

A night-time photograph of an industrial facility, likely a refinery or chemical plant, with numerous tall distillation columns and structures illuminated by warm lights. Overlaid on the scene is a complex network of white lines and glowing nodes, representing a digital or data network. The background is a deep blue sky with some clouds.

# INNOVATION DAY

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## ASSET PERFORMANCE MANAGEMENT

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**Abdelrahman Ghozlan**

MAY, 2024

**Honeywell**

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Introduction to Asset Reliability

Asset Health and Performance Models

Tackling Sensorization Gaps

Reliability Copilot

Improved Operational Safety : CCC

# HONEYWELL ASSET RELIABILITY SOLUTION

## INTEGRATED DIGITAL WORK PROCESSES

**EVENT MANAGEMENT**

**CMMS WORK ORDER  
INTEGRATION\***

**CASE MANAGEMENT\***

### HEALTH

PREDICTIVE HEALTH DIAGNOSTICS

QUICK CONNECT: VIBRATION ANALYTICS AND WIRELESS SENSORS

DOWNTIME REPORTING\*

INSTRUMENT ASSET MANAGEMENT

CORROSION ADVISOR

MOBILE EQUIPMENT MONITORING FOR MINES

### PERFORMANCE

PERFORMANCE MONITORING

CCC TURBOMACHINERY ADVISOR

HONEYWELL UOP POLYBED™ PSA VALVE ANALYTICS  
OFFERED THROUGH PROCESS TECHNOLOGY ANALYTICS

## PLATFORM ENGINEERING TOOLS

**CONFIGURATION STUDIO**

**AI/ML WORKBENCH**

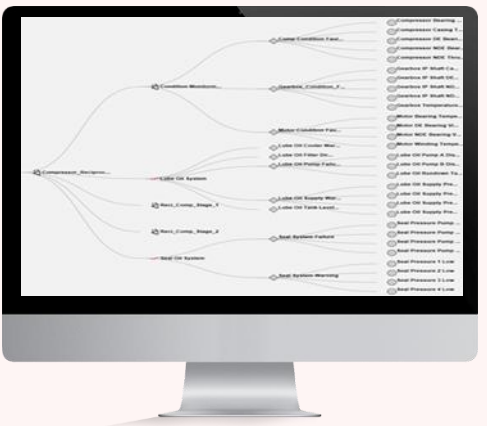
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# ASSET HEALTH & INTEGRITY SUBMODULES

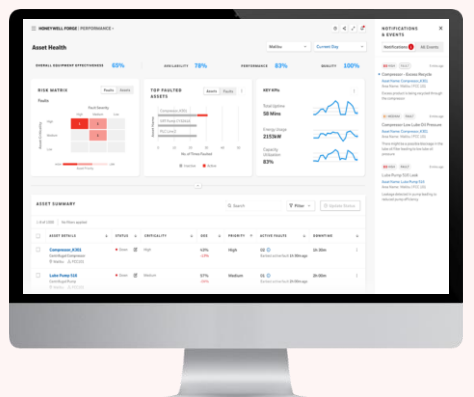
## ASSET HEALTH

FMEA FOR ELECTRICAL, STATIC, ROTATING, AND MOBILE ASSETS HEALTH MONITORING



FMEA + AI/ML (APR or MMPCA)

