HONEYWELL FORGE

PRACTICAL ASSET PERFORMANCE MANAGEMENT: Honeywell Performance+ Industrials Asset Performance

Honeywell

THE CHALLENGES FOR
MODERN INDUSTRIALS

HUMAN CAPITAL

DEPENDENCY ON EXPERTISE

20-25% EXPERIENCE LOSS

5-10YR. WORKFORCE RETIRING WINDOW

98% LACK OF DATA DRIVEN DECISIONS

OPERATIONAL

RELIABILITY / AVAILABILITY TARGETS

99% DESIRED **85-95%** ACTUAL

OEM BUDGET CONSTRAINTS

5% COST OUT OF TARGET

FRAGMENTED VIEWS

20+ IT SYSTEMS

CAPACITY CONSTRAINTS
Improve Output & Performance

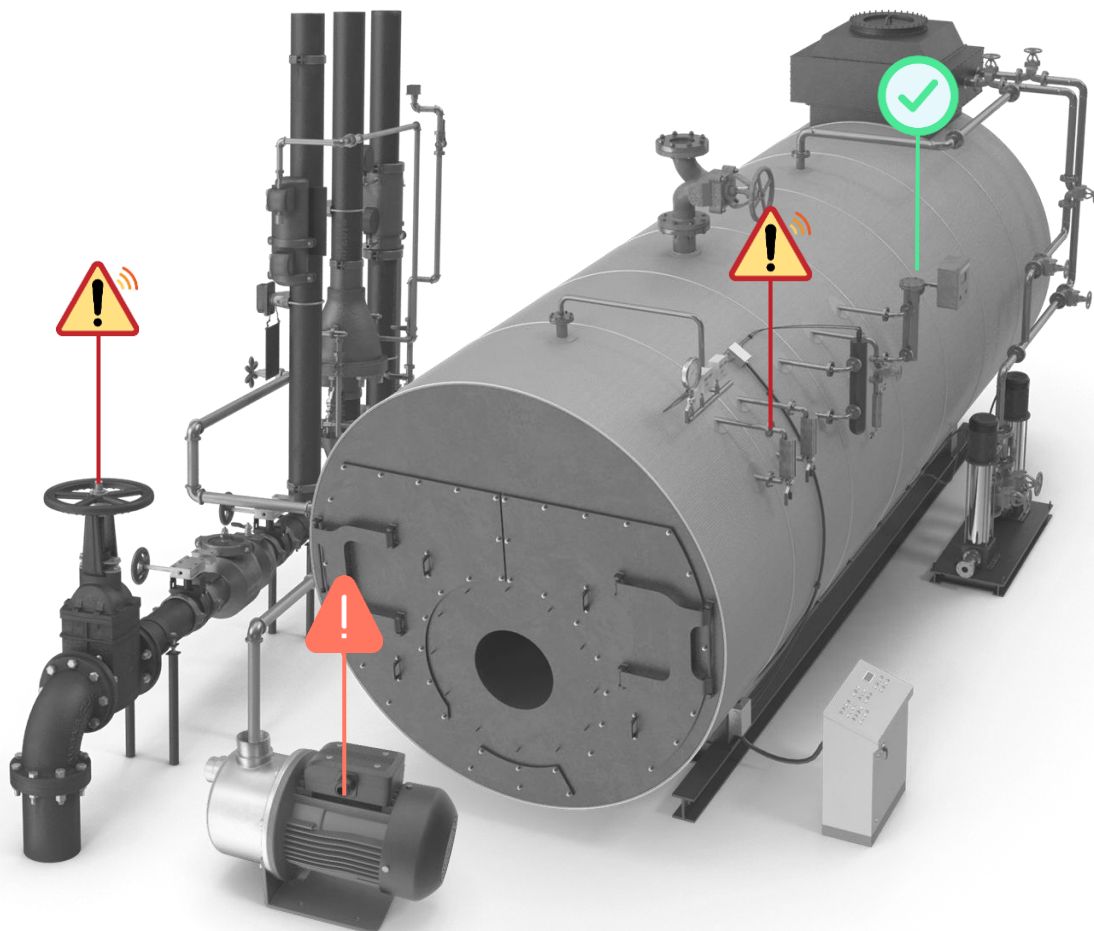**SAFETY RISKS**
Need Better Visibility

APM SOLUTIONS

~2-5YR. DIFFICULT TO ADOPT / CONFIGURE

6MOS. LONG DEPLOYMENT TIMES

INSUFFICIENT EARLY WARNINGS

HARD TO JUSTIFY INVESTMENT

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WHAT IS ASSET PERFORMANCE MANAGEMENT?

INCREASE EQUIPMENT UPTIME
- Predictive Problem Solving
- Incident Investigation
- Risk Analysis
- Scheduling & Planning

UP TO 5% RELIABILITY & AVAILABILITY IMPROVEMENT

IMPROVE EFFICIENCY
- Performance Visibility
- Objective Driven Improvements
- Constraint Analysis

UP TO 5% EFFICIENCY OUTPUT

REDUCE MAINTENANCE COST
- Operations Management
- Workflow Management
- Personnel Training & Analytics
- Inventory Analysis

UP TO 5-10% O&M COST REDUCTION

REDUCE OPERATIONAL RISK
- KPI & Performance Tracking
- Lost Opportunity Identification
- Actionable Recommendations
- Maintenance Strategy Optimization
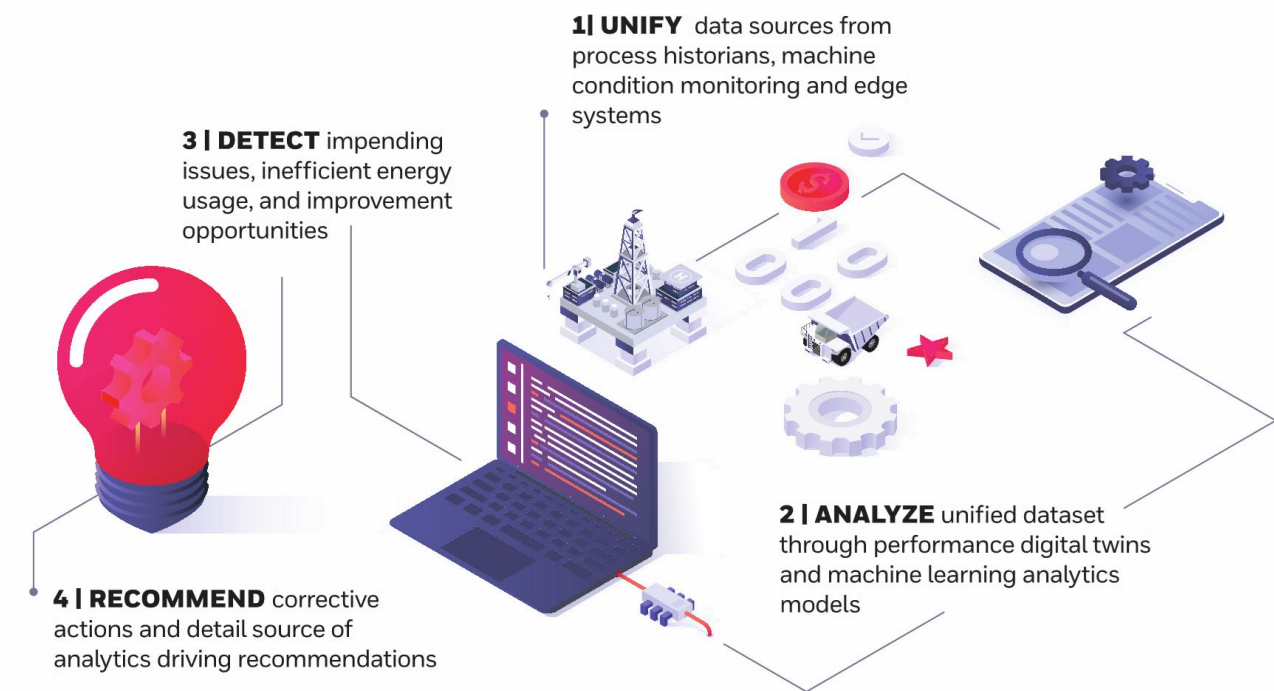- Benefit Quantification

