automated, and benefit at least in part from automation technology, model-based controls and real-time optimization, remote expert support, remote monitoring, diagnostics and analytics, or remote operation. Since recently, monitoring, analytics and optimization applications are being developed outside the deterministic real-time control realm and have been fueled in part by low-cost IoT sensors. Some companies prefer working with managed and safe industrial grade instruments, and extract as much as possible information from their smart devices for the same purpose.

Oil and Gas Industry

Drilling optimization, well and reservoir management, and simultaneous exploration and production remain a focus for profitability. The industry has applied digitalization and made great strides towards the smart field or intelligent energy vision, encompassing operational, environmental, safety and HSE aspects. Difficult or dangerous to reach locations have led the industry to implement remote monitoring and operation. Under pressure to reduce carbon footprint, the industry engages in research on carbon compensation and neutrality schemes as well as sustainable energy sources. The industry needs standard asset-based information models for analytics and must improve asset integrity, reliability and maintain process safety.

As companies increasingly realize the impact of data quality and integrity on the quality of decision making, there is a growing interest in improving them. Companies discover the degree to which their data are incomplete, outdated, inconsistent, delayed and poorly accessible and the operational and asset risks this implies. Indicators for data quality can be obtained in observing the differences between a process simulation, a data sheet or 3D model of an equipment and the as-maintained plant information. The latter may not be as readily available as you may expect. Often companies discover that processes to clean-up, update and ingress data, and governance data quality need overhaul.

Companies also realize that combining data sources to provide additional context, enable self-service analytics to many roles such as engineering, operations, maintenance or safety. This would also provide awareness and insights across functions. For example, an operations person may want to know engineering decisions to understand plant performance (illustrated in the Figure below), and a maintenance person may want to understand operational history to trouble shoot an equipment failure. Or instead, he or she
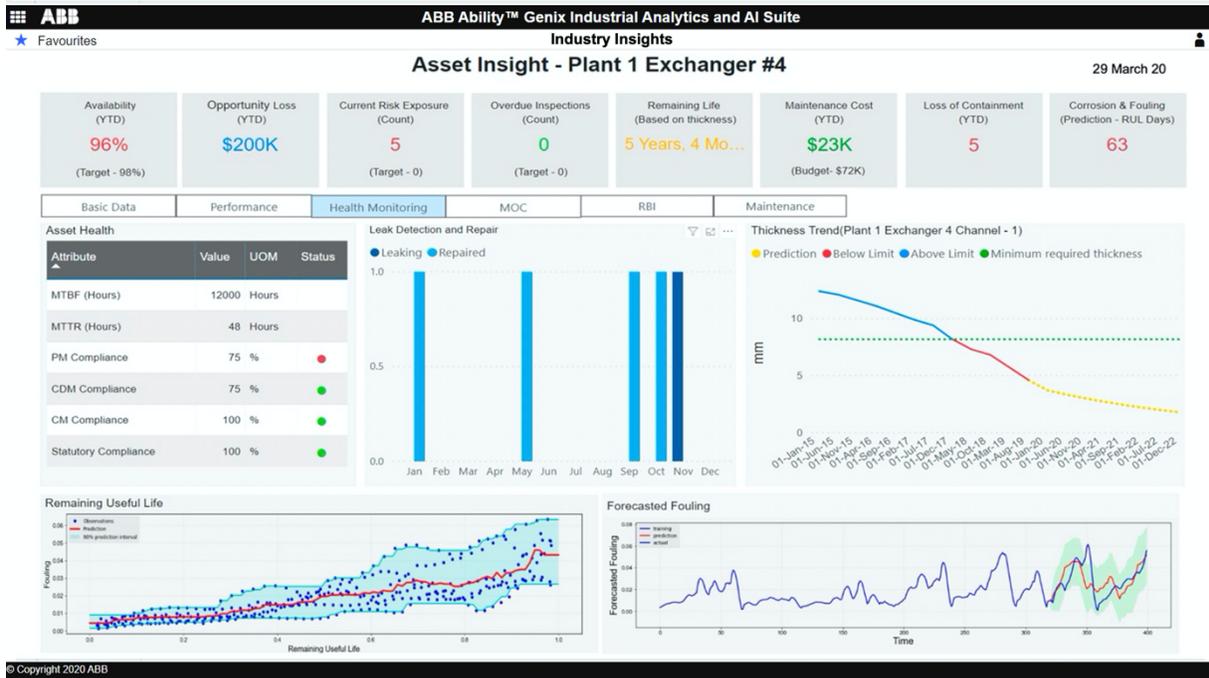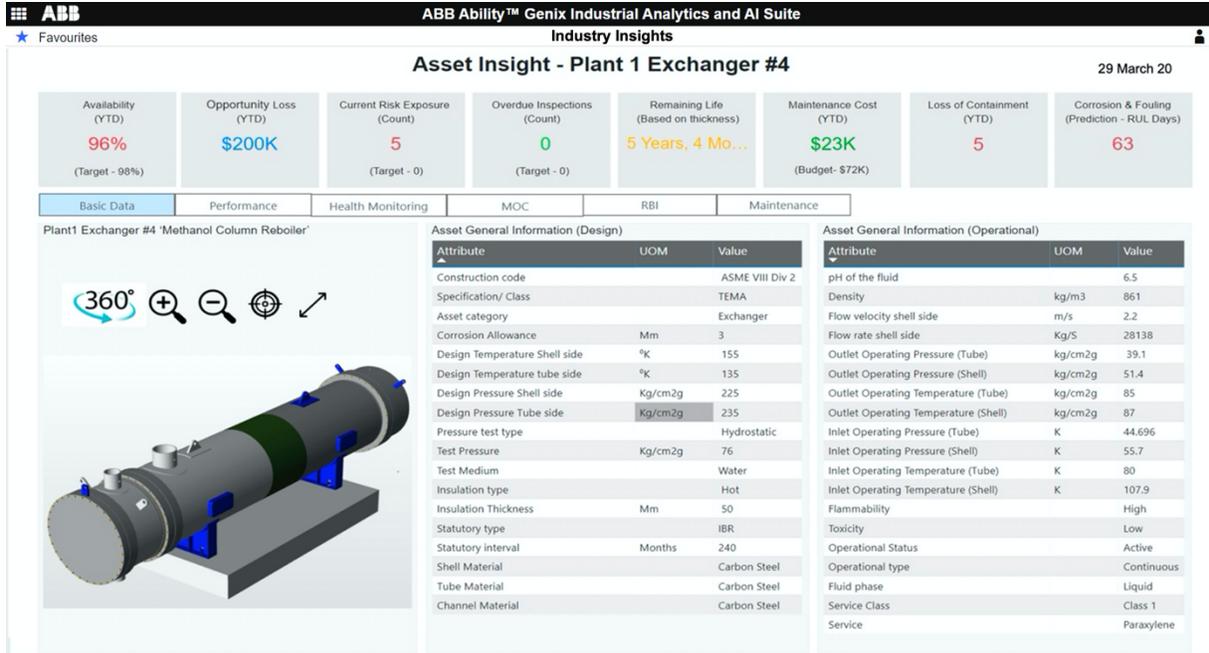

