# Snap-On Advanced Analytics

Do you already have a basic monitoring system?
Our Advanced Data Analytics snap on to it. Seamlessly

We deploy a scalable, flexible Analytics layer as cloud solution via optimized data transfer technology, to enrich the analytics scope of your current monitoring software. All of the state-of-the-art, Smart Analytics integral to Quadrical's Digital Twin based CMMS – available as snap-on plug & play Analytics software. True Condition based Maintenance guidance for your plants, the custom-built Digital Twins improve your plant generation by 2 – 4%, while increasing O&M efficiency by 15%

Truly informed, data-driven decision support, with self-serve Advanced Analytics to build deeper insights. Open Architecture. Fully Extensible
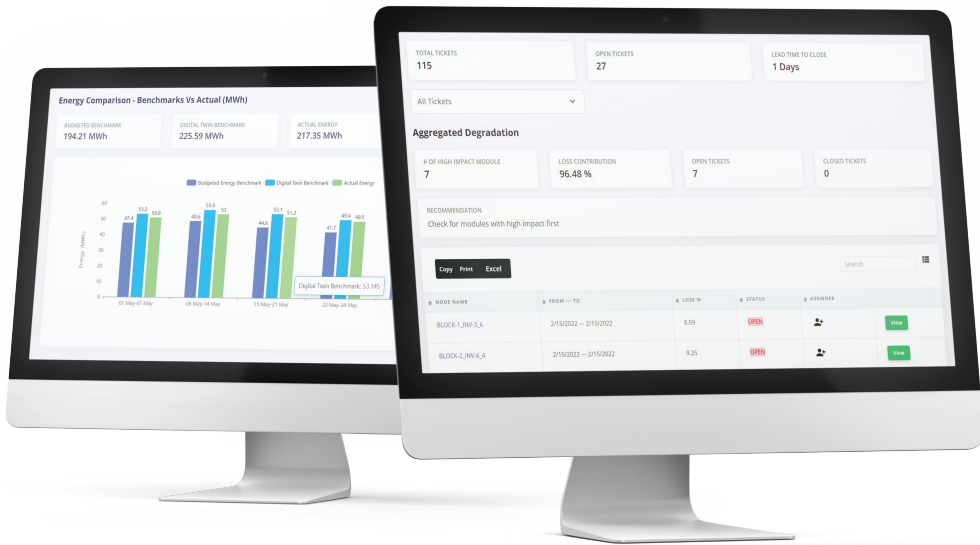
All your portfolio data in one centralized cloud location – clean, and analysis-ready

Open access to clean data in a cloud based, AI-first Data Lake – so your team simply plugs & plays via your preferred user interface and analysis software e.g. Power BI, Tableau, Jupyter-notebooks etc

Benefits

- Historical and RealTime data aggregated on a single cloud hub for flexible visualization of any metric across peers & time

- Plant operating data gathered from all data acquisition systems like SCADA, SMART IoT devices, weather forecast providers etc. is surfaced on the Data platform that updates in RealTime

- Scalable, flexible deployment of your own data analytics libraries, KPI calculations etc. directly via Tableau, PBI, Python notebooks

- Fully reliable sets of plant data with improved data quality, for truly informed decision making

Why clean data?

Raw, unprocessed plant data is often riddled with data gaps, missing values, anomalies.

Analysis on these datasets not only yields inaccurate insights that are flawed due to bad data quality, but also costs the asset management team extra time and wasted effort

Deployed on 2300MW Solar + 450MW / 1800MWh Storage

Advanced Analytics powered by Digital Twins for Directly Actionable Recommendations

We create multiple, granular Digital Twins that are entirely data-driven, and developed to learn and adapt to the true operating behavior of your plant in field conditions. Performance anomalies get flagged in RealTime. You get them as Revenue Prioritized Daily Tickets.

Benefits

*   Accurate, specific, fully actionable O&M Guidance, in form of revenue quantified daily tickets with automated workflows
*   2-4% generation improvement and 15% O&M efficiency gain through reduced leakage and outages
*   Prioritization rules and customizable alerts highlight critical events and potential performance issues. Instant notifications via email & SMS
*   Optimized tickets prioritization and dispatch based on revenue impact, distance clusters & ticket count
*   Reduction in performance volatility

Plug & Play. That's all

Yep. No need to fret about switching costs to access our Advanced Intelligence! Quadrical's Advanced Analytics seamlessly snaps on via hardware-independent, API-based data transfer protocols to any data acquisition system, monitoring platform or alerting software.