UP TO 30% WORKER PRODUCTIVITY

SUSTAINABILITY CARBON EMISSIONS
- Analytics & Content
- Process Optimization
- Energy Consumption
- Environmental Analysis

UP TO 5% EMISSION REDUCTION

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(Estimated averages from over 100 Honeywell Forge Asset Sentinel Installations and over 50,000 assets monitored globally from 2015-2017)

HONEYWELL FORGE ASSET PERFORMANCE MANAGEMENT

IMPROVE RELIABILITY & AVAILABILITY | MINIMIZE RISKS AND OPERATING COSTS

1| UNIFY data sources from process historians, machine condition monitoring and edge systems

3 | DETECT impending issues, inefficient energy usage, and improvement opportunities

4 | RECOMMEND corrective actions and detail source of analytics driving recommendations

2 | ANALYZE unified dataset through performance digital twins and machine learning analytics models

UNPARALLELED VALUE FROM DAY ONE

PLUG-AND-PLAY DEPLOYMENT

AUTONOMOUS DATA PROCESSING

MODEL VALIDATION WITH REAL EQUIPMENT

EARLY DETECTION OF EQUIPMENT CHANGES

DECISION MAKING AID WITH RECOMMENDATIONS

LONG TERM FUNCTIONALITY WITHOUT MAINTENANCE

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Powered by Azure IoT Hub

Experience the simplicity of a scalable SaaS solution

Straightforward deployment

Connect devices at any scale

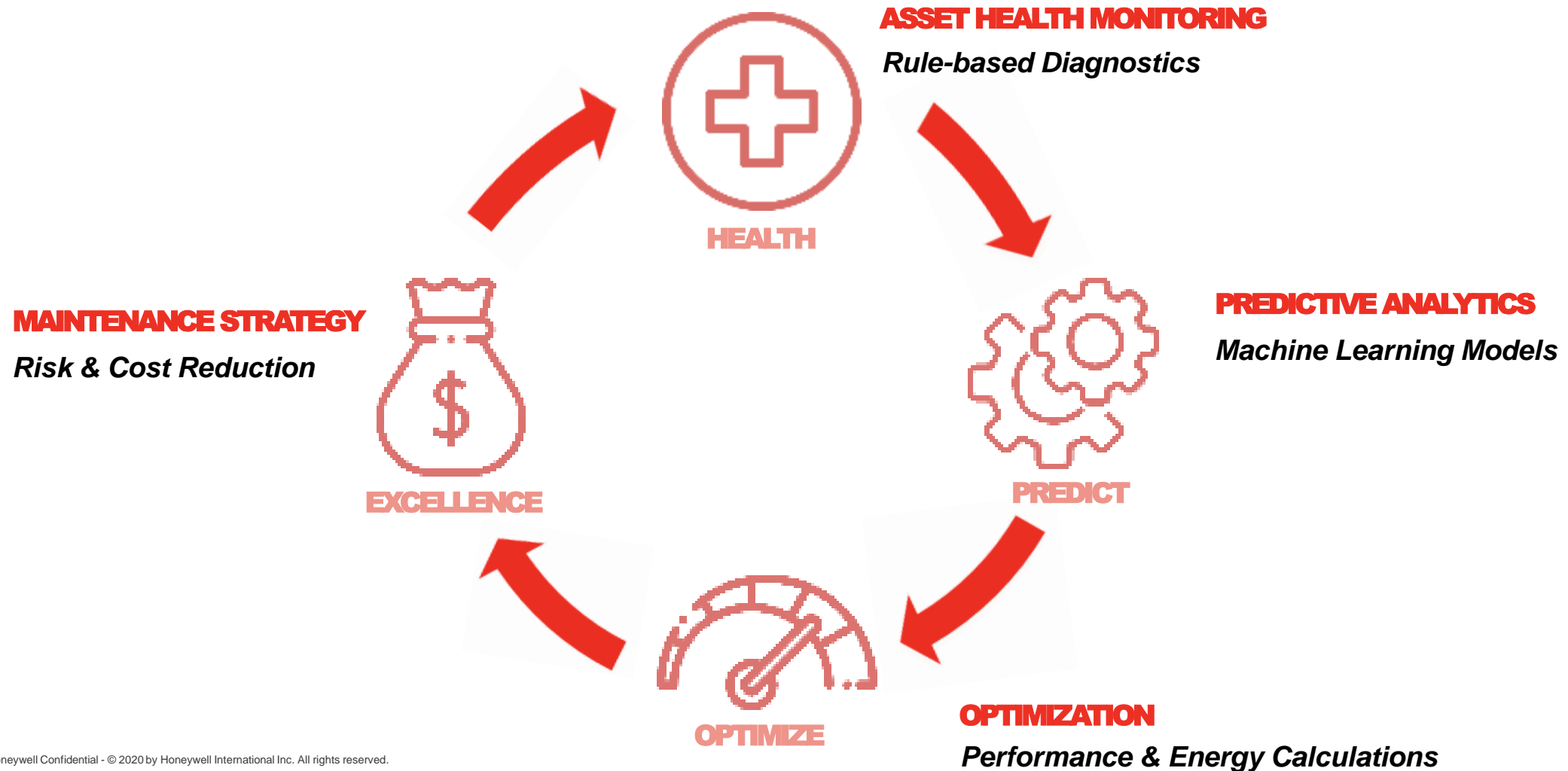Consolidate data and visualize insights

Best-in-class security and enterprise-grade services

Full integration into business systems

HONEYWELL FORGE ASSET PERFORMANCE MANAGEMENT

Cloud-based Modules Designed to Optimize Assets

ASSET HEALTH MONITORING

Rule-based Diagnostics

HEALTH

PREDICTIVE ANALYTICS

Machine Learning Models

PREDICT

MAINTENANCE STRATEGY

Risk & Cost Reduction

EXCELLENCE

OPTIMIZE

OPTIMIZATION

Performance & Energy Calculations

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HONEYWELL FORGE
ASSET PERFORMANCE MANAGEMENT (APM) FOR INDUSTRIALS

A PRACTICAL APPROACH TO APM TO ACCELERATE TIME-TO-VALUE

HEALTH
Asset Health Monitoring & Performance in Near Real-Time

PREDICT
Predictive Analytics Using AI/ML to Predict Health and Performance Degradation in Advance

OPTIMIZE
Identify Sources of Performance Losses and Inefficiencies Including Energy Use
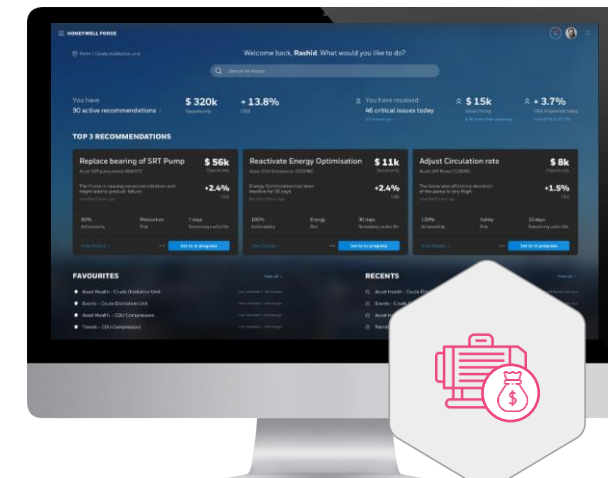
EXCELLENCE
Outcome-Based Strategy for Maintenance and Cost Reductions

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HOLISTIC ASSET MODELING

PERFORMANCE MODEL
QUANTIFIES the WORK done by the machine. Imperative to measure efficiency and associated cost of inefficiency.

MECHANICAL HEALTH
EARLIEST identifier of machine issues from vibration TIME WAVEFORMS and associated SPECTRAL DATA.

MACHINE LEARNING MODEL
IDENTIFIES SMALL VARIATION in all monitored parameters. Calculates the CORRELATION between measured parameters. A correlation change may identify health deterioration or sensor issue, etc.