Engineering and Asset Health Information Of Heat Exchanger #4

may want to compare performance of similar equipment across the company's sites, something that is often very difficult due to inconsistent tag naming, or to hurdles accessing data on servers in different and/or remote regions. Only rarely do companies extend combinations of sources to types of information such as quality-related, supply chain-related, client and vendor-related, and business-related data sources.

In developing common information models companies also discover the impressive complexity and effort to do so. Interfacing existing applications with and developing new analytics applications on top of that common pool of contextualized information, is then the next, considerable task.
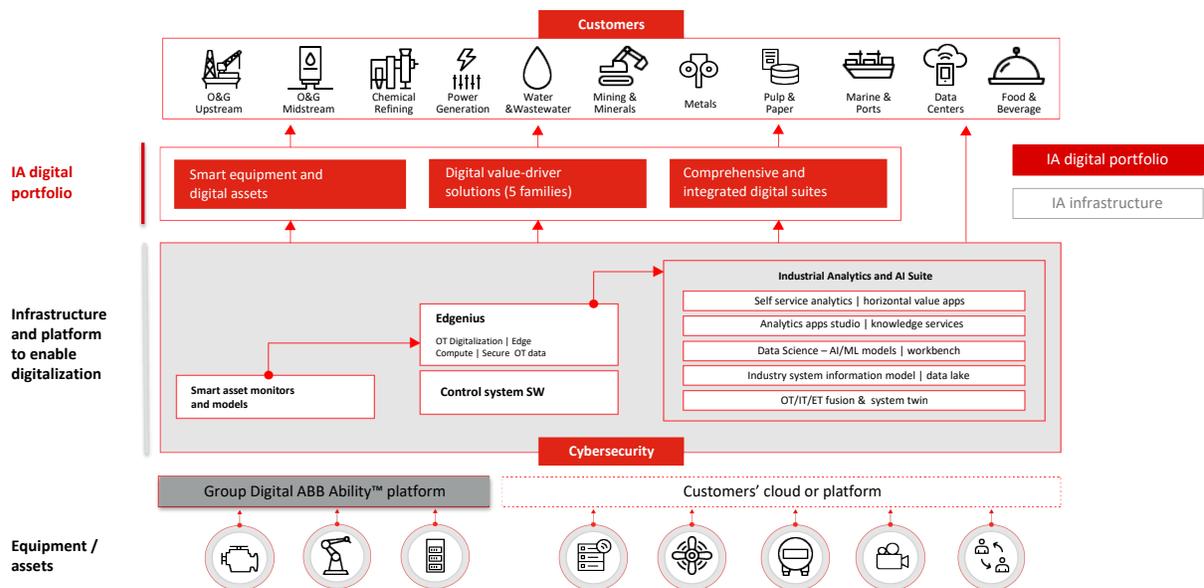

