ORACLE DATA SHEET

Oracle Adaptive Intelligent Apps for Manufacturing

Machine Learning and Artificial Intelligence (AI) Driven Analytical Cloud Applications for the Manufacturing Industry

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ADAPTIVE INTELLIGENT APPS FOR MANUFACTURING

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- SaaS (subscription) based analytical applications on Oracle Cloud
- Purpose-built applications for the manufacturing industry
- Applicable across all discrete and process manufacturing industry verticals
- Designed to work in a heterogeneous mix of IT systems
- Machine Learning / AI based analysis
- Target audience: Business users in manufacturing and quality management, Process engineers, Production Supervisors, Quality Managers, as well as Data Analysts and Data Scientists

Machine Learning and AI for Manufacturers – The Need

The hottest technology disruption that seems to be taking every industry by storm today is Machine Learning (ML) and Artificial Intelligence (AI). We have seen the promise of these technologies in our day-to-day lives as a consumer. Whether it is about movie recommendations from Netflix, or suggested products to buy from Amazon, or the personalized ads from Google, these technologies are becoming part of our daily lives. The beauty of this technology is that computers are not being explicitly programmed to perform a certain task. Instead, computers/machines are learning from the data that is being fed to them and are deciding the pattern of events happened in the past or what is likely to happen in the future or what is the best recommendation/action to perform under a given circumstances. This is the main and fundamental difference between traditional programming and ML/AI based approach.

So, what does this mean to the manufacturing industry? How can these disruptive technologies be leveraged by manufacturers to reduce defects, rework, scrap, cost and improve yields and manufacturing cycle times? Enterprises need to use a “data driven” approach and look at the data with a “new lens” (i.e. using ML/AI techniques) to realize significant cost savings and achieve greater operational excellence thereby making them more agile and competitive in the industry. Traditional operational reporting and business intelligence techniques do not provide actionable answers to the tough questions that manufacturing users are asking because they focus on “What Happened” and not “Why it Happened”. In many cases, the manufacturing users might not even know the right question(s) to ask. The expectation from users is that a ML/AI based “expert system” will automatically start learning from the data and provide insights, predictions, recommendations, and suggestions. So, what kinds of data are we talking about? Manufacturers are dealing with two major categories of data. Firstly, the Information Technology (IT) data coming from business applications such as

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ERP/SCM/CRM/HCM/MES/Quality etc. and secondly the Operational Technology (OT) data coming from the physical world of machines, equipment, sensors, test stations etc. The OT data needs to be further contextualized with the IT data to get a holistic view of what's happening. Analyzing only OT data such as temperature, pressure, vibration etc. coming from machines or analyzing only IT data such as parts, suppliers, lots, serials, work orders etc. is not sufficient. The holy grail for actionable intelligence is when OT data is contextualized with IT data and the combined data set is analyzed using ML/AI techniques. This results in a new class/level of intelligence that can provide meaningful and significant outcomes.

