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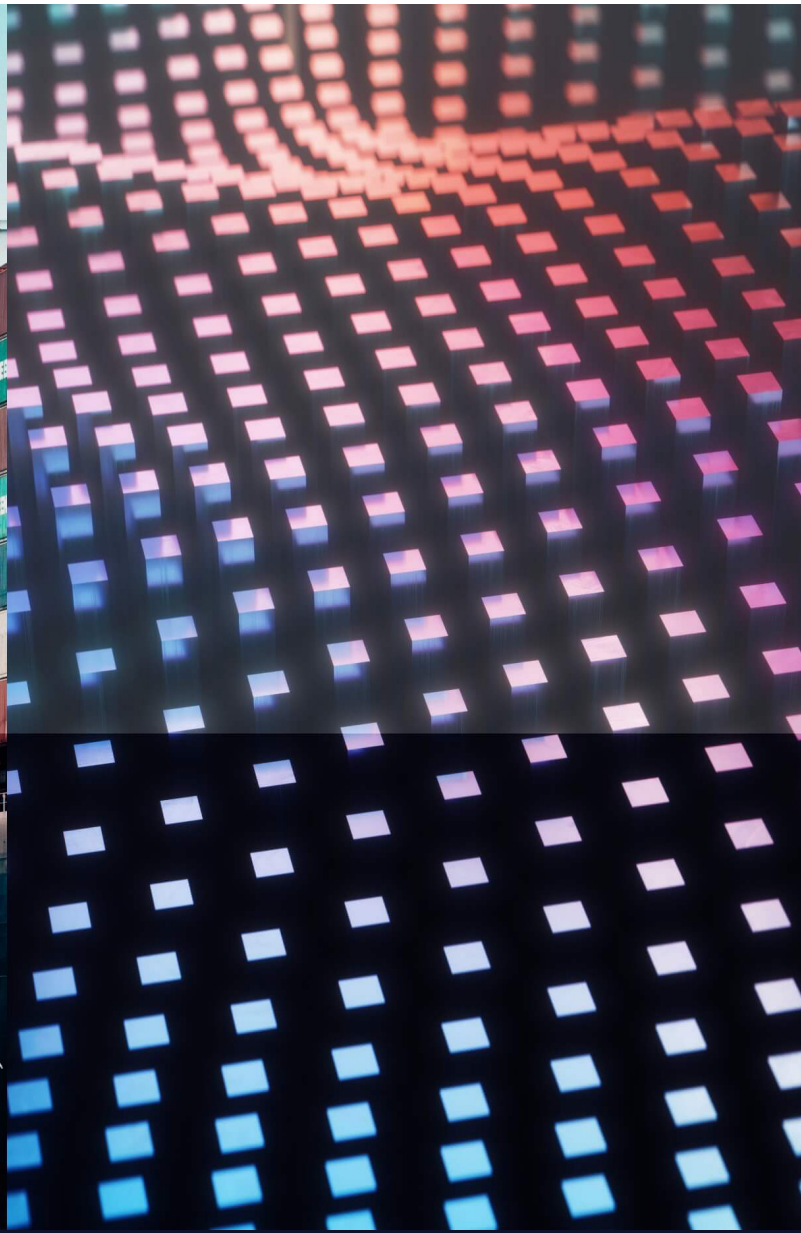
Operational Excellence

Market Overview: Industrial AI Analytics Solutions

By Joe Lamming, Henry Kirkman
With Malavika Tohani

May 2023



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This report outlines how industrial AI analytics solutions are revolutionizing the industrial sector by applying cutting-edge software and hardware techniques to manage, optimize and improve assets and processes. In this report, we provide a comprehensive overview of the current state and future trends of this dynamic market, based on an in-depth analysis of the drivers, challenges and opportunities for established industrial asset management (IAM) software vendors, AI-focused challengers, asset management service providers and customers. The report discusses how the market is segmented by vendor background, and analyses how each segment leverages its strengths and capabilities to deliver high-impact industrial AI solutions. In addition, it explores how vendors can develop more self-service MLOps (machine-learning operations), AI analytics and generative AI to meet the growing demand for scalable, flexible and user-friendly industrial AI solutions.

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Organizations mentioned

3d Signals, ABB, Accenture, Adarga, AES, Altair, Amazon Web Services (AWS), Arcadis, ArcelorMittal, AspenTech, Augury, Avanseus, AVEVA, Baker Hughes, C3 AI, Clarifai, Cognite, Dataiku, DataProphet, DataRobot, Deloitte, Delta Bravo, Electric Reliability Council of Texas (ERCOT), EthonAI, Falkonry, Flutura, General Electric (GE), Goldman Sachs, Google, Grafana Labs, H20.ai, Hitachi Energy, Hitachi Vantara, Honeywell, Hortifrut, IBM, Iguazio, inmation, Intel, Intelecy, Itus Digital, Kelvin AI, MaxGrip, McKinsey & Company, Meta, Microsoft, Midjourney, Mtell, NVIDIA, OpenAI, OYAK Cement, QiO Technologies, RapidMiner, Samotics, SAP, Schneider Electric, Seeq, Senseye, Siemens, Sight Machine, SLB, SmartSignal, Software AG, SparkCognition, Sparta Systems, Stanford University, SymphonyAI Industrial, TrendMiner, Uptime AI, Veracel, Wipro, Yokogawa, Zementis.