DEFINE
MEASURE
ANALYZE
IMPROVE
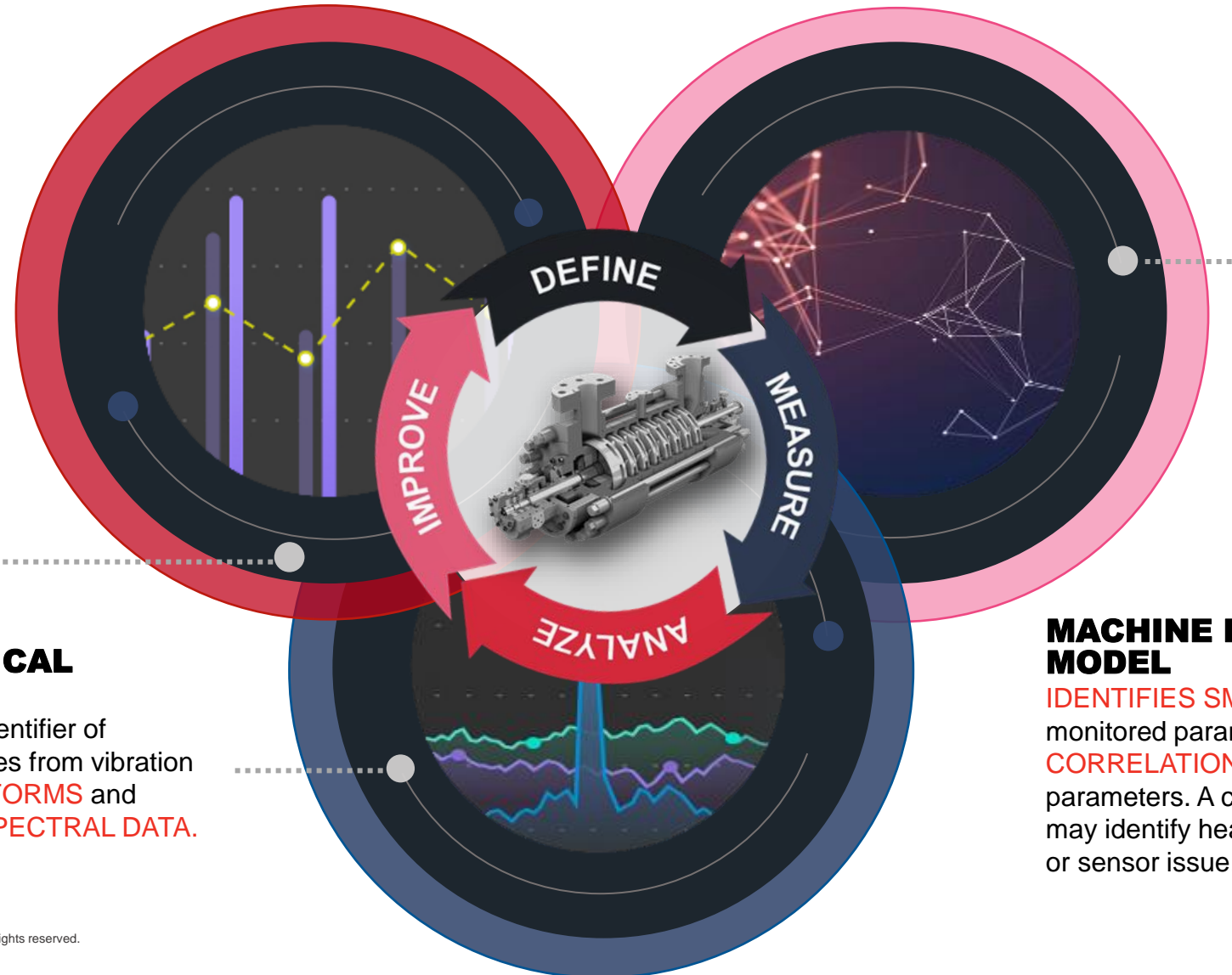
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HONEYWELL FORGE APM FOR INDUSTRIALS
ADVANCED ANALYTICS PORTFOLIO

HEALTH

- Condition Monitoring by adaptative threshold analytics
- Fault and symptom Management, with cause, consequence and corrective actions
- Reliability KPIs-OEE, Availability, Running Status, Run Hours, Downtime
- Instrument Health option with HPS Field Device Manager
- Maintenance Request and work order tracking *
- Downtime Reporting*

PREDICT

- Overall Health Index
- Anomaly Detection
- Failure Prediction and diagnostics*
- Statical RCA
- Prognosis -Time to Reach Limit, Remaining Useful Life*
- Analytics Workbench supporting BYOML
- Prebuilt ML Models for Industrial assets

OPTIMIZE

- Operate within Design limits
- Actual Vs Design Performance
- Thermodynamic Library
- Energy Efficiency
- Real-Time Perf Monitoring with UniSim
- Performance Models and performance faults library
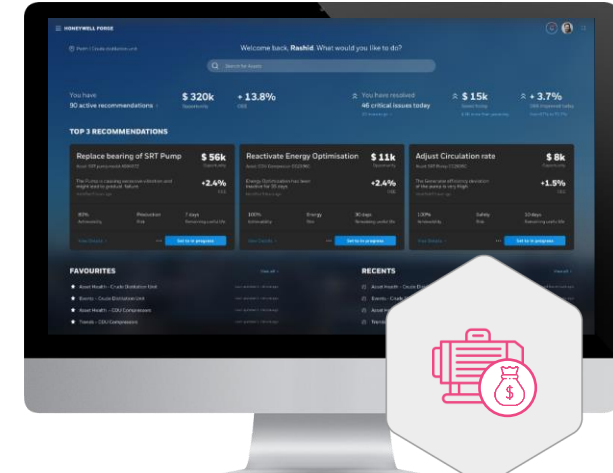
EXCELLENCE*

- FMEA
- Criticality Analysis
- Risk / Cost
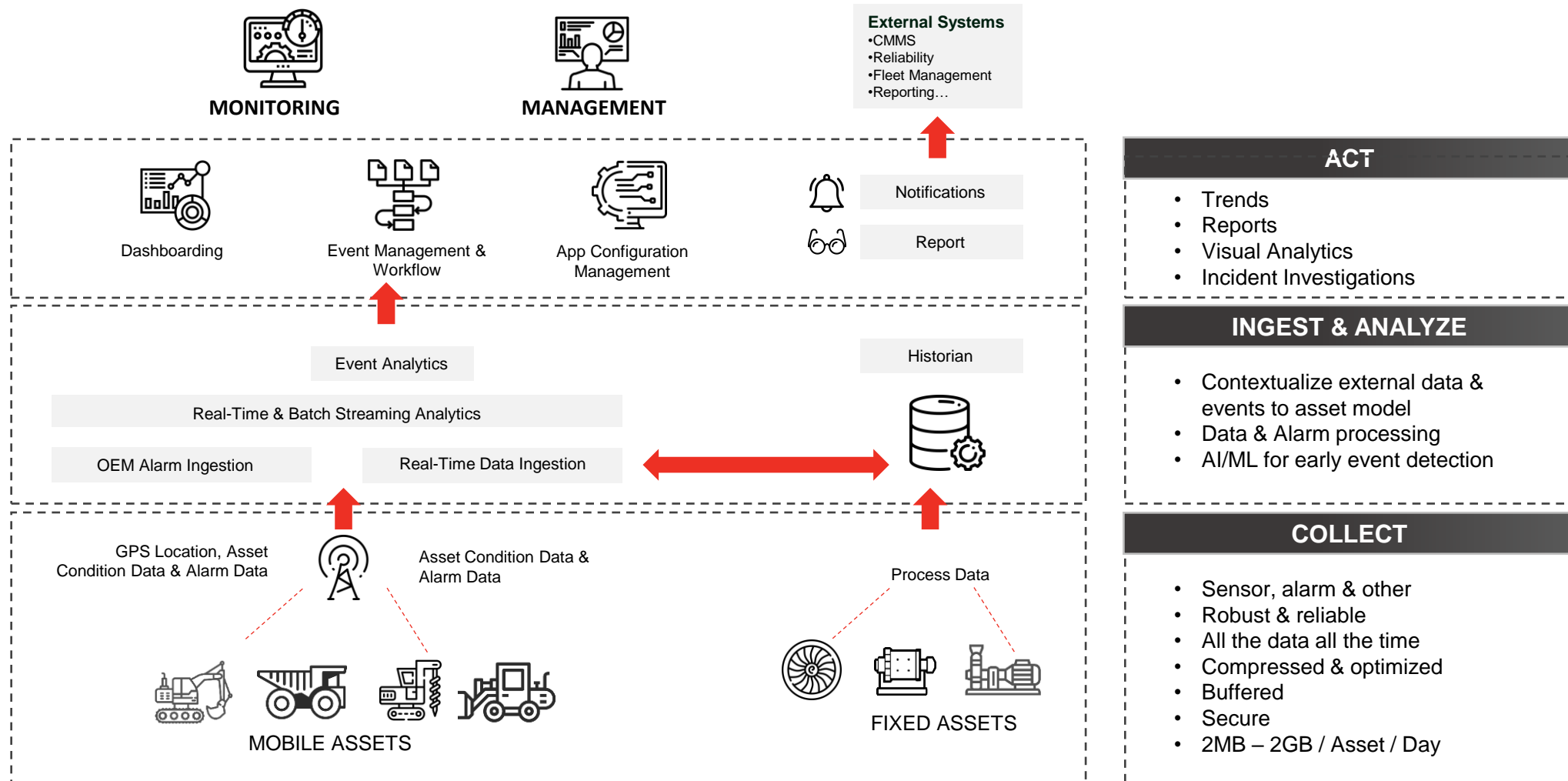- Maintenance Actions
- CMMS & Work Order