Oracle Adaptive Intelligent Apps for Manufacturing

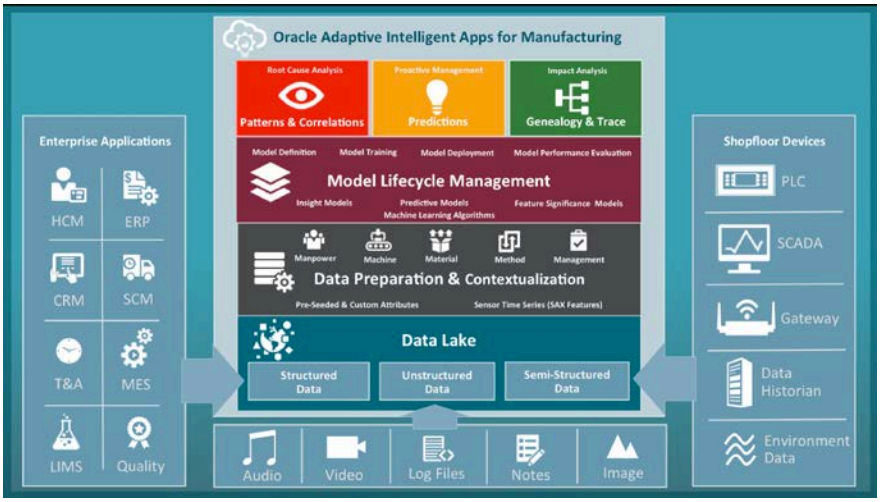

Figure 1. AI Apps for Manufacturing - Functional Architecture

Oracle Adaptive Intelligent Apps for Manufacturing is an SaaS analytical cloud application that collects, stores, and analyzes massive amounts of Operational Technology (OT) data coming from shop floor systems such as Equipment, Machines, Sensors, Test Stations, Data Historian etc. and contextualizes it with Information Technology (IT) data coming from business applications such as ERP, SCM, HCM, CRM, MES, Quality etc. and analyzes it by applying machine learning and artificial intelligence (AI) techniques to discover key patterns and correlations that affect manufacturing efficiencies and provides actionable predictive analytics to maximize yield, and minimize defects, scrap, cycle times, cost etc. It also provides comprehensive capabilities for backward and forward tracing of products and processes spanning manpower, machine, material, method, and management related information to facilitate rapid root cause, impact and containment analysis.

KEY FEATURES

- Comprehensive Data Import/Ingestion services to acquire data from disparate business applications/systems such as MES, Quality, LIMS, ERP, SCM, HCM, CRM etc. systems as well as from Machines/Equipment and Sensors
- Comprehensive data lake to store structured, semi-structured, and unstructured data
- Contextualization of machine/sensor data with business applications data such as MES, Quality, LIMS, ERP, SCM, HCM, CRM etc.
- Robust Time-Series analysis algorithms to make sense of high frequency machine/sensor data (SAX Features)
- Model Lifecycle Management that includes Model Definition, Model Training, Model Deployment, and Model Performance Evaluation
- Presentation layers for Insight (Patterns and Correlations), Predictions, Genealogy and Traceability
- Outbound REST services to enable downstream integration to other applications and systems

New Class of Business Questions that Oracle Adaptive Intelligent Apps for Manufacturing can Help Answer

- Are there **patterns** in data that strongly relate to yield loss or defects?
- Is there a **correlation** between product failures in the field or customer returns & the manufacturing process used?
- What are the top **influencing factors** for quality, yield, and cycle time?
- Can we **predict** process deviations and product defects early during manufacturing to minimize scrap & rework?
- Can we **trace** man, machine, method, and material for defective products and identify similar products and impacted customers **(smart recall)**?

Data Acquisition and Storage

- **Data from Machines and Equipment**
  Leverage automated and manual upload capabilities to ingest data from sensor enabled equipment, machines, and facilities on the shop floor.
- **Data from Enterprise Applications**
  Ingest data from transactional applications such as MES, Quality Management, LIMS, ERP, SCM, HCM, and CRM.
- **Embedded Data Management Platform**
  Utilize embedded Oracle PaaS technologies across Database and Big Data stacks running on Oracle Cloud Infrastructure (OCI) that support a manufacturing-aware data lake which stores structured, semi-structured, and unstructured data coming from a variety of sources.