Basic Forms Of Artificial Intelligence Are Already Industry-Standard

Over the summer of 1956, a dozen or so mathematicians and scientists gathered at Dartmouth College in New Hampshire to study whether learning and other forms of intelligence could made to run on a machine. The project, known as the Dartmouth Summer Research Project on Artificial Intelligence (AI), is today considered to be the event where the field was founded. Lofty goals of the time included developing machine-based systems for human language understanding, abstract reasoning, problem-solving, creativity and self-improvement. Two-thirds of a century later, these problems have not yet been solved. Significant advances have been made in natural language understanding, problem-solving and abstract reasoning, especially with OpenAI's recent launch of GPT-4; similarly, aspects of self-improvement are foundational to machine learning (ML). However, human-like problem-solving is not yet an AI reality.

Algorithmic decision-making in day-to-day operations was first deployed in the life insurance and arbitrage trading industries in the 1950s and 1960s (see **Figure 1**). After a decade of 'AI winter', the 1980s saw improvements in data management systems, the proliferation of enterprise and industrial computers and a resurgence in AI investment. So-called expert systems – where human knowledge is codified for easy retrieval by business and industrial users to inform decisions for non-experts and to help automate processes – received intense interest. Inflated expectations meeting limited realities then led to another AI winter in the 1990s, alongside the quiet start of the integration of automation and data analytics into consumer, enterprise and industrial systems worldwide. Despite the dotcom bubble bursting in the early 2000s, large technology firms pioneered the use of ML to find patterns in and monetize the billions of actions performed by hundreds of millions of web users. As sensor and mass data storage prices began to fall, enterprise and industrial users deployed homegrown and commercial analytics solutions, utilizing AI and other techniques, to better understand market dynamics, resolve production issues and improve asset management.

Maturing Techniques, Cost Reductions And Funding Fuel AI Growth

Industrial assets comprise everything from pumps, valves and actuators, all the way up to entire wind turbines, solar arrays, oil drilling platforms and manufacturing facilities. Verdantix defines industrial-focused AI-based analytics as:

> *"Computer programs that can ingest operational technology (OT), engineering technology (ET) and information technology (IT) data – such as on temperature, vibration, and from magnetic sensors and control systems, and/or unstructured data such as images, video, audio and free text – and provide insights that would not be possible using a conventional rules-based system."*

Many of today's AI systems rely on deep neural networks and decision trees. Monitoring the health and performance of assets is critical to the success of industrial firms, as unplanned downtime or poorly optimized operations can result in costly delays, financial penalties and lost production. In an increasingly digitized and competitive landscape, the last decade and a half has seen the rapid rise of industrial AI analytics-focused vendors, especially between 2009 and 2012. This growth has mainly been driven by:

Figure 1

A Brief History Of Industrial AI Analytics

1950s
Rule-based analytics

1957
First trainable artificial neural network, known as the Perceptron, and Bellman equation for reinforcement learning

1960s
First neural network and AI hype

1966
Failure of machine language translation

1969
Book 'Perceptrons' illustrated infeasibility of neural network-related AI

1970s
First AI winter

1970
Invention of backpropagation for training neural networks

1980s
Second neural network and AI hype

1980-81
Introduction of enterprise expert systems

1982
AspenTech launches Aspen Plus for chemical process modelling

1985-86
Efficient training of deep multilayer neural networks popularized via backpropagation

1989
Backpropagation first applied to handwriting and optical character recognition (OCR)

1990s
SVMs and second AI winter

1990-91
DART scheduling and logistics AI system sees success in US military applications

1992
Support vector machines (SVMs) gain popularity for classification and regression

1993-95
Expert system AIs fail to live up to expectations and investments are reduced

Figure 1 (continued) ↓

Figure 1 (continued)

2000s
Integration of specialized AI within everyday systems

2000-08
Fuzzy logic, recommender systems and classification see commercial uses

2009
Large-scale AI training accelerated with graphics processing units (GPUs)

2010s
Proliferation of deep learning transformers

2011
- **Augury** founded
- **General Electric** acquires **SmartSignal**
- **IBM** launches natural language platform, IBM Watson
- **Sight Machine** founded

2012
- **DataRobot** founded
- **Falkonry** founded
- **H2O.ai** founded
- AlexNet convolutional neural network demonstrates effective computer vision

2013
- **Dataiku** founded
- **DataProphet** founded
- **Kelvin AI** founded
- **SparkCognition** founded

2015
- **Avanseus** founded
- **General Electric** launches **GE Digital**
- **QiO** founded
- **Samotics** founded

2016
- **ABB** launches AI analytics solution, ABB Ability
- **Adarga** founded
- **Cognite** founded
- **Software AG** acquires **Zementis**

2017
- **SAP** launches Analytics Cloud
- Multi-head attention transformers introduced for natural language processing (NLP)

2018
- **AVEVA** merges with **Schneider Electric** software business
- **SymphonyAI** launches **Industrial AI**

2019
- **Baker Hughes** and **C3 AI** launch BHC3 Reliability
- **Hitachi** launches AI analytics solution
- **Uptime AI** founded

Figure 1 (continued)

2020s
Multimodal large language models

2020
- **Honeywell** acquires **Sparta Systems**
- Transformers used in powerful language model GPT-3 and in computer vision

2020-2023
Proliferation of open-source text, speech, vision processing and generative AI

2022
- **Altair** acquires **RapidMiner**
- **Siemens** launches **Xcelerator**

2023
- **Accenture** acquires industrial AI firm, **Flutura**
- Hype around generative AI intensifies