*Roadmap planned feature. *Any descriptions of future product direction, intended updates or new or improved features or functions are intended for informational purposes only and are not binding commitments on us and the sale, development, release or timing of any such products, updates, features or functions is at our sole discretion.*

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PRE-BUILT ASSET TEMPLATES ACROSS INDUSTRIES

HEALTH

PREDICT

OPTIMIZE
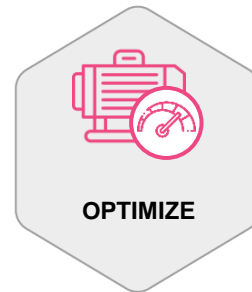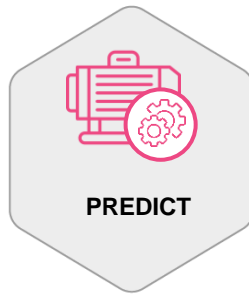
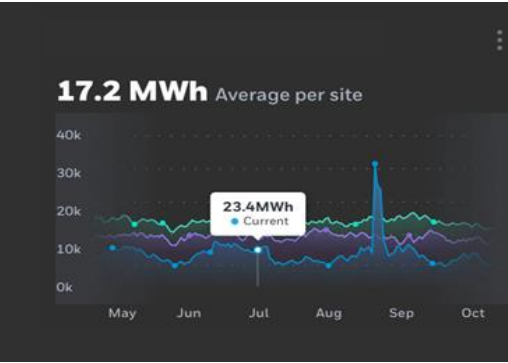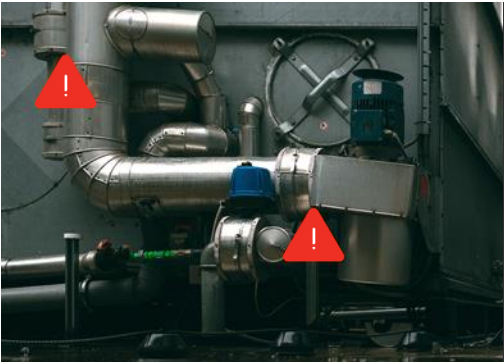- AGITATORS
- AUXILIARY EQUIPMENT
- BLOWERS AND FANS
- CASING
- CHOKE
- COLUMN
- COMBUSTION ENGINE
- COMPRESSOR
- CONVEYOR AND ELEVATORS
- CRANES
- CRUSHER
- CURRENT RECTIFIERS
- DOWNHOLE SAFETY VALVE
- DOWNHOLE WELL COMPLETION
- DOZER
- DRILL
- DRUM
- ELECTRIC GENERATOR
- ELECTRIC MOTOR
- ELECTRICAL / TRANSFORMERS
- ELECTRICAL PANELS
- ELECTRICAL SUBMERSIBLE PUMPS
- EXCAVATOR
- FANS & BLOWERS
- FILTERS

- STRAINERS
- FLOWLINES
- FREQUENCY CONVERTER
- GAS LIFT VALVES
- GAS TURBINE
- GEARBOXES
- GRADER
- HEAT RECOVERY STEAM GENERATOR
- HEATER / TREATER
- HEATERS & BOILERS
- HYDROCYCLON
- INFLOW CONTROL DEVICES
- INFLOW CONTROL VALVES
- LOADER
- MECHANICAL SEALS
- MILL
- MIXERS
- MULTIPHASE PUMPS
- ONSHORE PIPELINES
- OXIDIZER
- PERFORATION
- PIPING
- PLUNGER LIFT EQUIPMENT
- POWER TRANSFORMERS
- PRESSURE VESSELS
- PUMP
- SCREENER

- SHOVEL
- SILOS
- STEAM TRAPS
- STEAM TURBINE
- STORAGE TANKS
- SUCKER ROD PUMPS
- SURFACE WELL HEAD & X-MAS TREES
- SWITCH GEAR
- SWIVELS
- TANK
- TANK LEVEL
- THICKENER
- TRUCK
- TUBING
- UPS
- VAPOUR RECOVERY UNITS
- VARIABLE SPEED DRIVES
- WINCHES

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HONEYWELL FORGE
APM FOR INDUSTRIALS | HIGH-LEVEL SYSTEM ARCHITECTURE

MONITORING

MANAGEMENT

External Systems
- CMMS
- Reliability
- Fleet Management
- Reporting…

Dashboarding

Event Management & Workflow

App Configuration Management

Notifications

Report

Event Analytics

Real-Time & Batch Streaming Analytics

OEM Alarm Ingestion

Real-Time Data Ingestion

Historian

GPS Location, Asset Condition Data & Alarm Data

Asset Condition Data & Alarm Data

Process Data

MOBILE ASSETS

FIXED ASSETS

ACT
- Trends
- Reports
- Visual Analytics
- Incident Investigations

INGEST & ANALYZE
- Contextualize external data & events to asset model
- Data & Alarm processing
- AI/ML for early event detection

COLLECT
- Sensor, alarm & other
- Robust & reliable
- All the data all the time
- Compressed & optimized
- Buffered
- Secure
- 2MB – 2GB / Asset / Day

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THE HONEYWELL FORGE APM ADVANTAGE

REDUCE MAINTENANCE LEAD TIME	ACCELERATE TIME-TO-VALUE FROM MEM DEPLOYMENT	INCREASE OEE & OPERATIONAL MARGIN	FOSTER A CRAWL-WALK-RUN APPROACH	LEVERAGE EXISTING MONITORING SOLUTIONS
IDENTIFY MAINTENANCE ISSUES 2-3X EARLIER	LOWER DEPLOYMENT LABOR BY 50%	$2-3M/YR SMALL SITES $7-10M/YR LARGE SITES	6-MONTH AVG. BREAK EVEN PER PHASE	EMBED SITE KNOWLEDGE AND UNIFY INSTALLED SYSTEMS

REAL OUTCOMES WITH HONEYWELL FORGE

(Estimated average from over 100 Asset Sentinel Installations and over 50,000 assets monitored globally from 2015-2017)

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OUTCOME: UNIFIED ASSET MANAGEMENT

HUMAN CAPITAL IMPROVEMENTS

Embed Knowledge – site specific and SME defined

Continuous-Automatic – data stream/KPI calculations

Free Personnel – to manage more assets concurrently

OPERATIONAL IMPROVEMENTS

Identify – new levels of untapped productivity

Predict-Plan – potential downtime and maintenance needs

Unified workflow – across all plant teams

PROCESS DATA LIKE EXPERTS DO

Asset Digital Twins

Performance Models

Machine Learning

Plant Developed KPI's

Opportunities

Performance Metrics

Recommendations

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ACCENTUATE YOUR EXPERTS

Asset Performance Management (APM) for Industrials accentuates what your experts already do well, by automating initial analysis in a manner they already trust.