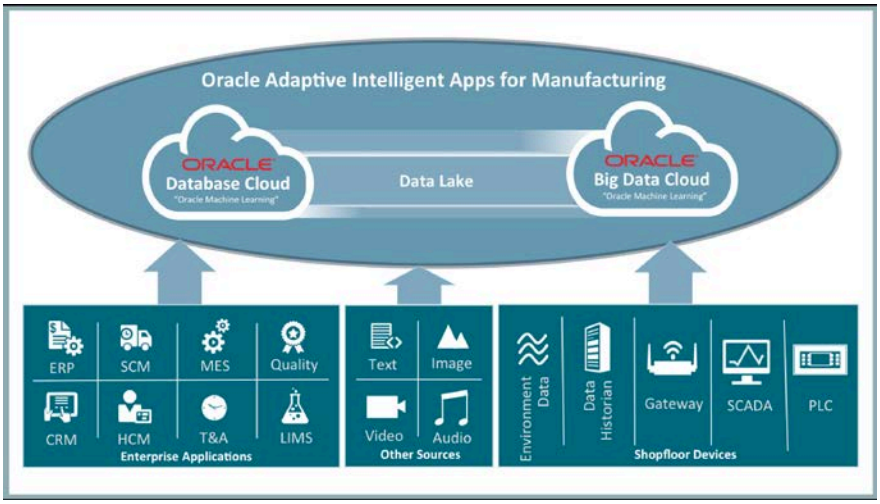

Figure 2. Data Acquisition and Storage

Data Contextualization and Preparation

- **OT and IT Data Contextualization**
  Use inbuilt capabilities to contextualize data coming from sensor-enabled machines and equipment (OT data) with transactional data (IT data) coming from MES, Quality Management, LIMS, ERP, SCM, HCM, and

KEY BUSINESS BENEFITS

- Helps enable a comprehensive **data driven continuous process improvement** strategy
- **Dramatically shrinks** root cause, impact and containment analysis timeframes
- **Enables the foundation for "smart recall"** type analysis based on genealogy and traceability to identify impacted products and customers
- **Prevents cost overruns** due to rework and scrap by predicting problems in advance
- Helps achieve **Manufacturing Operational Excellence**

CRM, to get a comprehensive snapshot of the manufacturing state at any given point in time.

- **Sensor-Time-Series Data**
  Convert continuous streams of sensor-time-series data from machines and equipment into time-window aggregates using SAX (Symbolic Aggregate approXimation) to facilitate machine-learning analysis.

- **5M Data Preparation**
  Organize the massive data present in the data lake into 5M categories (manpower, machine, method, material, and management) with a pre-seeded library of attributes from Oracle applications as well as custom attributes to facilitate comprehensive analysis of the entire manufacturing process.

Figure 3. Data Contextualization and Preparation

Model Lifecycle Management

- **Model Creation**
  Leverage simple and intuitive user interfaces to allow data scientists to create an unlimited number of descriptive and predictive models for analyzing KPIs such as yield, quality, cycle time, scrap, rework, cost, and others.

- **Model Training and Deployment**
  Continuously train models with historical training data sets to attain the required accuracy levels and scores. One-touch deployment allows selected models to be immediately deployed for monitoring ongoing manufacturing processes.

- **Model Performance Evaluation**
  Evaluate accuracy of predictive models using a confusion matrix by comparing predicted values with actuals, and continue to refine the models for improved accuracy.

Figure 4. Model Lifecycle Management

Insights (Patterns and Correlations Analysis)

- **5M Input Factors**
  Analyze 5M (manpower, machine, material, method, management)-related information from manufacturing operations to understand the impact on key business outcomes.

- **Top Influencing Factors**
  Identify the factors and variables in the manufacturing environment that have the highest influence on key performance metrics.

- **Patterns and Correlations from Historical Data**
  Identify the relationship between a multitude of influencing factors and variables from the manufacturing process that affect key performance indicators such as yield, quality, cycle time, scrap, rework, and costs.