Source: Verdantix analysis

- **Reduction in the cost of sensors and other edge devices for data acquisition.**
  Sensors, such as those used to measure temperature, vibration and magnetic effects, have become ubiquitous across industrial assets as the cost of the hardware has fallen. Goldman Sachs estimated the average cost of an Internet of Things (IoT) sensor in 2004 to be $1.30, dropping to $0.60 in 2014 and to around half that in 2023. Similarly, the cost of historians, simultaneous control and data acquisition (SCADA) systems and other on-premise data collection and processing solutions has fallen as competition from cloud-focused start-ups has intensified. The Verdantix 2022 global corporate operational excellence survey saw 87% of 301 respondents rate the availability of new technology such as AI analytics and industrial Internet of Things (IIoT) devices as a 'significant' or 'very significant' factor driving the digital transformation of plant operations (see Verdantix Global Corporate Survey 2022: Operational Excellence Budgets, Priorities & Tech Preferences).
- **Rise in customer interest for high-ROI big data analytics.**
  As the internet began to facilitate the creation of digital twins of real-world interactions, in areas ranging from e-commerce to social media, technology providers witnessed the intensification of corporate interest in drawing insights from the increasingly large data sets. While heavy industry generally sees slower upgrade cycles than consumer technology, the potential to predict asset failures, understand production inefficiencies and reduce safety risks offers clear financial benefits to buyers. In the Verdantix 2022 global survey, 27% of respondents from industrial firms noted plans to invest in AI analytics for predictive maintenance and associated workflows in 2023. Similarly, 31% planned new investment in asset failure prediction software.
- **Increased access to large-scale AI training on cloud infrastructure.**
  Starting around 2006, cloud services such as Amazon Web Services (AWS), Google Cloud Platform, IBM Cloud and Microsoft Azure began productizing ML model training infrastructure, data storage and real-time deployment. Dedicated data centres and managed services offered by cloud providers now enable low-latency, high-bandwidth distributed computing for petabyte-scale data sets to train larger AI models, without developers needing extensive infrastructure expertise. In 2022, Meta trained a large language model

AI system on a cluster of 2,048 NVIDIA A100 graphics processing units (GPUs), while Midjourney utilized a Google supercomputer with 4,000 TPU (tensor processing unit) chips for training its AI model.

- **Improvements in software and hardware for training deep learning models.**
  The demonstration of GPU acceleration in AI model training in a 2009 Stanford University research paper opened the door to developing significantly more powerful deep learning solutions. Since then, AI-focused hardware such as the Cloud TPU v4 by Google, C600 by Graphcore and H100 GPU by NVIDIA have seen use in accelerating the rate at which new AI models can be developed. Similarly, more efficient and scalable software tricks for model training and data pre-processing have led to the creation of deep learning systems capable of perceiving and acting within the real world. Such advances have helped researchers and firms develop and deploy sophisticated computer vision systems – such as AlexNet in 2012 – which are able to detect a wide variety of objects in complex, real-world spatial environments. Eleven years ago, training AlexNet took almost a week – today, on the same data set, the model can be trained in an hour.

Four AI Techniques Are Transforming Industrial Analytics

The early days of advanced AI analytics saw improvements in training techniques, the proliferation of inexpensive data acquisition, cloud-scale big data acceleration and the arrival of purpose-built computer hardware to speed up development. Building on these established workflows, and distilling AI learnings from the hyperscalers, industrial firms are investing in and seeing success with several core AI technologies (see **Figure 2** and **Figure 3**).
These encompass:

- **Anomaly detection to identify irregularities.**
  Foundational to many timeseries-focused industrial AI analytics solutions, anomaly detection can be as simple as an alert when a sensor value falls outside a pre-defined range. AI-based solutions utilize elements such as convolutional variational autoencoders (CVAEs) to detect subtle patterns of anomalies in sensor data. Falkonry worked with steel production multinational ArcelorMittal to analyse historical and real-time timeseries data, to help operators rapidly determine the cause of weld and strip breaks. The final solution delivered a 1% increase in production improvement, along with a 20% full-time hours equivalent work reduction. Similarly, RapidMiner worked with a multinational auto parts manufacturer to predict critical equipment failure by detecting anomalies compared with historical sensor and maintenance report data.

- **Computer vision to monitor assets and processes through images and video.**
  Technologies collecting visual data are common in most of today's industrial facilities, comprising CCTV and thermal and production imaging cameras, alongside the smartphones used during inspections. As the old adage "a picture is worth a thousand words" goes, visual data are non-trivial for a machine to understand, compared with timeseries. Subjects of interest within an image or video may appear against a variety of background colours and textures, under different lighting scenarios, and may even be partially obscured by other objects. However, advances in convolutional neural networks and vision transformers are greatly improving the accuracy and speed of computer vision systems for industrial uses. A $10-billion-turnover Indian potato chips manufacturer implemented SparkCognition's Visual AI Advisor to automatically detect defects, learn with operator feedback and track trends over time – resulting in more than 90% defect detection accuracy and a 50% reduction in man-hours required for testing.