- Created by SMEs for SMEs, Honeywell Forge Asset Sentinel automates and accelerates issue detection and data analysis

APM for Industrials is an extension of SMEs, augmenting their efforts to highlight issues early from data they cannot readily consume

- SMEs have more time to focus on issues revealed from data, rather than collating and hunting through mass data to understand an issue

Asset Sentinel houses all plant implicit knowledge and embedded knowledge from decades of Honeywell experience

- SME's can embed the knowledge they have evolved over years
- Where you're short on SME's, draw from Honeywell embedded knowledge

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HONEYWELL FORGE

DEEP DIVE:
THE ENGINE INSIDE APM FOR INDUSTRIALS

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HOLISTIC ASSET MODELING

50 MW TURBINE COMPRESSOR

PERFORMANCE MODEL

QUANTIFIES the WORK done by the machine. Imperative to measure efficiency and associated cost of inefficiency.

MECHANICAL HEALTH

EARLIEST identifier of machine issues from vibration TIME WAVEFORMS and associated SPECTRAL DATA.
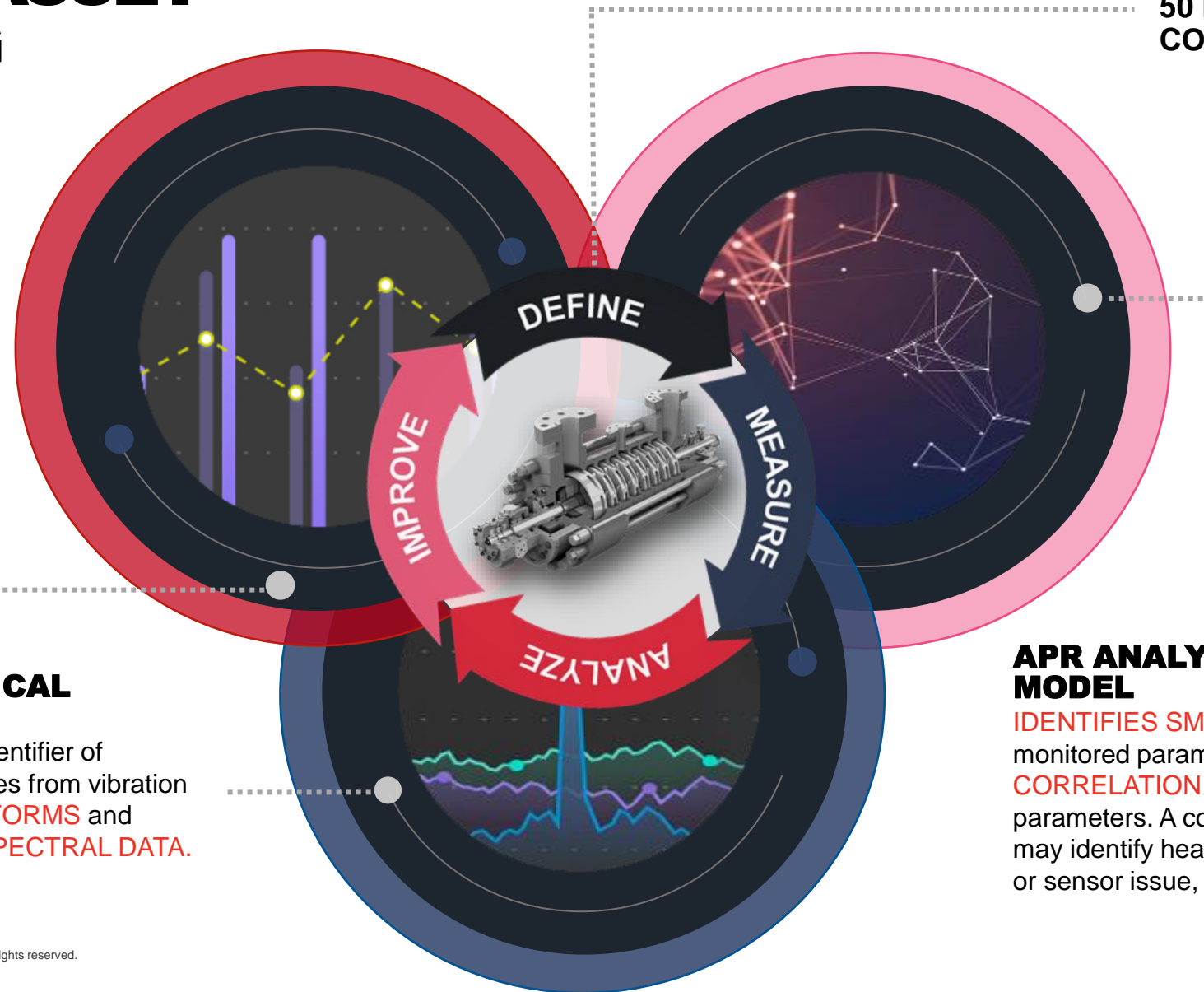
APR ANALYTIC MODEL

IDENTIFIES SMALL VARIATION in all monitored parameters. Calculates the CORRELATION between measured parameters. A correlation change may identify health deterioration or sensor issue, etc.

DEFINE

MEASURE

ANALYZE

IMPROVE

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PERFORMANCE MODEL

PLANT DATA

🌡️ **PROCESS TEMP'S**

⚙️ **PROCESS PRESSURES**

⏱️ **MACHINE SPEED**

💧 **GAS COMPOSITION**

⏲️ **PROCESS FLOW RATES**

📊 **VIBRATION LEVELS**

💧 **LUBE/SEAL OIL PRESS**

🌡️ **BEARING TEMP's**

🔻 **OIL FILTER PRESS DROP**

PERFORMANCE MODEL

$$Po = \frac{Ho \times vaporflow}{\eta o \times 3600} \times MW$$

$$Pe = \frac{He \times vaporflow}{\eta e \times 3600} \times MW$$

$$\eta_{Polyo} = \frac{H_{Polyo}}{H_M}$$

$$Head = H_{Polyo} - \frac{1545\, n_1 T_1 Z_1}{M_G} \left(\left(\frac{P_2}{P_1} \right)^{\frac{1}{n_1}} - 1 \right)$$

INVISIBLE TO PERFORMANCE MODEL

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HONEYWELL FORGE | Industrial Solutions

ConnectedPlant \ John Smith

Centrifugal Comp Dashboard | RECYCLE COMPRESSOR

CompOverview
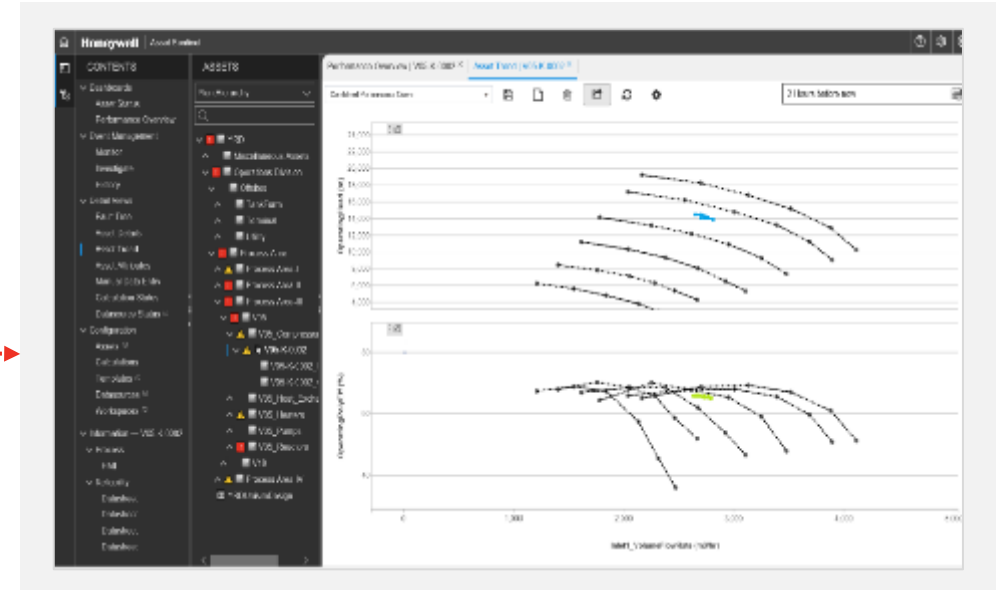
Centrifugal Compressor

-6	-18	24	29	468
Head Deviation	Efficiency Deviation	Power Deviation	Operational Loss	Degradation Loss