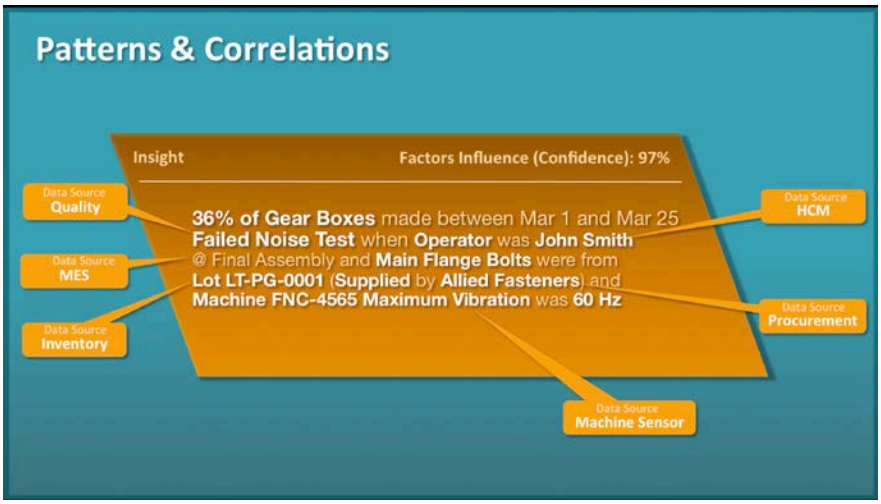

Figure 5. Patterns and Correlations

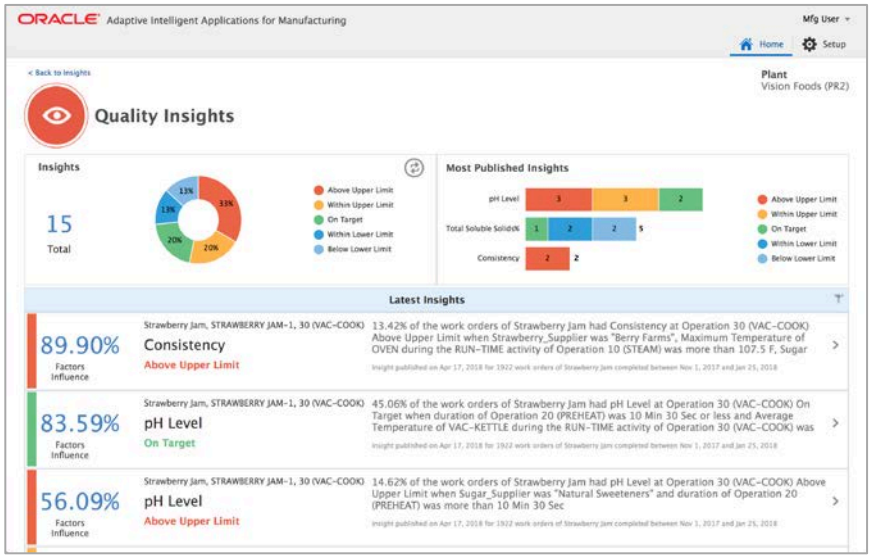

Figure 6. Quality Insights

Predictive Analysis

- **Critical Outcomes During Manufacturing**
  Compare current manufacturing conditions against suspect patterns from historical data analysis to predict potential yield loss and product defects.

- **Prediction Alert Rules**
  Configure the application to receive alerts for predictions that match specific conditions such as confidence%, product context, etc.

- **Downstream Orchestration**
  Subscribe to the published REST services for predictive alerts (for example, put job on hold, create quality non-conformance, etc.) to create transactions in other applications.