- **AI forecasting to support predictive analytics.**
  Techniques utilizing historical data from sensors on industrial assets, and from programmable logic controllers (PLCs), SCADA systems and enterprise asset management (EAM) solutions to assess the probability of future events and their associated risks, are seeing strong returns. More accurate forecasts improve asset uptime, efficiency and life expectancy – and provide greater clarity on budgets, spare parts and inventory (see Verdantix Best Practices: Transitioning To Predictive Maintenance For Enhanced Asset Management).
  Perishable goods producer and distributor Hortifrut implemented H2O.ai's solution to predict the quality

and degradation of goods during sea transportation, based on a variety of data collected before and during voyages. Similarly, GE Research and GE Renewable Energy developed an AI-based prediction system to streamline and reduce logistics costs by 10% for wind turbine supply chain management. GE Digital also deployed its Alpha Trader AI-based analytics solution with the Electric Reliability Council of Texas (ERCOT), to predict day-ahead conditions and increase revenues by $8 million over 10 months.

- **Natural language processing to improve data discoverability.**
  Industrial operations have historically relied upon verbal and written communication and note-taking. In recent years, the digitization of processes has provided facilities managers and C-Level executives with unprecedented real-time visibility – but natural language remains difficult to analyse at scale. The emergence of natural language processing (NLP) is now offering industrial firms the ability to discover data and drive analytics using raw inspection reports (see Verdantix Smart Innovators Industrial Data Management Solutions).

Figure 2
Segmentation Of The Industrial AI Analytics Market

Maintenance Management	Production and Process Management	Sustainability and Resource Management	Asset/Plant Performance Management	Supply Chain Optimization	Use Case
• Semantic search • Text classification • Sentiment analysis	• Object detection • Visual defect detection • Thermal image analysis	• Condition monitoring • Performance benchmarking	• Predictive maintenance • Production optimization		Capability
Natural Language Processing	Computer Vision	Anomaly Detection	Forecasting		AI Technology

Source: Verdantix analysis

Figure 3

AI Use Cases, Descriptions And Example Vendors

Industrial AI Analytics Use Case	Asset Information Management	Asset Condition Monitoring	Predictive Maintenance	Production And Process Management	Supply Chain Optimization	Energy Management	ESG Tracking And Reporting
Description	Driving documentation discoverability, automating tagging, version control and enriching metadata	Detecting faults, monitoring asset health and prioritizing the criticality of assets	Predicting asset failure, prescribing appropriate maintenance, advising on asset investment planning, optimizing OPEX/ CAPEX and spare parts and inventory	Predicting and monitoring production quality, optimizing production processes and operational strategy, using data to perform process hazard analysis	Forecasting demand, recommending raw material purchases and inventory, minimizing waste, optimizing logistics and improving visibility	Aggregating energy usage, monitoring and predicting energy efficiency, recommending improvement actions	Aggregating environmental, social and governance data, monitoring regulatory compliance, streamlining reporting
AI Vendor							
ABB	■	■	■	■	■	■	
AspenTech			■	■	■		
Augury	■	■	■	■			
Avanseus	■		■	■		■	
AVEVA	■	■	■	■	■	■	■
Baker Hughes	■	■	■			■	
C3 AI	■		■	■	■	■	■
Clarifai	■		■				
Cognite	■	■	■	■		■	

Figure 3 (continued) ↓

Figure 3 (continued)

Vendors	Asset Information Management	Asset Condition Monitoring	Predictive Maintenance	Production And Process Management	Supply Chain Optimization	Energy Management	ESG Tracking And Reporting
Dataiku	■		■	■	■		
DataProphet				■		■	
DataRobot			■		■		
Delta Bravo				■			
EthonAI		■		■			
Falkonry			■	■			
Flutura		■	■	■			
GE Digital	■	■	■	■	■	■	■
H2O.ai	■	■	■				
Hitachi Vantara	■	■	■	■	■	■	■
Honeywell	■	■	■	■	■	■	
IBM	■	■	■			■	■
Itus Digital	■	■					
Kelvin AI		■		■			■
QiO Technologies		■	■	■		■	■

Figure 3 (continued) ↓

Figure 3 (continued)

Vendors	Asset Information Management	Asset Condition Monitoring	Predictive Maintenance	Production And Process Management	Supply Chain Optimization	Energy Management	ESG Tracking And Reporting
RapidMiner							
Samotics							
Seeq							
Senseye							
Sight Machine							
SparkCognition							
SymphonyAI Industrial							
TrendMiner							
Uptime AI							

Source: Verdantix analysis

The Industrial AI Analytics Market Comprises Vendors From Three Key Backgrounds

AI and ML techniques such as anomaly detection, computer vision, forecasting and NLP are maturing such that success is being found in real-world deployments. Vendors in this space approach analytics from a wide range of origins, but generally fall within the following three categories, consisting of (see **Figure 4**):

- **Established IAM software providers.**
  Established industrial software providers offer decades of automation, asset management and process optimization experience. The emergence of AI and ML techniques presents a degree of disruption to business-as-usual, pushing incumbent asset management software providers to explore the augmentation of existing analytics tools with AI. General Electric acquired SmartSignal, a predictive analytics provider, in 2011, while AspenTech acquired Mtell, a predictive and prescriptive maintenance software provider, in 2016. In February 2023 AVEVA launched its predictive analytics software release, featuring automated model-building.