Operating Polytopic Efficiency %
56.28
Expected Polytopic Efficiency %
74.04

Operating Speed rpm
10111.00

Operating Polytopic Head m
8592.50
Expected Polytopic Head m
9109.20

Antisurge Flow m3/hr
43.00
Antisurge Valve Opening %
13.00

Discharge Temperature deg C
97.13
Discharge Pressure barg
63.36

Suction Temperature deg C
54.47
Suction Pressure barg
49.36
Suction Flow m3/hr
2936.58

Gas In

Gas Out

Operating Shaft Power KW
1950.47
Expected Shaft Power KW
1571.75

Running Status

Compressor

Stacked scale Custom

Item	Units
Centrifugal_Pump_P02/OperatingEff	%
Centrifugal_Pump_P02/DesignEff	%
Add item_	

09:47:57 AM   9:55 AM   10:00 AM   10:05 AM   10:10 AM   10:15 AM 09/10/2019 10:22:57 AM

Comp Performance Curve

Operating Head (m)

Inlet Volume Flow Rate (m3/hr)

Operating Poly Efficiency (%)
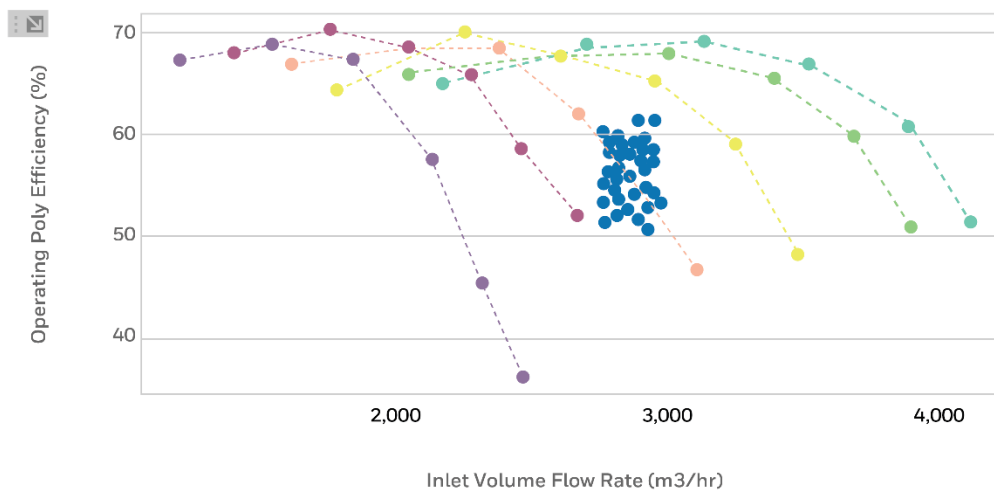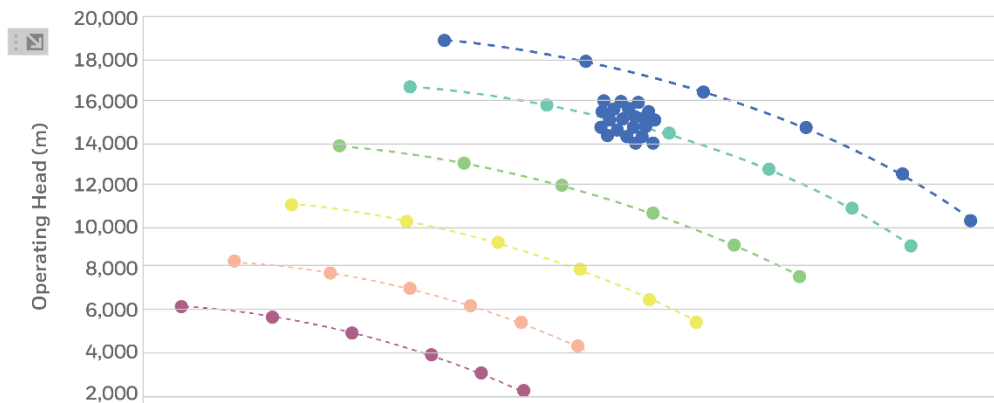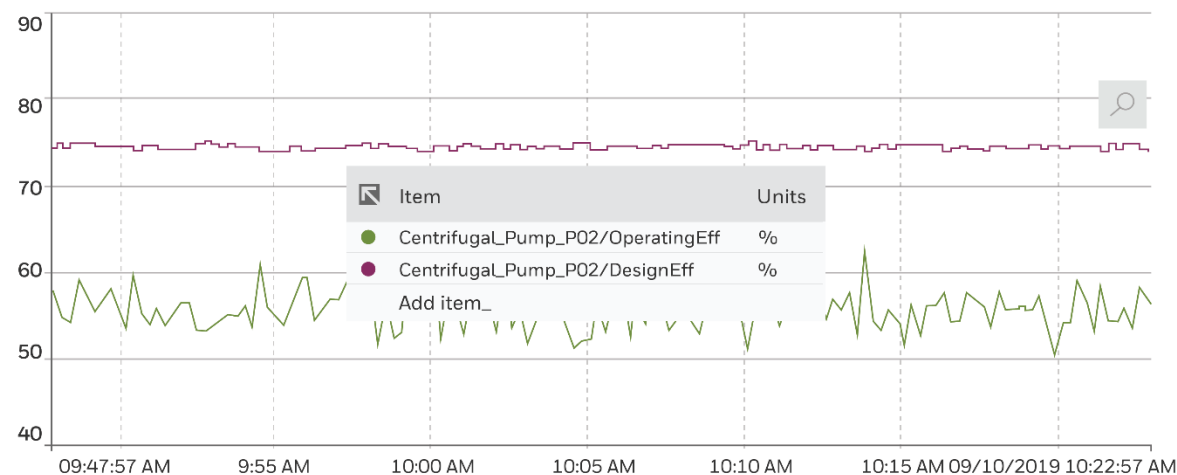
8:02:57 AM   8:37:57 AM   9:12:57 AM   9:47:57 AM   1:32:20 P