ABB's Digital Offering: Smart Assets, Value Driver Solutions and Industrial Analytics and AI Suite

ABB's Digital Offering and Landscape

ABB's digital strategy is to provide a solution to bridge the gaps between current best practices and the state of the art. The "ABB Ability Genix Industrial Analytics and AI Suite," is a three-layer configurable technology suite that complements company data and know-how with ABB's domain knowledge, associated services, and apps. The first layer enables monitoring health and performance of ABB sensors and devices. The purpose of this layer is to make these assets perform assisted by apps to monitor health, prevent failures, and ensure safety. The second layer adds connectivity to devices and sensors through control systems such as ABB 800xA and adds the information from third-party instrumentation and automation connected via edge equipment. This additional information is used by analytics with

built-in intelligence and optimization within digital suites to address operational performance management, asset integrity and performance management, sustainability and safety including energy, based on more accurate data provided by the first layer.   Each application suite has distinct views for different roles and functions in the company. The third layer seamlessly integrates any existing automation and instrumentation with existing IT systems, and complements these with additional sensors, if required. In addition, the layer provides additional context by applying standard information models to data in a semi-automated way and transforms them into searchable and intelligble manufacturing data, the "industry cognitive models." A "cognitive data lake" provides storage for raw and curated data. As asset data from multiple sources may need cleansing, the "System Digital Twin Integrity Hub" allows to visualise inconsistencies, resolve them, remove overlapping data, and provide synchronization with the sources. The data models are further enriched with dimensions from models such as ISA-88, ISA-95, PPDM or PODS, resulting in a multi-dimensional structure that enables efficient development and performance of analytics applications. The layer provides application management, an analytics development and deployment environment for profiles ranging from citizen scientists, and domain specialists to experts. In this layer, the digital suites benefit from even more information sources and are deeply integrated providing cross-functional insights and optimization, increasing the levels of autonomy of operations.
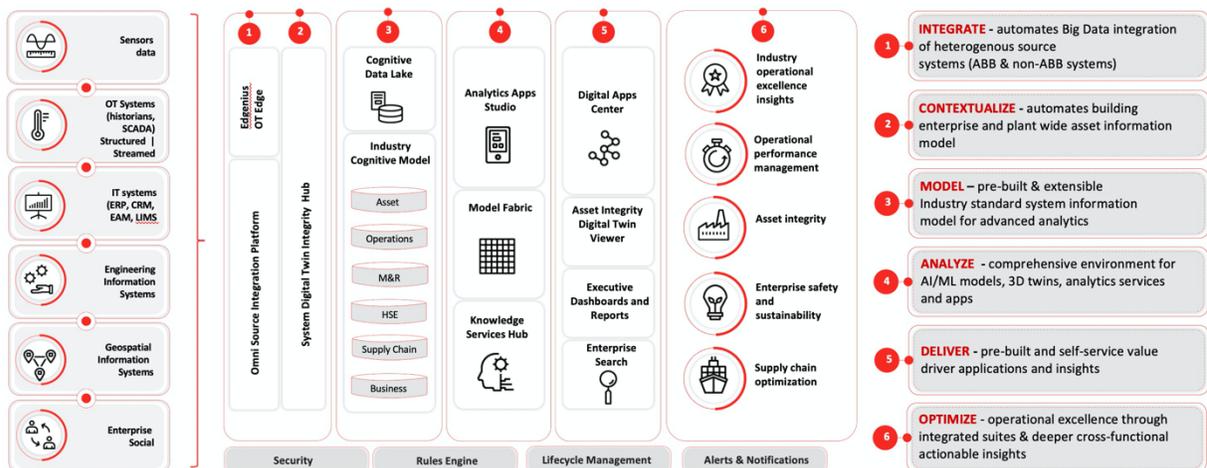
The Architecture of ABB's Digital Industrial AI Suite