Benefits

*   Hassle-free deployment. We generate Advanced Actionable insights and analyses by integrating effortlessly with your existing systems' backend API
*   Zero risk or disturbance to any of your existing systems
*   Seamless transfer of Digital Twin generated tickets into your existing ticketing system, via APIs
*   Single-click access via crosslinks to Quadrical dashboards with:
    1. Detailed workflows for revenue prioritized tickets
    2. Granular diagnostics related to degradation types, soiling, shading etc.

Our Secret Sauce - Digital Twins

Digital Twins are at the core of Quadrical Solar Asset Management Platform

We start by building a detailed digital replica of your plant, by creating and adding up digital twins of each node. The bottom-up addition of yield expectations for each string in RealTime, produces the most accurate estimate of your plant's generation capacity at any time with unprecedented granularity and accuracy.

This means not one Digital Twin, but Twins, Triplets, often 500 Mini Twins for a 50MW Plant.

Next, we leverage these special purpose mini twins for identifying and quantifying shading, soiling, insulation, long term degradation, anomalies, due diligence etc. This lets us arrive at the most precise benchmark for your plant.

This true Condition based Maintenance guidance, with alerts, are benchmarked to our proprietary Digital Twin baseline. They help you improve plant generation by 2 – 4% and O&M efficiency by 15%

Seamlessly integrating with your plants, our cloud-only solution causes zero disruption to your existing systems.

We then optimize your asset performance as our Digital Twins learn and adapt to your plant's inherent characteristics over time. You can call these iterations and their compounding effect *stitch-in-time*, or *daily improvements* like the *Toyota way*. It all means increased profitability today, and better plant monetization even in 2027 and 2034.
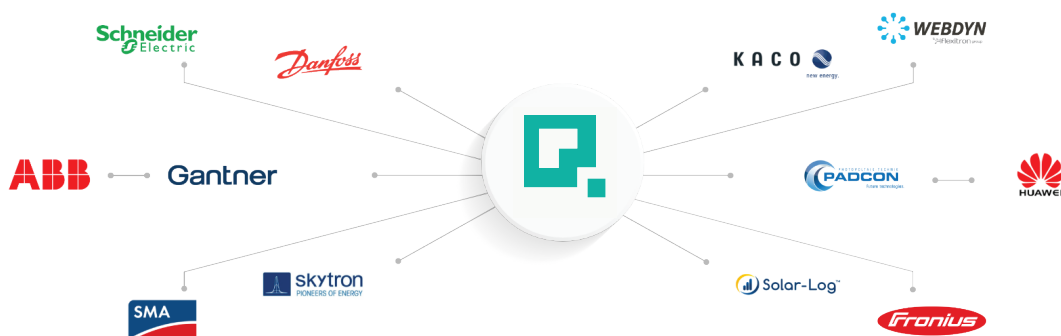
We've successfully integrated with 10+ cloud APIs/data systems already using out-of-the-box frontend integrations.