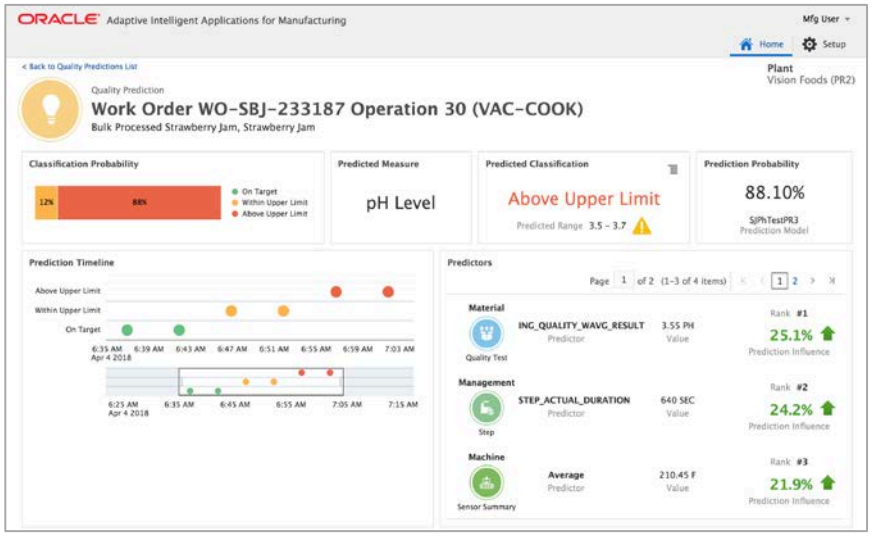

Figure 7. Quality Prediction

Genealogy and Traceability Analysis

- **Self-Guided Navigation for Traceability**
  Using an intuitive graph based navigation, traverse back the entire manufacturing process to identify 5M (manpower, material, method, machine, management) related information.

- **Time-Window Traceability**
  For any window of time period, view all relevant manufacturing events such as machine sensor reading anomalies, alarms/alerts, quality test results, work order start/stop, and status changes such as released, on hold, etc.

- **Impacted Products and Customers**
  Trace forward from any combination of manufacturing factors to identify products made under those conditions and impacted customers.

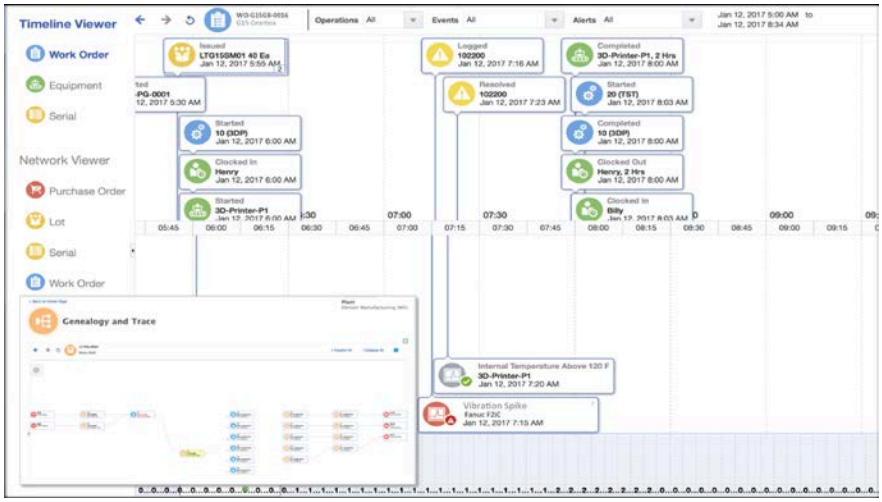

Figure 8. Timeline and Network Viewers

Products that were manufactured in the past (or still being manufactured) can be traced to understand the complete genealogy across all the 5M factors (Manpower, Machine, Method, Material, Management) that were involved when the product was made. The Genealogy and Traceability feature of this solution provides a comprehensive set of forward and backward trace capabilities to identify the suspect root cause and analyze the overall impact on other products, customers, and suppliers and take timely actions to mitigate risks. This feature enables the foundation for “smart recall” type analysis.

Summary

Oracle’s Adaptive Intelligent Apps for Manufacturing helps manufacturers take on a practical path towards realizing their “Smart Manufacturing” and “Digital Transformation” vision by moving up the data driven intelligence maturity curve (from Reactive to Predictive/Prescriptive decision making). Leveraging the power of machine learning and artificial intelligence (AI) techniques, this solution opens up opportunity to provide truly actionable intelligence to help manufacturers deploy a very effective “continuous process improvement”

strategy to ensure that superior quality products are produced in a timely manner at the lowest cost, helps dramatically shrink the root cause, impact, and containment analysis timeframes and helps achieve highest levels of customer satisfaction and manufacturing operational excellence.

Oracle Cloud

Deploying your business applications in the cloud can deliver both short-term and long-term benefits, including cost savings, improved agility, and faster innovation—but only if your cloud is enterprise-grade. When evaluating your cloud strategy, it's important to consider the level of control and choice you will either maintain or give up to achieve some of these benefits. There are also additional risks to consider when outsourcing all or part of your applications to a third-party cloud provider, making it important to always evaluate the quality of these services as key purchasing criteria.

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