The platform is flexibly configurable, that is, the customer can choose functionalities, apps focused on business outcomes, has pre-built and self-service analytics options, and can choose among options to visualize presentation of

data and metric; and it can be deployed seamlessly throughout the edge, fleet, plants and enterprise, on-premises or hosted, on private or hybrid and on a single or multi-cloud platform according to a company's specific needs.

The following sections provide more detail on the ABB Ability Industrial Analytics and AI Suite, the expected benefits and recommendations for implementation.

Information-driven Operations and Optimization

A first step towards improved operation and improved decision making is getting access to information based on accurate data from a broad range of sources. Where the access to data was most challenging, (that is, for operational data sourced from legacy equipment, instruments and control systems) the ABB Ability Genix Industrial Analytics and AI suite provides a broad range of standard connectors using open standards. The platform adds where necessary, digital software to existing ABB devices and sensors, increasing the smartness of the equipment. Indirectly this increases the accuracy and reliability of process and safety monitoring and inference of unmeasured variables. The ABB Ability Genix Industrial Analytics and AI suite adds connectivity to devices and sensors through - control systems such as ABB 800xA and adds the information from third-party instrumentation and automation connected via edge equipment. Herewith any pre-existing instrumentation and automation information, regardles of brand and make, is seamlessly accessible.

Minerals and Mining Industry
Although heterogeneous, the industry is generally subject to very cyclical economics, and variable value of geological deposits along their lifecycle, and has invested in cost, capital and energy optimization. Geopolitical tensions and changing regulations are difficult-to-control risk factors. Remote asset monitoring and operation, autonomous drilling and transportation as well as modular and mobile processing equipment are applied to respond to pressures. All monitoring optimization and management solutions from within the mine down to stockpile management and transportation are applied. The pressure to lower environmental footprint leads to the application of technologies ranging from electrification, digitalization of power supply, to control of containment.

Should a company want to add a measurement, the platforms can take in (IoT) sensor data, or ingress sound and visual information streams. They can buffer operational data with little delay and make them accessible across the globe.

Technology Maximizes the Value of Human Contribution

The potential of combining these data sources is enormous. Engineering, trouble shooting, maintenance, reliability engineering, quality

management and many more functions become far easier if personnel can look up facts, find root causes, compare implications, run optimizations, etc. This potential is conditioned by two main factors.

- The first factor is context. Data make sense only when placed into proper context. For example: Production was lower during the period that maintenance activities were carried out, or Maintenance on the chiller must be carried out before the peak in production expected next week. More strategically: The upcoming turnaround could be shortened by several weeks if design and asset information integrity could be improved. In order to be able to execute these analyses and make proper decisions, the engineers, managers and excutives must have data that is understandably linked to equipment, has human readable-labels, and is
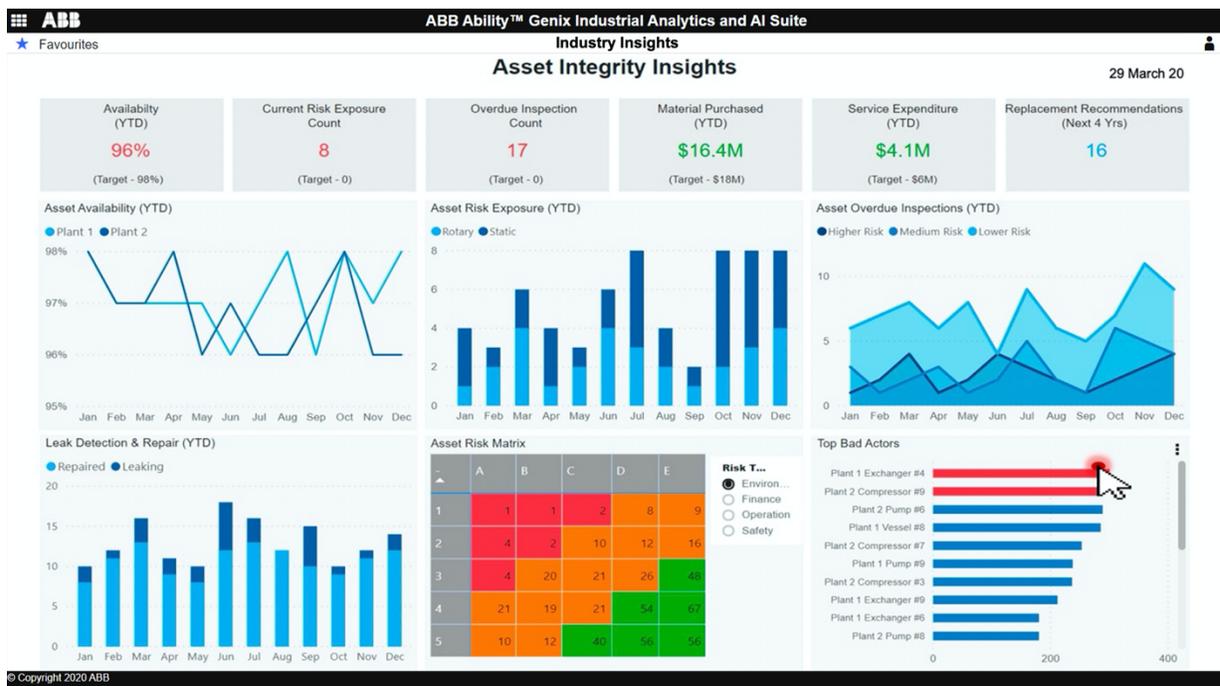
Managerial Asset Integrity Dashboard Indicating Heat Exchanger 4# As Bad Actor