Features

Integration Capability	Compatible with top platform providers (SCADA, Inverter portals, analytics systems, dataloggers, CMS, DAS, SQL, FTP)
Onboarding Speed	Plant onboarding with historical data in 2 days
Advanced Analytics Tools	Advance Performance Analysis leveraging Digital Twin AI for extremely accurate and granular expectation from every device, at any location, weather conditions, and time Quick Audit: Comprehensive Audit of last 6-mos data for actionable analysis (and revenue based tickets) of Temporal Loss and Short-term Degradation Deep Audit: Multi-year due diligence Audit for granular and quantified view of Structured and Long-term Degradations Alarm & Event Analysis Trend Analysis Ad hoc analysis (XY Analysis) Basic RT Analysis Heat Map and GIS Visualization Comparative Analysis (Peer analysis) Soiling Loss Analysis (Beta) Loss Analysis
Operations & Maintenance Tools	Rich no-code framework for user-defined alerts including multivariate rules, statistical rolling-windows, instance and daily aggregates, peercomparisons, and Digital Twin comparisons Maintenance Dashboard Operations Dashboard Maintenance Management - Predictive, Preventative, Breakdown, Condition based Maintenance **Portfolio-wise Auto & Manual Ticketing** • Comprehensive Ticketing Management: Breakdown, Alerts, Condition based Maintenance, Predictive maintenance, and Preventive Maintenance • Assigning of Jobs and maintenance log-sheet Alert & Alarm Management (MTBF/MTBI/MTTR, Top 10 Alarms) Rule Based Alert / Adhoc alerts Priority and Dispatch Management Revenue-impact, distance clusters and ticket count based Work Flow or Force Management / Incident Management ROC team to manage and coordinate tickets directly with customer's O&M field staff Flexible, site-wise Resource allocation, notification, and escalation Health & Safety Management Track Contractual Guarantees Budget Vs Actual (Annually & Monthly)
Reporting & Notification Tools	Standard Scheduled Reporting (Monthly & Weekly Reports) Flexible visualization of any parameter across peers and time RealTime, on-demand ad hoc reports Auto Schedule of Reports Email & SMS Notifications Centralized Data Platform • With integrated capabilities for site-digitization, satellite weather, yield forecast, and custom report via PowerBI, Tablaeu, and Jupyter notebooks • Notification on the portal Open schema for extensibility with PowerBI, Tableau, and Jupyter-notebooks Seamless data exports of visualizations
Additional Tools & Capabilities	Digital Twin based Audit Platform (for comprehensive view of historical and current losses) Audit Management Mobile App (in roadmap) Third-party data integration (Drones, CCTV, DustIQ, Other Sensors) GIS based Asset Tracking Custom Dashboard - Drag and Drop widgets Data Uploading Enterprise Search Engine Scalability Manage large portfolio by region, customer, any other clustering approach Data Storage & Archival Data Migration Management Data Security

The Software

Seamless Onboarding

- Cloud agnostic. Your cloud or ours based on customer preference
- Data Engineers deploy standardized data migration process from ground to cloud in record time.*
- Flexible, infinitely scalable architecture, with expert support for your teams
- Swift, open architecture integration with all major OEMs: Secure, remote connections any critical source—from SCADA data to power forecasts—regardless of hardware manufacturer or 3rd party service

*Recently we onboarded 40 Plants (850MW) in 45 days.

Ingest Data from Multiple Sources

Data ingested from plants is correlated with relevant streams (production, weather, device IoT, expected performance ratios, and ongoing operations) for exhaustive operational efficiency

Scalable, Flexible Data Management Strategy

- **Data Aggregation**
  Completely transparent and unbiased view of all your assets with a single, standard schema structured for each plant across the portfolio
- **Data Accessibility**
  Plant operating data is cleaned and harmonized and structured into an AI-first Data Platform
- **Zero Sync Issues**
  All data is fetched, processed, and can be utilized via the Data Lake in RealTime (OPC/CDC data clients enable this live sync)
- State-of-Art Cloud Storage & Data Archiving Solutions
  To provide unlimited scale, 99.99% data availability, 99.5% or more system uptime performance
- Highest standards of data security and secure encryption in-flight and at-rest

Reliable, Trusted, Optimized Data Platform

Data from all plants, SMART devices (Block, MFM, Inverter etc.) is cleansed to enable intelligent filling of missing values, de-duplication and configurable time-synchronization, improving the data quality and reliability for RealTime reporting, and accurate forecasting and plant performance optimization

Plug & Play

Connecting most SCADA compliant energy production sensors, standard IoT sensors for device information and weather feeds, our software goes to work. With easy integration supporting all manufacturer types – the Quadrical Ai Platform will ingest all relevant cross-plant data into a single standardized schema. You will benefit with out-of-the-box reports and visualizations

Intuitive, Customizable Dashboards & Reporting

With proprietary advanced modelling techniques, we enable RealTime monitoring and O&M workflows in interactive dashboards with built-in extensive visualization and reporting capabilities custom & standard generation, operational reports identify and drive additional revenue opportunities

Accurate Performance Forecasting

Our Customer Success Team helps you plan future production to align with predicted demand and optimize plant capacity with both planned and predictive maintenance strategies

Open Architecture Integration (Public API)

Single standard schema for entire portfolio, so your team has open access to clean, raw data

Proprietary Digital Twin data is also accessible for your team to enrich your analytical scope, while we continue to build our advanced analytics

Extensible

No code development required. Future-Proof with Extensibility to build new reports to track custom KPIs, and

- Combine internal information around operations/operational revenue data to further improve future reporting

Role-based & Network-based Access Controls

Plus, other specific controls such as encryption in SQL and other databases, so that data in transit stays protected against 'out of band' attacks (e.g., traffic capture)

AI. Out-of-the-Box

With Digital Twin AI based Advanced Predictive Analytics, we are set up to truly benefit you. You can say we're simply out-of the-box. First, Prediction AI will give you forecasts not only for regulatory compliance but also for budgeting, logistics and planning.