- **Industrial AI analytics specialists.**
  Founded with AI and ML at the core of their solutions, these industrial specialists compete with incumbent solution providers by offering easy-to-implement analytics for high-value use cases, and the ability to deliver return on investment (ROI) quickly. Firms such as Falkonry focus on measuring and visualizing timeseries anomalies; Kelvin offers tools to codify operational efficiency improvements; and QiO concentrates on energy and maintenance optimization. A handful of AI analytics providers partner with sensor manufacturers and real-time data platform providers, although Augury vertically integrates its analytics pipeline by offering customers sensor modules for direct mounting to industrial assets. EthonAI focuses on application-agnostic surface defects, and is able to learn from just 25-50 defect-free product images. Overall, industrial AI specialists direct their efforts towards resolving niche challenges, adopting more of a data-driven, rather than a physics or domain knowledge, perspective.

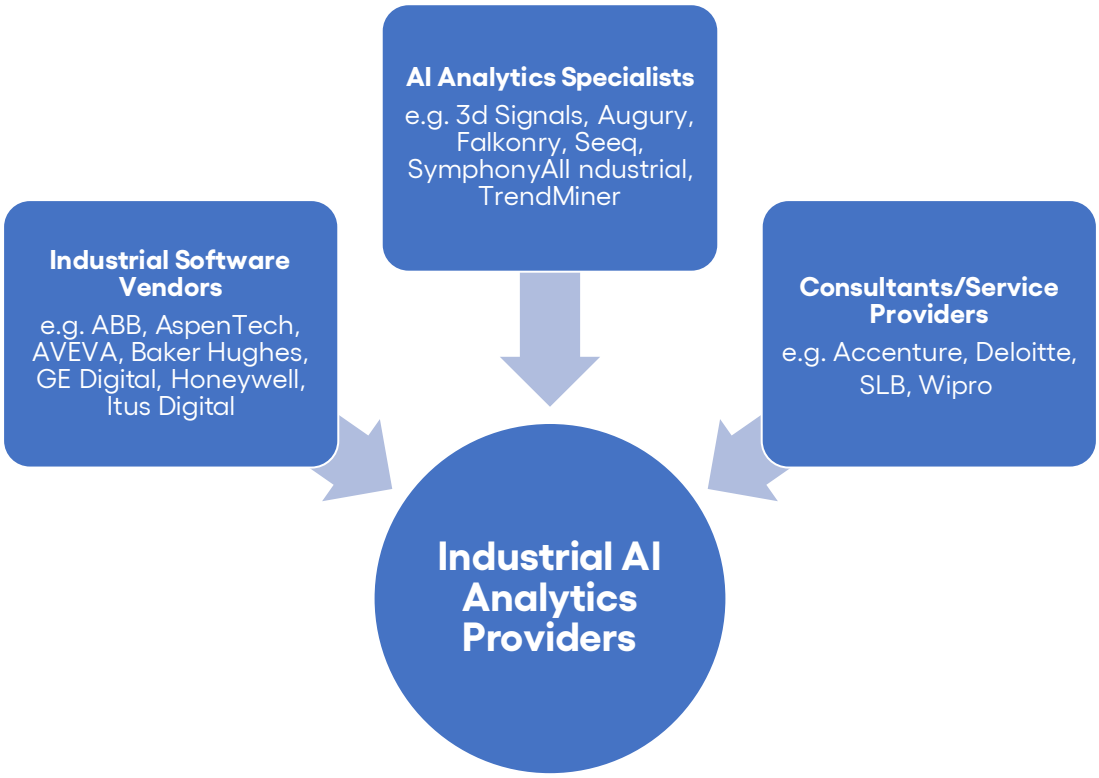
- **Asset management service providers or consultants.**
  Leveraging diverse project portfolios and domain expertise, service providers can offer industrial firms a composition of analytics solutions to closely meet the specific needs of complex projects. Accenture, Arcadis and SLB have strong digital solutions arms that can deliver advanced analytics in combination with consulting services (see Verdantix Global Corporate Survey 2022: Asset Management Service Providers Brands Recognition). In March 2023 Accenture announced the acquisition of Flutura and its physics-informed Cerebra AI platform to boost its capabilities when developing complex industrial projects for international clients.

Incumbents Leverage Decades Of Expertise And Physics-Based Asset Management

The industrial AI analytics market comprises incumbent asset management software providers, vendors built on AI and ML from the ground up, and asset management service providers and consultants (see Verdantix Green Quadrant: Asset Performance Management Solutions 2022). Drilling deeper into how established industrial software vendors offer AI as part of existing solutions, we see that they:

Figure 4

The Three Backgrounds Of Industrial AI Analytics Vendors



Source: Verdantix analysis

- **Predict and prescribe actions from AI analytics with extensive asset strategy libraries.**
  Long-established industrial software vendors have, through internal development and acquisitions, built an arsenal of failure modes and effects analysis (FMEA) tools and combined this with AI-based analytics to help asset managers understand the causes of downtime and catch major failures before they result in disruption. AVEVA acquired MaxGrip's asset reliability software and asset libraries in 2020, while the Baker Hughes and C3 AI partnership, BHC3 Reliability, helps managers identify anomalies and prescribe actions across specific oil and gas use cases. In 2016 AspenTech acquired process analytics software firm Mtell, and in 2020 worked with cellulose manufacturer Veracel to deploy its prescriptive maintenance software to increase yield by 1% to 3% and reduce maintenance costs by 5% to 10%.