linked through time stamps, in order to be able to replay the "film" of plant states, decisions and events. At a more standardized information models, that is, organized according to asset hiearchy at a minimum, and possibly also according to process (phase), transaction, material and people manipulating products or processes. The ABB Ability Industrial Analytics and AI suite is an analytics platform that helps to map data sources to common information models such that data become intelligible for all collaborators in the enterprise. The latter is invaluable

in itself, and the time and resource gains in assisting users in this process are enormous, as early, unassisted projects of this type have shown.

- Second, to be exploitable, data quality and integrity are essential: data must be complete, up-to-date, accurate and consistent. The latter is easier said than done. Technology can help in the ingress, normalization, cleansing and contextualization of data. In particular, the ABB Ability Industrial Analytics and AI Suite can perform part of these tasks in an automated way. While this takes away repetitive work from personnel, their engagement in entering valuable data when required, contextualizing data and mapping data to information models, identifying outliers, and complementing areas of scarce data is necessary. For example, when a technician comes across a device in the field with information that is inconsistent with the asset information database, he must update that information on the spot. There must therefore be guidelines, processes and tools that help him to do so. The technician's manager must explain, and the technician must understand the importance of up-to-date information; and the technician must be motivated through feedback or incentives to go that extra mile.

Providing Meaningful Information

When the basis of accurate and up-to-date information is in place, the next goal is to represent information in a way that is meaningful at a glance for different roles such as operators, supervisors, managers, experts and executives. These representations shouldn't be laborious to create, so this pre-supposes easy-to-configure dashboard components and reports, that can be used in a self-service mode, and create standardized, uniform views for sharing information and best practices across the enterprise and beyond. Given that these dashboards and reports can provide additional context and insight by combining information categories as described above, the value of these fact-based views is potentially very high in themselves. They will improve the quality and timeliness of decision making and thereby impact the bottom line.

Hydrocarbon Processing Industry

Beyond profitability goals, the industry aims to improve its environmental footprint and improve its reputation in sustainability. Energy efficiency analysis and management are important as well as the tight control of containment. Groundbreaking work is ongoing to modernize control systems and the real-time applications realm, among others through the definition and use of open standards. Digital transformation is used to create value-adding applications cheaper and faster by using add-on Industrial IoT and analytics. The industry needs standard asset-based information models for analytics and must improve asset integrity, reliability and maintain process safety.

This section has highlighted the benefits of good quality data and information. We also need to mention that the lack of

these creates considerable risk in making inaccurate operational and maintenance decisions. In particular in the case of abnormal plant behavior, these can have catastrophic consequences, impacting people's lives and health, both inside the plant and in the surroundings. The cost of such disasters can wipe out up to a decade of profit, and sometimes lead to asset sell-off to pay for the liabilities. In ARC's opinion, it is worth getting your information right to get the right information.