Then, Anomaly Detection AI will make Preventative Maintenance become planned with a predicted and prioritized task lists of failures and degradations, based on their exact revenue impact.

You will know exactly what to do to improve your portfolio's profitability, and what is worth doing first.

Quadrical's Audit identifies losses with granular bucketization, and catches faults, failures, and degradations with much higher accuracy than traditional approaches.

Built to Scale, Iterative system in a SaaS Cloud makes it Future-Proof. Fully Extensible. Open Architecture.

Our Plant Audit is a Proof of Concept (PoC), that can show the "what" of your solar plant. It acts as your reliable decision support tool, which you can use to deep dive into plant - inverter - SCB – string level performance analysis, supported by lists of initial failures and degradations flagged by our Audit. With this state-of-the-art performance analysis and revenue prioritized ticket lists, you not only save significant amount of time in finding the right issues, doing root cause analyses and foreseeing impending failures, but also achieve O&M targets faster, as you proactively act on the issues. Working with us means true data-driven decision making due to significantly improved data quality available in RealTime. With time intrinsic learning capability of our Digital Twin algorithms allows our CMMS to provide more clarity on the types of issues, failures, and their root causes.

Add-Ons to Snap-On Advanced Analytics

Remote Operations Center (ROC)

Optimize O&M strategy and on-field execution by giving Quadrical responsibility for overall efficiency and impact.

ROC team supports 24/7, 365 days with continuous RealTime monitoring, in-house performance engineering and proactive services.

- Triage issues: Analyze ticket generated by our rules based and AI system to ensure 100% accuracy /confidence
- Coordinate ticket execution and follow-up for fixes, with site O&M teams
- Post fix follow-up to capture appropriate failure modes, for future prevention

We leverage learnings, live-site QA, operations and customer feedback – to iteratively tune site configurations for KPI improvements.

Scope limited to tickets captured in Quadrical Centralized Management Platform.

Available ONLY as Add-On to Digital Twin based CMMS and Snap-On Advanced Analytics
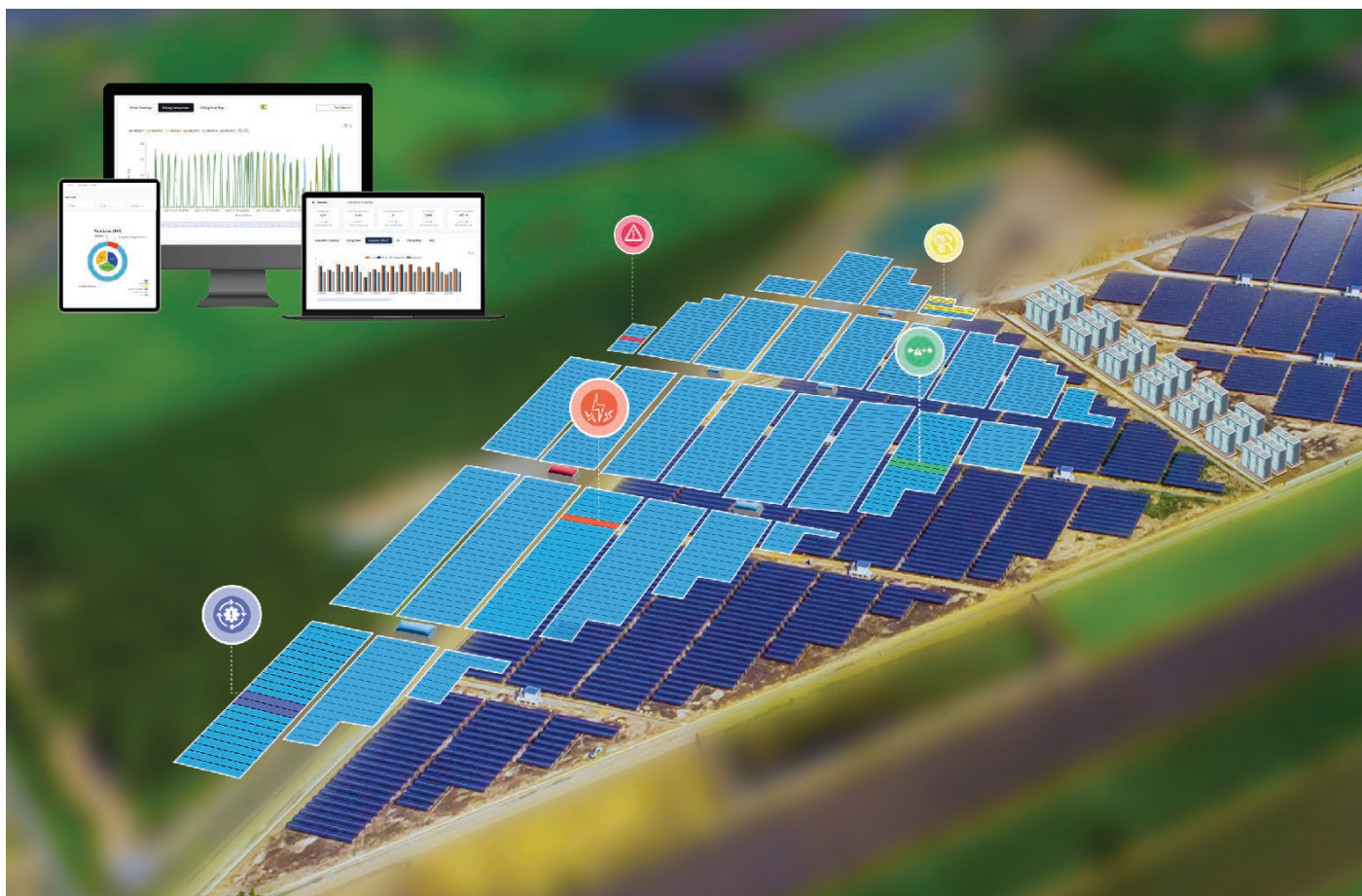
Why Quadrical