9/10/2019 9:47:57 AM to 9/10/2019 10:22:57 AM
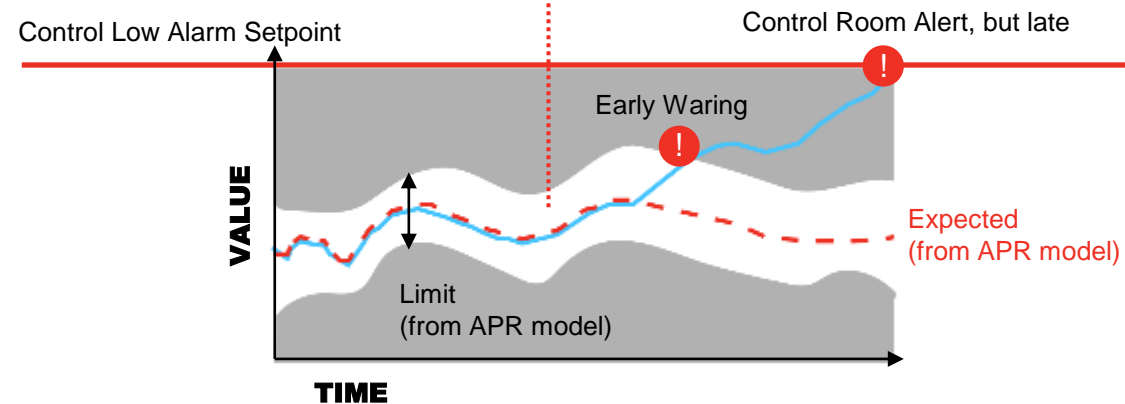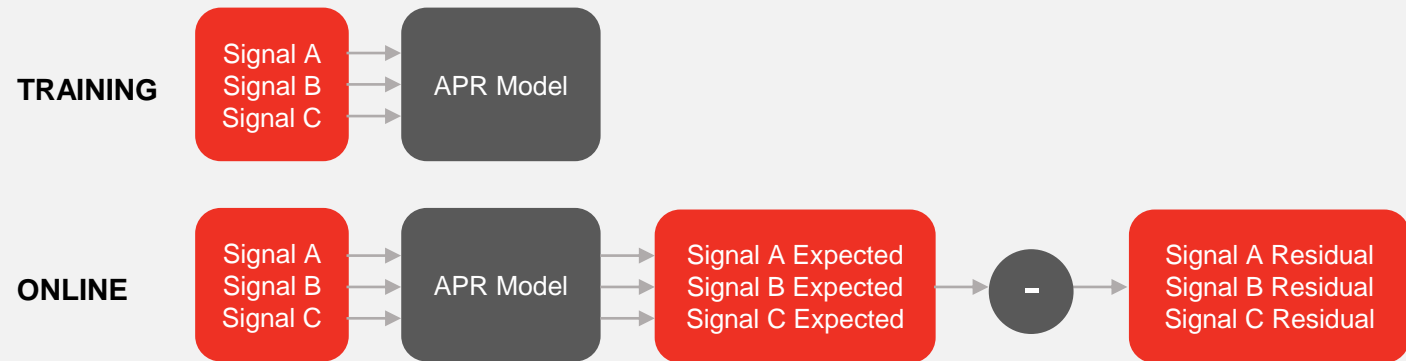
Last refreshed 10:22:57

5 sec

Playing

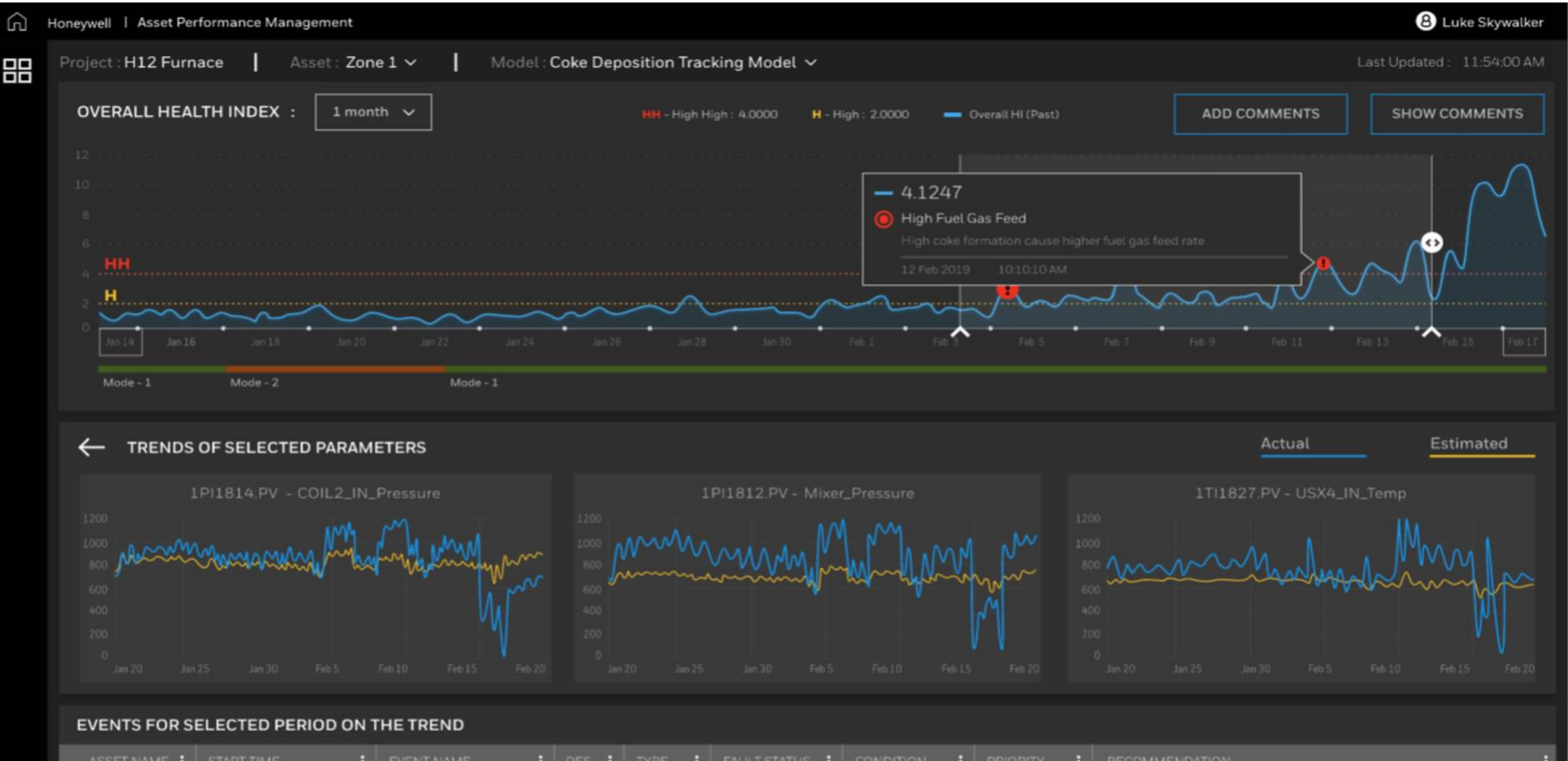# ADVANCED PATTERN RECOGNITION & ML MODEL

PLANT DATA

- PROCESS TEMP'S
- PROCESS PRESSURES
- MACHINE SPEED
- GAS COMPOSITION
- PROCESS FLOW RATES
- VIBRATION LEVELS
- LUBE/SEAL OIL PRESS
- BEARING TEMP's
- OIL FILTER PRESS DROP

ANALYTIC MODEL

TRAINING

Signal A / Signal B / Signal C → APR Model

ONLINE

Signal A / Signal B / Signal C → APR Model → Signal A Expected / Signal B Expected / Signal C Expected → − → Signal A Residual / Signal B Residual / Signal C Residual

Control Low Alarm Setpoint

Control Room Alert, but late

Early Waring

VALUE

Expected (from APR model)

Limit (from APR model)

TIME

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ANALYTIC MODEL – FURNACE

HEALTH MODEL

PLANT DATA

 PROCESS TEMP'S

 PROCESS PRESSURES

 MACHINE SPEED

 GAS COMPOSITION

 PROCESS FLOW RATES

 VIBRATION LEVELS

 LUBE/SEAL OIL PRESS

 BEARING TEMP's

 OIL FILTER PRESS DROP

HEALTH & FAULT MODEL

Asset Index = Availability * Performance / 100

Availability – percent of time available

Metrics Start Date – time stamp on all metrics

Performance – percent of "no faults" time

Status (Faulted) – in/out of fault; potential fault

Status (Maintenance) – in/out & planned/unplanned

Status (Running) – running/not running

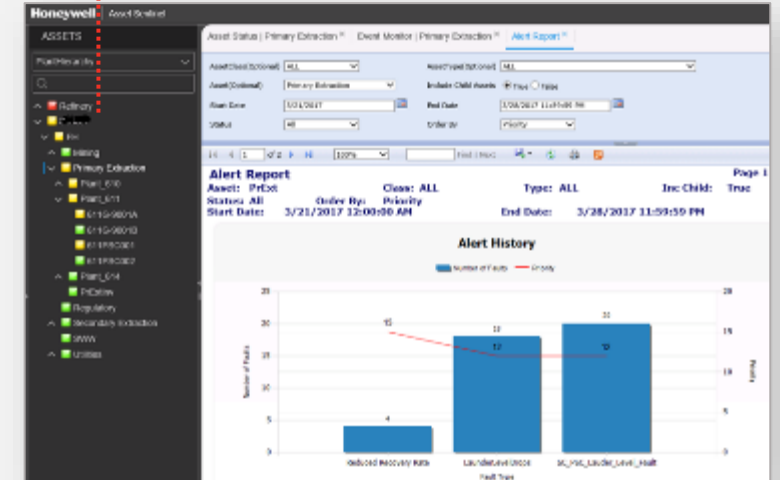**Status (Uptime)** – available/unavailable