- **Benchmark AI analytics with physics-based models.**
  ML models are trained to understand an operating environment and how to perform the next action, categorize an observation or predict an outcome. Models learn by examples, but limited examples can result in false positives – or worse, false negatives. The use of physics-informed predictions or synthetic training data can help improve accuracy. AVEVA's Dynamic Simulation used first-principles physics simulations to train Microsoft's low-code, engineer-focused Project Bonsai reinforcement learning system, to develop a more robust control system for a petrochemicals process. Utilizing Microsoft Azure cloud resources to train multiple

instances of the ML and simulation software, AVEVA developed a control system that was able to make the right sequential decisions to complete the chemical process without breaching operating limits.

- **Compete with the new breed of vendors with modular solutions.**
  End-to-end, monolithic AI analytics solutions can present difficult-to-interpret 'black box' insights, which may reduce actionability. Modular solutions, however, enable comprehensive industrial software providers to compete effectively with the AI specialist start-ups. ABB Ability's integrated digital platform has more than 100 pre-built AI and ML models for anomaly detection, timeseries forecasting and optimization, which can be repurposed by operators to create thousands of derivations to deliver insights to a wide variety of asset classes. Itus Digital allows its customers to quickly create asset twins by dragging and dropping failure modes and associated protections from a pre-populated Asset Twin Library (see Verdantix Itus Digital Differentiates With An Innovative Approach To APM, Underpinned By Easy-To-Implement Digital Asset Twins). Meanwhile, in October 2022, GE Digital launched its Carbon Reduction Advice and Carbon Data Insights software as optional features within its Performance Intelligence software.

- **Connect to a wide variety of data types, both structured and unstructured.**
  Mature solutions from incumbent software providers present pre-existing connections to a rich ecosystem of industrial data sources across timeseries, images, inspection reports and more, offering firms a holistic view of operations and maintenance. Hitachi Energy, formed after Hitachi's majority acquisition of ABB Power Grids in 2018, provides comprehensive data ingestion from power generation and distribution assets, while Hitachi Vantara's Lumada DataOps solution helps pre-process and store data for driving analytics (see Verdantix Strategic Focus: Why Industrial Firms Need DataOps Platforms For Asset Management Digitization). Similarly, AspenTech's acquisition of industrial DataOps and data integration provider inmation, and subsequent launch of AspenTech DataWorks, offers industrial firms the ability to centralize the management of data ingestion, processing and augmentation, and facilitates the storage of diverse data.

AI-First Vendors Use Cutting-Edge AI From The Ground Up

Incumbent industrial software firms offer customers a comprehensive suite of solutions to improve plant operations, complete with integration with legacy data acquisition systems and failure predictions based on trends drawn from decades of experience. Conversely, several industrial start-ups are building their product portfolios with process- and asset-agnostic AI and ML as the foundation. These vendors differentiate themselves from the incumbents (see **Figure 5**) by offering capabilities which incorporate:

- **Easy visualization of insights with strong business intelligence (BI) tools.**
  Without the bandwidth and distilled subject-matter expertise necessary for developing fully prescriptive analytics for broad categories of industrial assets, many AI-first vendors provide general analytics and novel visualizations. Such solutions often take the form of anomaly visualizations and timeseries predictions based on historical trends within an intuitive graphical user interface (GUI). Falkonry offers colour-coded visualizations of anomaly magnitude to help operators understand the extent of abnormalities of timeseries data generated by diverse industrial sensors. Similarly, H2O.ai worked with renewable energy firm AES to develop custom AI models for predicting wind turbine failures and for operator-prescribed scenario analysis.

- **Extensive integrations with new and existing data sources for rapid deployment.**
  Building an industrial data management pipeline is a challenging task, especially for industrial firms with global operations. AI-first vendors therefore focus on integrating with common industrial data systems such as historians, SCADA systems, manufacturing execution systems (MESs) and asset performance management (APM) and EAM systems to fit a specific analytics task, as well as bringing data in from technologies such as IIoT sensors, drones and cameras. QiO deployed its AI-based monitoring software Foresight Optima with chipmaker Intel to ingest available telemetry data and reduce the power consumption of its data centre central processing units (CPUs) by between 24% and 52%. TrendMiner offers quick connectors to plug

into historians and SCADA systems from vendors such as AVEVA, Honeywell and Yokogawa. SymphonyAI Industrial, meanwhile, provides tools for pulling data from historians and EAM and enterprise resource planning (ERP) systems, to drive predictive maintenance and digital twins.

- **Use-case-specific out-of-the-box solutions for quick time to value.**
  Unable to compete with incumbents on broad, feature-rich analytics solutions, AI-first vendors focus on delivering insights for common pain points such as asset health monitoring, energy management and yield maximization. By pre-configuring data ingestion, data quality and transformation pipelines, customers within the scope of the use case benefit from a quick set-up and a rapid time to value. After implementing Falkonry's software, an oil and gas firm was able to predict valve failures six weeks in advance and reduce per-incident downtime costs by $300,000. Samotics offers SAM4 Health, tailored towards eliminating unplanned downtime in variable frequency drives, electric motors and specific pump types, while SAM4 Energy focuses on the AI-based monitoring of equipment to help firms reduce energy consumption.

- **Low/no-code self-service analytics.**
  Not all industrial firms have access to a data science team to configure data management systems, develop AI training pipelines and deploy and maintain analytics for operators and business users. Recognizing the need to provide industrial engineers and facilities managers with a self-service interface, AI-first vendors abstract the functionality unrelated to delivering informative, predictive or prescriptive insights for industrial assets and operations. Seeq's Data Lab enables users to generate custom insights by providing access to its Python library. Similarly, Intelecy provides a no-code AI platform that allows operational staff to develop and implement ML models for industrial data analysis without the need for coding skills. The platform integrates with industrial protocols, features built-in MLOps, offers a library of advanced algorithms, and includes a data explorer for visualizations.