Optimization For Distinguished Performance

Ultimately, to optimize operations and respond to industry pressures, companies require tools that can make optimizations that individuals cannot make themselves. Important areas that can benefit from such support are:

- Industrial operational excellence and performance management
- Asset integrity and performance management
- Risk mitigation
- Safety and sustainability
- Energy efficiency
- Supply chain optimization

Optimization may require a combination of data mining, additional data contextualization, categorization, machine learning, mathematical optimization or application of artificial intelligence routines. Recent developments in cloud computing have made mathematical methods more easily accessible but they are by no means a panacea. They must be informed by domain knowledge including physics, chemistry and engineering science. The quality of the optimization results further rely on data quality and data integrity. The added value of those functions is not only that they are likely to provide an optimum for the next time window or period, but also that they are free of the cognitive biases that humans suffer from, as we discussed earlier. Below, examples of industrial analytics in the domains of operational excellence, asset performance management, asset life assessment and risk migitation are highlighted.

Operational Excellence and Performance Management

From a corporate-level enterprise performance cockpit with high-level KPI's related to production, margin and inventory, maintenance and asset integrity, sustainability and HR, drilldowns are available on each topic. An example is the downstream performance management dashboard, that provides operational KPI's with a graphical representation capacity utilization by location. Detailed capacity utilization and opportunity loss
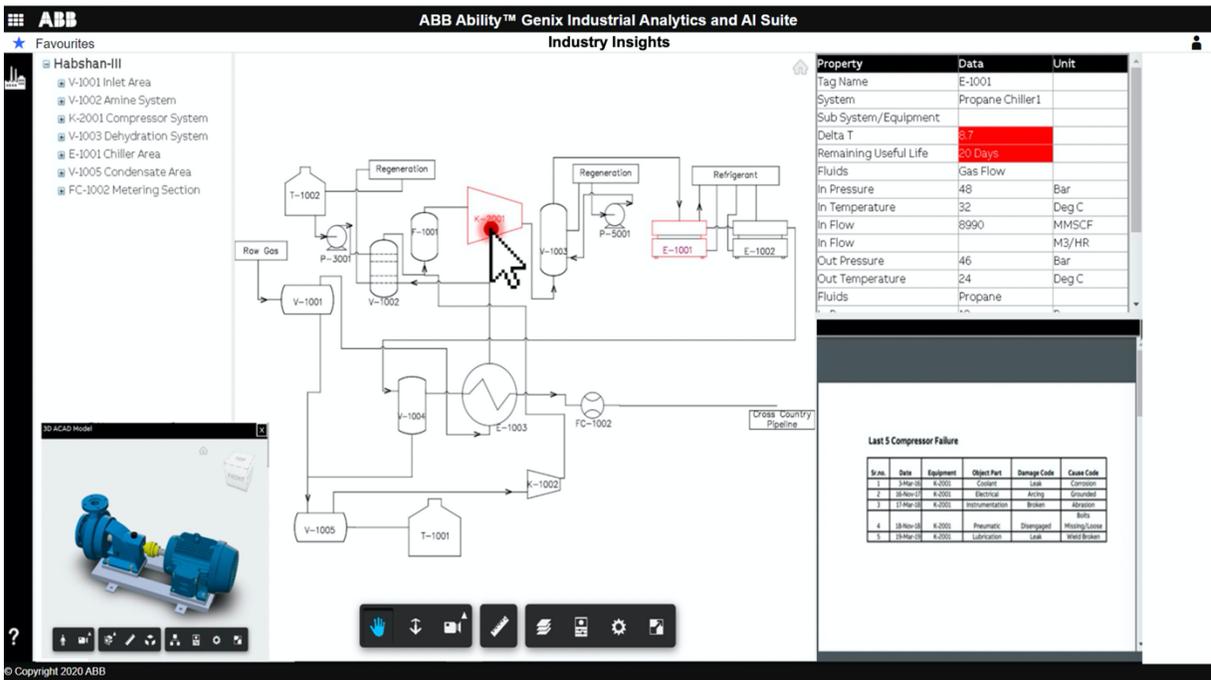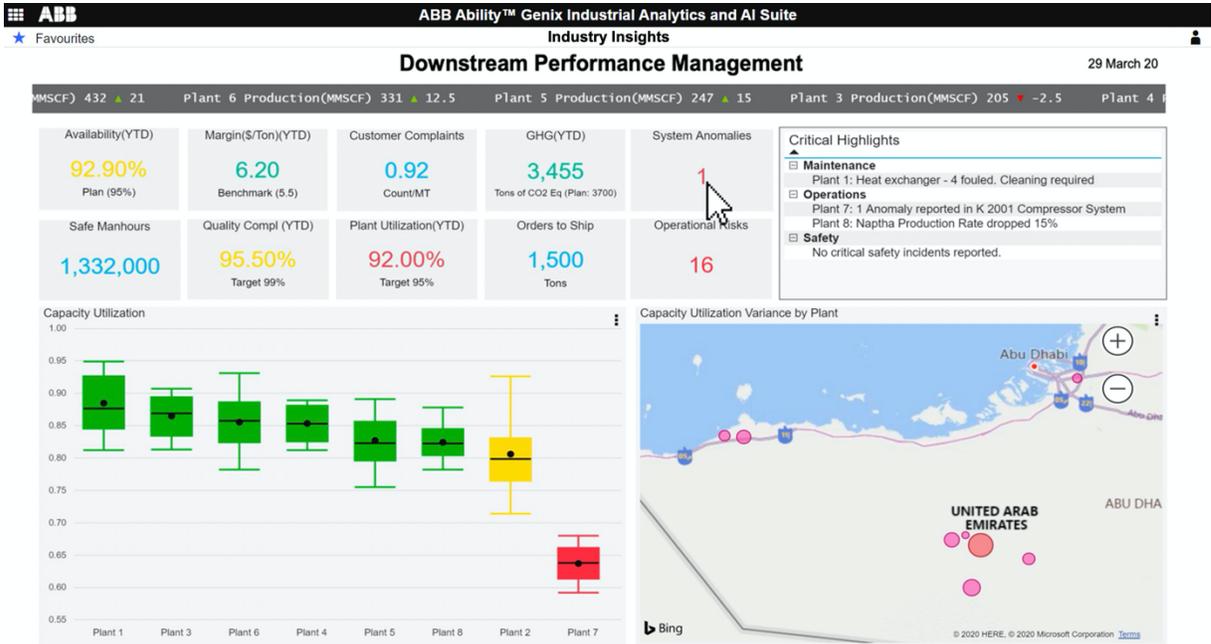