Time (Downtime)

Time (Faulted)

Time (Maintenance)
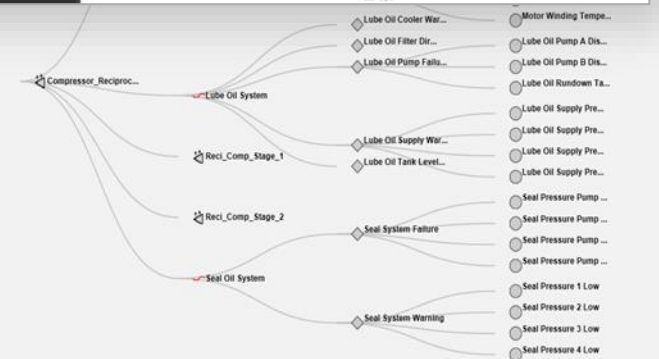
Time (Running Cumulative)

Time (Running)

Time (Uptime)

STANDARD KPI METRICS

FAULT TREE

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CASE STUDIES

APM IN A PERFORMANCE MATERIALS & TECHNOLOGIES PLANT

THE CHALLENGE

Honeywell PMT was struggling with several unplanned shutdowns, lack of performance analysis & reporting, and reactive maintenance practices.

THE RESULTS

2.2% **CAPACITY** ADDED

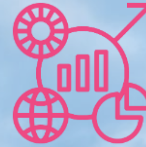**3%** **OI** INCREASE

2.2% **REVENUE** INCREASE

6 **MONTHS** TIME-TO-VALUE

CLOUD-BASED REAL-TIME APM

EMBEDDED SITE KNOWLEDGE

RELIABILITY DASHBOARDS

HCP DESCRIPTIVE ANALYTICS

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CONNECTING REFINING DISTRIBUTED ASSETS IN KAZAKHSTAN

![ҚазМұнайГаз NATIONAL COMPANY ҰЛТТЫҚ КОМПАНИЯСЫ]

THE CHALLENGE

- Diagnostic notifications went to control system "journal"; not visible to maintenance
- Rudimentary performance calculations lacked definitive issue identification

THE SOLUTION

- Connected stranded systems to the rest of the enterprise

THE RESULTS

$2-3M/yr COST REDUCTION

PAVLODAR REFINERY:

- 1350 assets
- 2 units – downtime reporting and OEE tracking
- 300 UI displays linked in Honeywell APM

ATYRAU REFINERY:

- 1340 assets
- 2 units – downtime reporting, OEE tracking
- 90 UI displays contextually linked to APM

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ADNOC DEPLOYS THE LARGEST PREDICTIVE ANALYTICS & DIAGNOSTICS PROJECT IN THE INDUSTRY

Upstream & Downstream Asset & Process Performance Management

Connected Worker Productivity & Assistance Mobility Solutions

$1.5M
Best Run Unit Savings After Implementing Digital Twins

$20-25M
Total Yearly Prospected Project Benefit

INDIA'S LARGEST REFINERY INTEGRATES ENTERPRISE DATA AND MAINTENANCE OPERATIONS

Centralized Asset Performance Data & Reporting

Standardized & Integrated Field Inspection Operations

$3M
Annual Productivity Increase Due To Data Centralization, Field Workflows Digitization & Automated Reporting

7 SITES COVERED

1,000+ ASSETS MONITORED

2,500 FIELD OPERATORS CONNECTED

2,000 PLANNER / SUPERVISORS ENABLED

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SUSTAINABILITY IN THE MIDDLE OF THE NORTH SEA

Lundin Petroleum

THE CHALLENGE

Lundin Norway partnered with Honeywell to obtain insights of energy usage and identify energy waste across platform operations.

THE RESULTS
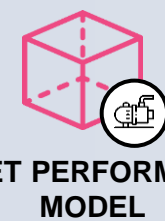
$1.2M Annual Energy Savings*

5.6KMT Annual CO2 emission reductions*

*Investment outcomes assume US$110,000 invested over 5 months, leveraging pre-existing installed Honeywell APM software solutions

PROCESS MODEL + **ASSET PERFORMANCE MODEL**

- CALCULATION OF PERFORMED WORK
- ITEMIZATION OF ENERGY LOSS SOURCES

- GAS TURBINES
- DIESEL GENERATORS
- PUMPS
- COMPRESSORS
- POWER TRANSFORMERS
- HEAT EXCHANGERS
- FILTERS
- CHOKE VALVES

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MONITORING WELLS AND PROCESSES IN THE GULF OF MEXICO

THE CHALLENGE

- Need for greater visibility of well condition and productivity measures

- Numerous unmanned wells in addition to major platforms

THE SOLUTION

- Single health & performance platform integrating process & assets

300+
WELLS

12
PLATFORMS

THE RESULTS
$8-10M/yr
COST REDUCTION

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CENTRALIZED ASSET MANAGEMENT AND REPORTING

Kairos Mining

THE CHALLENGE

- 5 mines without systematic reporting
- Slow and labor-intensive data gathering impeded timely action
- Needed improved data collection
- Delayed reporting often too late for timely action

THE SOLUTION

- Automated, near real-time monitoring and reporting of 7 sites
- Enterprise scalable cloud solution for future expansion
- Roll-up of machine performance calculations to unified KPI dashboard
- Automatic, continuous data collection
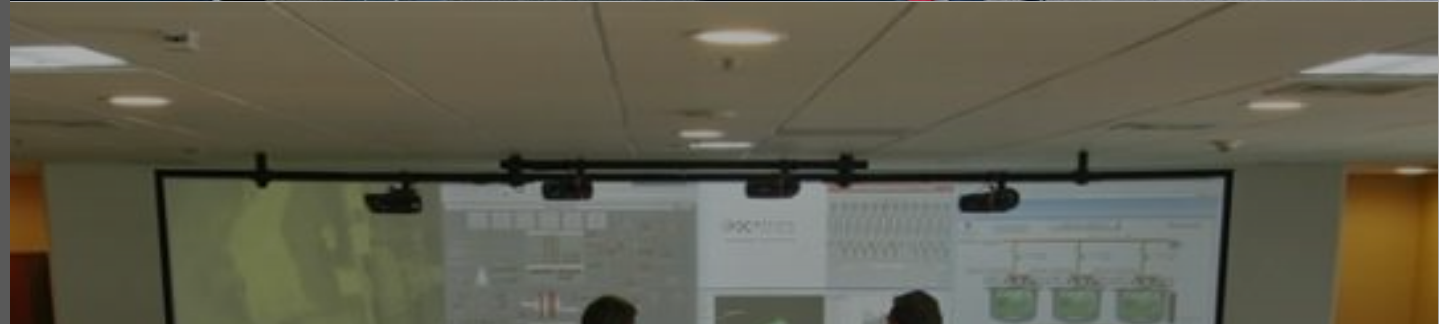
THE RESULTS

$45M/yr

REVENUE IMPROVEMENT

* Combined incremental revenue derived from Honeywell automation technologies, APM, APC, and other optimization thru Honeywell Connected Plant.

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START TODAY. GET RESULTS FAST.

Honeywell APM solutions increase asset reliability and operational efficiency - reducing unnecessary maintenance and unscheduled downtime

Honeywell Forge Asset Performance Management for Industrials connects disparate data sources, uses advanced analytics, and drives stakeholder collaboration from actionable insight

Make every day your best day of production

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INTEGRATE
ASSETS & PROCESS

- Interconnect systems to a unified data-stream
- Integrate workflow across operational, engineering & maintenance personnel

ANALYZE

- Real-time data driven models drive issue identification
- Embed your site implicit knowledge and experience
- Digital twins built from Honeywell SME's

IMPROVE

- Uncover and discover root causes of unit inefficiencies
- Create an objective-based decision making culture
- Act decisively in all situations

LET'S TAKE THE NEXT STEP IN YOUR APM JOURNEY TODAY!

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