Proprietary Digital Twin Technology

Personalized understanding of a plant's exact yield potential: Extremely accurate, granular (PR/efficiency) expectations from each instrumented device, at any location, weather condition, & time
Predictive capabilities: Error-free, highly accurate O&M guidance that starts with pinpointing underperformance & root causes
Specialized Digital Twins purpose-built separately for identifying and quantifying shading, soiling, insulation, ground-faults, long-term degradation, due diligence, classifications etc.

Condition based Monitoring

Degradation & Anomaly Detection

Better planning + Revenue prioritized execution

Optimized Tickets

Condition based Monitoring, Alerts + Predictive Maintenance

Prioritization & dispatch based on revenue impact, distance clusters & ticket count

Remote Operations Center (ROC)

Quadrical to manage ticket execution/ closure directly with site O&M

Fast Onboarding

Hit the Cloud running with **speedy and smooth onboarding**. Seamless integration with your current systems. **Plug & play cloud Products and Services** to swiftly integrate across portfolios of all sizes. Quadrical Ai Integration team is the fastest in the business with an average of ~1 GW installed in ~30 days

Immediate Value & RoI Gains

Strong experience in establishing secure remote connections (>400 different types) to the full spectrum of manufacturers of renewable assets, associated devices and CMMS

Standardized Data Migration Process

Independent of plants' hardware infrastructure and PV monitoring solutions. Flexible backbone architecture and technical expert support to surface RealTime current snapshots of portfolio performance, up and running on a custom-built dashboard

Ease of Deployment

Platform fully compatible with all inverter, data-loggers, DAS, FTP and SCADA systems

### Cutting-Edge Satellite Weather Integrations

Alleviates need for (& quality issues from) weather station

Reporting Extensibility (via Power BI, Notebooks)

Active Innovation Roadmap

Near-term roadmap includes Storage Analytics and Renewable Energy Certificates:

• Satellite Imaging - University of Cambridge
• IoT Soiling Platform - University of Waterloo
• iREC platform
• Utility Scale Storage
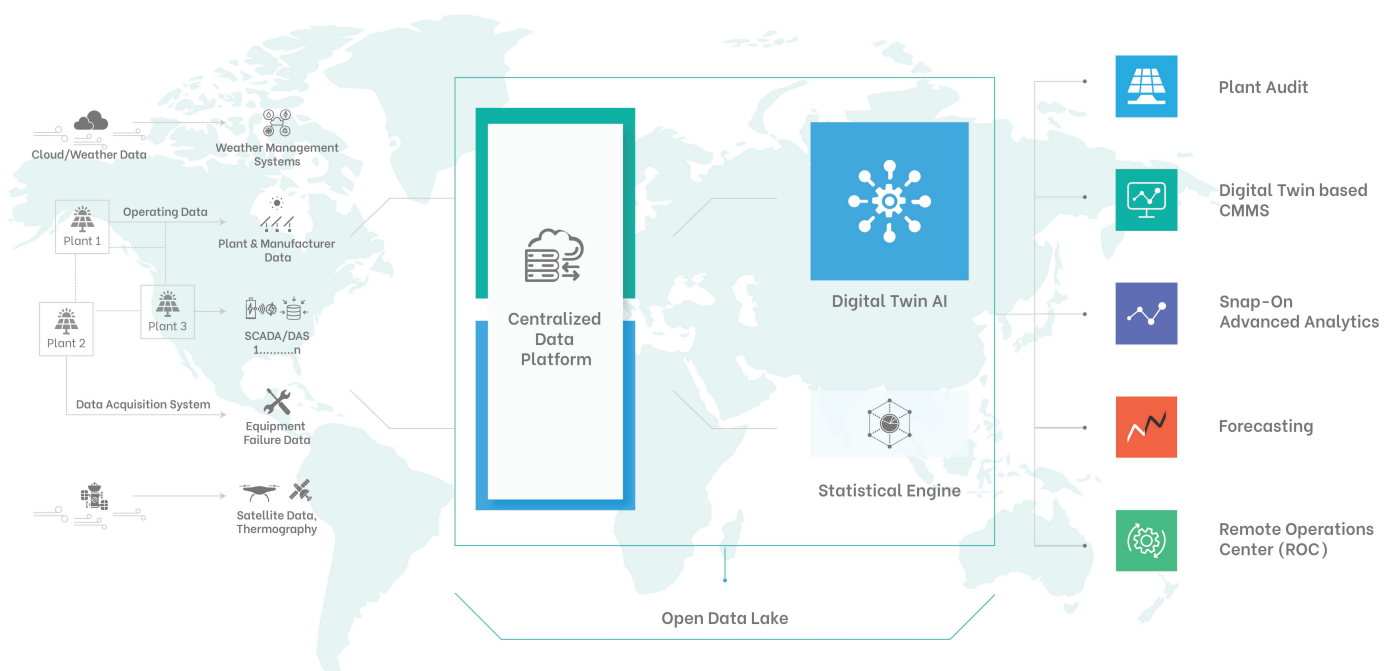
Our Clients say...

James V Abraham
(Founder and Director - SolarArise)

We worked with Quadrical to build a data platform, consolidating our plant data onto a common schema. Quadrical built out the schema with AI capabilities to help O&M teams to identify and rectify anomalies, prioritised by revenue impact. There are many players who claim capabilities and tools in Artificial Intelligence, but none have the true depth of technical abilities that Quadrical brings to the table.

Ramesh Kumar Modalavalasa
(Business Head - O&M, Vikram Solar)

As we onboarded 25 plants with Quadrical in 45 days, we've been impressed with their ability to fully own data quality and connectivity. With advanced Analytics-as-a-Service, we're already seeing the benefits with insights available for our operations team to identify the plant performance issues and possible breakdowns proactively. I am now confident that this platform has the potential to transform the way we do our operations. Look forward to us optimize our entire 1000MW+ portfolio while monitoring it in near RealTime.

Our Founders

Sharat has been a Global VP at Adobe Global, CTO at MMT (MakeMyTrip), and MD at Scale-Ups, prior to a career in the US with startups and companies like Microsoft. His sweet spot is building teams which do great things together and passion is making the benefits of AI and Big Data available to everyone. Sharat did his B. Tech at IIT Delhi, with an MBA from New York University.

Hugh has most recently been the CEO at Cognitive Systems, a hardware startup. Prior to that he was a VP and early employee at Blackberry, and is one of the people responsible for their superior security reputation. His interest in AI goes back to being a PhD student at Cambridge University. He also has an M. Eng from University of Waterloo.

Plant Audit | Digital Twin based CMMS | Snap-On Advanced Analytics | Forecasting | ROC