Operational Analytics Dashboard and Engineering Drilldown View

management are available in this suite. For operations, PFD and P&ID diagrams by plant provide the possibility to research the causes of poor utlizatoin rates. These diagrams graphically indicate issues and provide direct access to equipment-related operational and engineering data, providing clues for performance improvement.

One possible scenario for optimization could be to mine operational and maintenance data, compare the historical performance at similar operating points with the one at hand, and propose an optimal mode of operation.

Performance Management and Asset Integrity

A typical high-level asset integrity dashboard for managerial profiles is depicted in the previous section. It provides aggregated key performance indicators (KPIs), as well as comparisons of KPI's such as asset availability, term time window of for example a year. Each element of this overview provides access to dashboards with increasing level of detail, and over smaller
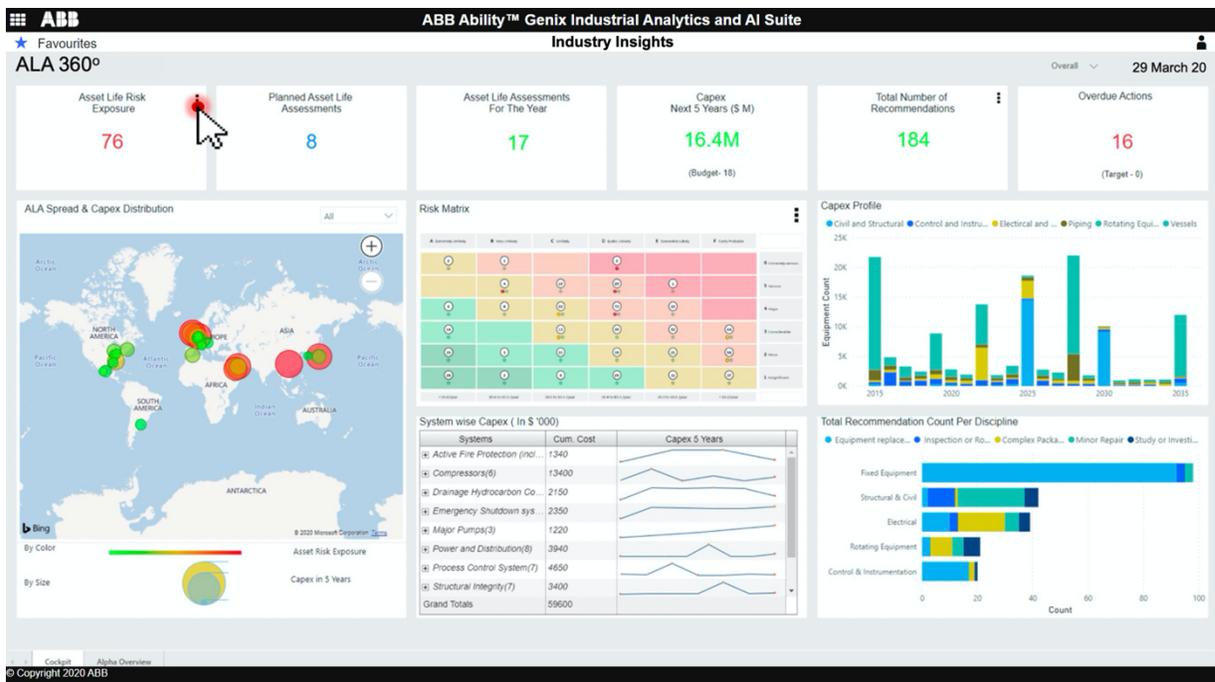
Strategic Asset Life Assessment Dashboard