Service Firms Compose Disparate Solutions To Deliver High-Impact Industrial AI

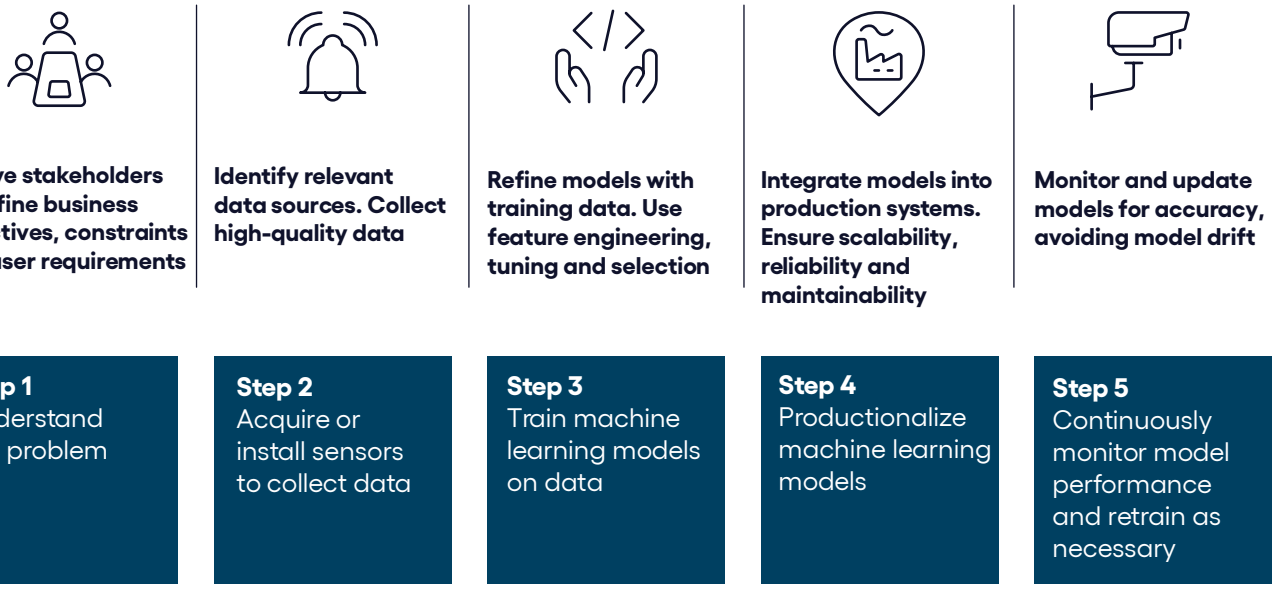
AI-first vendors take a more exploratory and dynamic approach to industrial analytics, offering analytics for easy-to-set-up specific use cases with strong visualizations of results. Asset management service providers, on the other hand, cater for far more complex industrial digital transformation projects, where a holistic solution composed of myriad vendors and solutions is required. The 2022 Verdantix global corporate operational excellence survey found that 53% of executives at 301 industrial firms plan to use third-party consultants for evolving their vision and strategy in asset maintenance management digitization, while 43% plan to use them for developing advanced analytics. To provide a bespoke industrial AI analytics solution to customers, asset management service firms:

- **Bring systems integration knowledge to complex industrial projects.**
  With vast experience and a deep understanding of industrial data systems, as well as of the technologies used today and in the past, asset management service providers use their teams to design, validate, implement and maintain the complex data systems needed to drive valuable analytics. The vendor-agnostic approach of these firms enables the selection of functionality most relevant to a project. Forty-six per cent of respondents in the Verdantix global survey plan to use asset management service providers to integrate legacy IT-OT systems from multiple vendors, while 50% aim to use consultants for industrial asset data management and governance. Accenture's Industry X digital transformation services, alongside the firm's acquisition of Flutura in March 2023, boosts its industrial AI capabilities in complex data-driven expansion, optimization and net zero projects involving plants, refineries and supply chains.