and smaller time windows, targeting more operational types of profiles. This provides full transparency throughout the organization. The top bad actor in the example is the "plant 1 Exchanger #4", the drill-downs for which had been given on page 6 in the section "Improving Operational Decision Making," illustrating the added value of combining operational, maintenance and engineering information in combined views for the purpose of

trouble shooting. Tools for management of asset information integrity, asset reliability improvement and integration with enterprise asset management solutions are also part of this suite.

Further detailed dashboards focusing on process performance, risk matrices per domain, and detailed instructions for maintenance operations are available or can be configured by accessing available information.

Asset Life Assessment, Risk Mitigation

This suite considers longer time windows, and the financial rather than the operational asset management view. It has high-level KPI dashboards including asset life risk exposure, planned and executed asset life assessments, total asset risk exposure against CAPEX profiles, an asset risk matrix onto which the company's assets have been mapped, CAPEX by year and CAPEX category and more.   Further drilldown into risk versus capitals can be tied to risk mitigation and how this reduces projected CAPEX.

Potential Impact and Benefits

ARC Advisory Group estimates that the ABB Ability Genix Industrial Analytics and AI Suite can contribute to the following improvements across operational domains[1]:

- More complete, up-to-date and accurate asset information and improved asset information integrity
- A more accurate and timely awareness across the enterprise of performance in the operational domains
- Faster analysis and trouble shooting through improved contextualization within and across operational domains
- Improved timeliness and quality of operational decisions based on improved information quality and a broader set of information sources
- Reduced workload related to OT and IT integration as well as clerical tasks; more availability for indepth analysis
- Improved cross-domain awareness and insights

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[1] In this paragraph "operational domains" refers to operations in the narrow sense, and also to maintenance, energy management, sustainability, HSE, quality, safety, etc.

ARC estimates that these improvements will contribute to better business outcomes, reduce environmental footprints and social impact; and in particular:

- Lower maintenance cost while improving reliability and lowering operational risk
- Improve asset integrity, occupational and process safety
- Lenghten useful equipment life and reduce capital expenditure (or provide more options for capital expenditure)
- Lower operational cost and improve energy efficiency and sustainability
- Increased throughput, revenue and/or profitability

Recommendations

ARC recommends industrial operations to compare their needs and ambitions with benefits that the ABB Ability Genix Industrial Analytics and AI Suite can provide, and consider the components of this offering that are able to provide business benefits. It is too early to provide quantified average benefits in this report, and as there is no "one size fits all" solution we encourage companies to engage in fast-track benefits studies for investment justification and project configuration purposes.

Digital transformation has more human aspects than technical. ARC encourages users to reconsider aspects such as strategy, ethics and values, business processes including innovation, organization, risk management and compliance, skills and competences, behavior, norms and culture, relationships across domains and within the company's ecosystem, leadership and empowerment. ARC believes that the interplay of these factors with the technology largely influences the outcomes of digital transformation.

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Acronym Reference:

AI	Artificial Intelligence	**KPI**	Key Performance Indicator
CRM	Customer Relationship Management	**LIMS**	Laboratory Information Management Systems
DCS	Distributed Control System	**ML**	Machine Learning
EAM	Enterprise Asset Management	**PFD**	Process Flow Diagram
ERP	Enterprise Resource Planning	**P&ID**	Piping and Instrumentation Diagram
IIoT	Industrial Internet of Things		
IoT	Internet of Things	**SCADA**	Supervisory Control And Data Acquisition
IT	Information Technology		

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