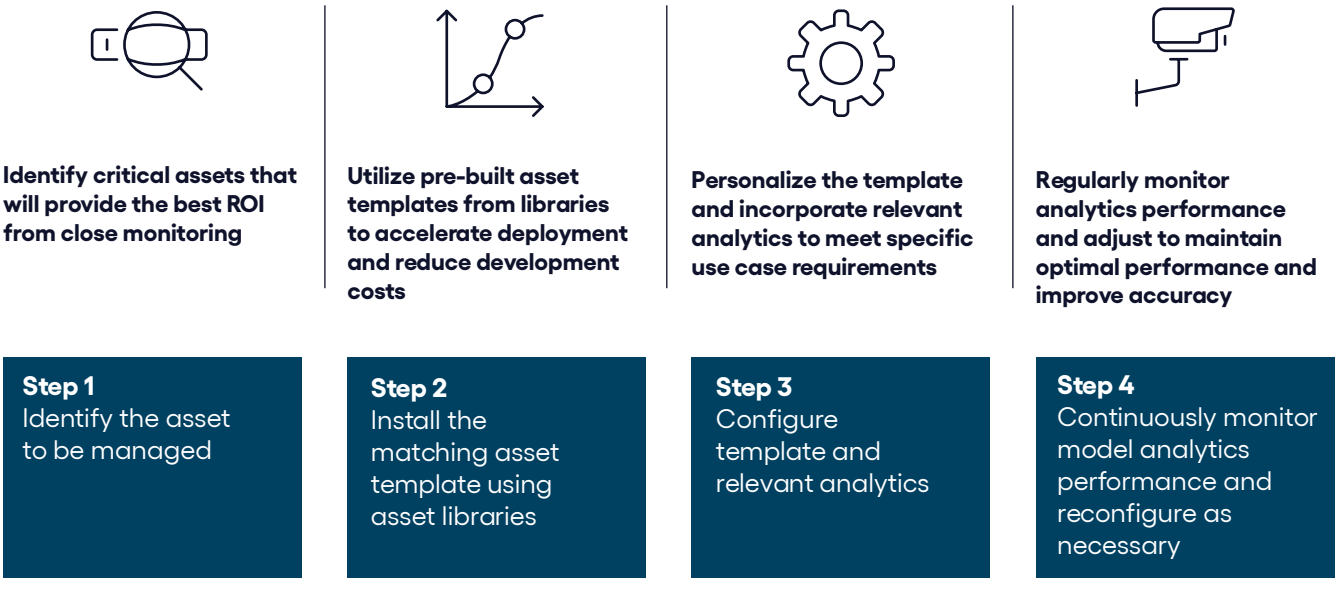
Figure 5

Comparison Of AI Analytics Workflows For AI-First Vendors vs Incumbent Vendors

AI-first vendors: step-by-step implementation process for typical AI-first asset management software deployment



Incumbent vendors: step-by-step implementation process for typical incumbent asset management software deployment



Source: Verdantix analysis

- **Help plan and implement reliability-centred maintenance.**
  Deep domain knowledge is needed during the development of analytics used for assessing failure modes and criticality of equipment. Sixty-four per cent of respondents in our survey plan to use third-party consultants for reliability-centred maintenance, improvement planning and implementation. Deloitte worked with a food packaging firm to reduce downtime and waste caused by plastic residue building up on a cutting blade used in production. Data scientists at Deloitte utilized prior experience of reliability engineering to create probability models and run simulations, helping the business increase overall equipment effectiveness (OEE) by 10% and profits by $200,000 per line.

- **Develop robust MLOps pipelines to ensure deployments continue to operate well.**
  Building AI and ML models for industrial analytics requires strong data management expertise and processes. However, deploying these models in production, monitoring their effectiveness and accuracy, and deciding when to execute re-training on new data requires MLOps. Asset management service providers help industrial firms scale their ML workflows and deployments, enabling fast, cost-efficient and reliable production and operations management. In January 2023 McKinsey acquired Israeli MLOps start-up Iguazio to offer clients enhanced AI project implementation expertise.

Vendors Should Focus On Enhancing Self-Service MLOps And Generative AI

Asset management service providers bring strong data systems expertise, reliability-centred maintenance and MLOps to industrial AI analytics projects. However, incumbent software vendors, AI-first challengers, and implementation service providers of such analytics should all aim to expand their offerings to take advantage of emerging AI technologies. They should look to:

- **Deploy MLOps to standardize the building, deployment and management of ML models.**
  Industrial analytics software providers should invest in developing robust MLOps frameworks to support end-to-end ML life cycles. These frameworks should emphasize collaboration amongst data scientists, industrial engineers and other stakeholders to maintain consistency in ML model quality. By implementing MLOps, vendors can also facilitate efficient model monitoring, versioning and continuous improvement to ensure optimal performance in dynamic industrial environments. Additionally, MLOps can help reduce the time it takes to bring AI solutions to market by automating repetitive tasks and promoting best practices in model development and deployment. By implementing DataRobot, OYAK Cement increased its alternative fuel usage from 4% to 30%, resulting in approximately $39 million in savings.

- **Partner with DataOps vendors and service providers.**
  AI analytics providers can benefit from partnering with DataOps vendors to improve data management, utilizing high-quality data for their models and accelerating analytics solution deployment through streamlined workflows. Grafana, an open-source visualization platform from Grafana Labs, integrates with a variety of DataOps platforms to accelerate dashboard development for performance monitoring. In addition, partnering with service firms enables AI analytics vendors to access domain expertise, tailoring their solutions to attract clients, while expanding their reach. This collaboration fosters accelerated adoption and integration of analytics technology and provides essential training and support. By gaining valuable feedback through these partnerships, vendors can drive innovation and continuously enhance their solutions.

- **Enhance data discoverability and analytics with generative AI.**
  Generative AI, a class of ML that generates new data samples based on input patterns, can enrich the contextualization of data, help eliminate code-heavy interfaces and improve the performance of algorithms with new, synthetic data streams. Incorporating NLP into databases for semantic search and within user interfaces lays the groundwork for advanced conversational AI systems, facilitating seamless, human-centric interactions with powerful analytics tools. C3 AI's Generative AI Product Suite features a natural language interface that can be natively integrated into various applications, such as ESG, customer relationship

management (CRM), reliability, and supply network risk. Generative AI can be beneficial in AI analytics areas that have traditionally relied on vast quantities of historical data, such as predictive analytics, object detection in images and supply chain management. By generating previously unseen patterns, scenarios and simulations, generative AI can enable more accurate predictions, adaptive maintenance plans, and improved identification of risks, bottlenecks and inefficiencies.

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