## CUSTOM HEALTH MODELS

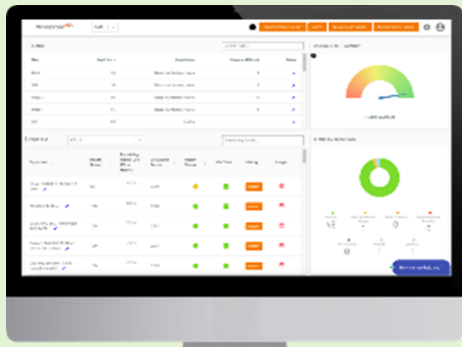


**Honeywell** BRING YOUR OWN MACHINE LEARNING (BYOML)

## VIBRATION ANALYTICS

VIBRATION/ FFT FOR BALANCE OF PLANT ROTATING ASSETS

### VIBRATION MONITORING

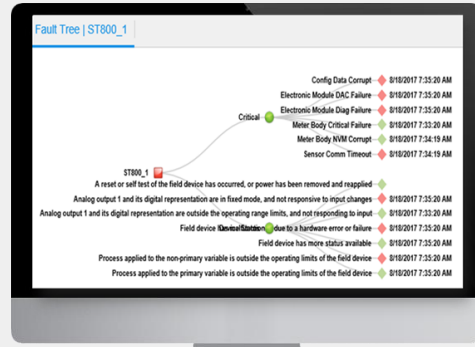


QUICK CONNECT VIBRATION ANALYTICS

## INSTRUMENT HEALTH

SMART & NON-SMART INSTRUMENT HEALTH

### HEALTH MONITORING

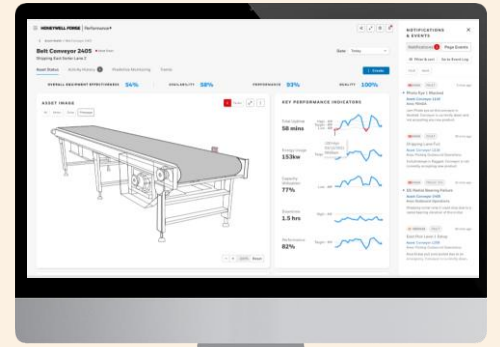


INTEGRATED INSTRUMENT ASSET MANAGER

## MINING ASSET HEALTH

MOBILE & FIXED ASSET MONITORING FOR MINES

### HEALTH MONITORING

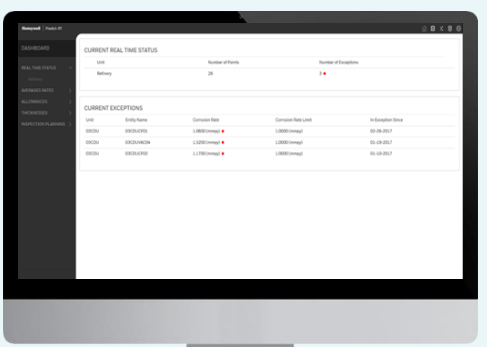


MOBILE & FIXED ASSET MONITORING

## INTEGRITY

FOR REFINING AND UPSTREAM O&G PROCESSES

CORROSION MONITORING



CORROSION ADVISOR

## REPORTING\*

UNIT, PLANT, ENTERPRISE LEVEL KPI MONITORING

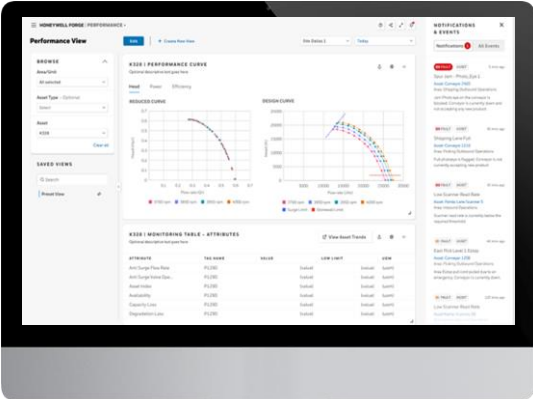
RELIABILITY REPORTING



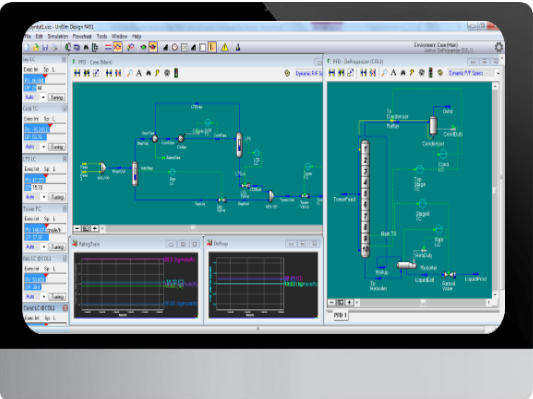
DOWNTIME REPORTER\*

# PERFORMANCE MODELS

## ASSET PERFORMANCE MONITORING



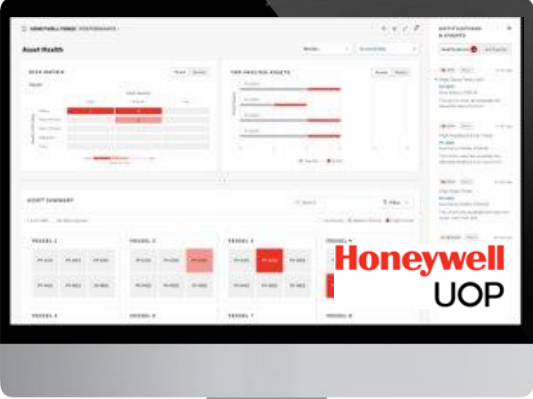
FIRST PRINCIPLES THERMODYNAMIC MODELS



HONEYWELL UNISIM® DESIGN SIMULATION MODELS



TURBOMACHINERY ADVISOR WITH COMPRESSOR CONTROLS CORP.



HONEYWELL UOP POLYBED™ PSA PROCESS TECHNOLOGY ANALYTICS

*\*ENERGY MONITORING & OPTIMIZATION SUBMODULE – FUTURE ROADMAP*



# **ASSET PERFORMANCE MANAGEMENT: LOOKING AHEAD**

## **IIOT for improvement of sensorization maturity**

Quick Connect Vibration Analytics & Corrosion soft-sensor

## **GenAI powered Intelligent Instrumentation**

Reliability Copilot

## **Improved operational Safety**

CCC



# **ADVANCED VIBRATION ANALYTICS CORROSION SOFT SENSOR TACKLING SENSORIZATION GAPS**

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**VIBRATION SENSORS AND ADVANCED ANALYTICS  
FOR BALANCE-OF-PLANT ROTATING EQUIPEMNT**

**REAL-TIME CORROSION MONITORING IN  
REFINERIES**

# MONITORING CRITICAL ROTATING ASSETS ONLY IS NO LONGER SUFFICIENT ...

... BUT MONITORING BALANCE OF PLANT HAS CHALLENGES



## Limited Instrumentation for Monitoring

Non-critical assets often do not have enough instruments to sufficiently monitor asset health



## Aged Assets with Poor Instrument Performance

Many plants have aged assets with poor instrument performance and low readings



## Cost for implementing monitoring

Expensive to implement new instruments for monitoring and take a process shutdown



## Limited subject matter expertise

Resource constraints limit the asset coverage and analysis that can be comprehensively done



## Limited Predictive Maintenance

Many plants only have predictive maintenance for mission critical assets which often represent only 20% coverage



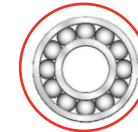
## Process Data is not sufficient

Process data is commonly monitored but does not provide insight to machinery health



# WHAT PROBLEMS CAN WE SOLVE?

- Un-instrumented Assets
- Assets with Significant Life and Low Confidence Sensor Readings
- Assets with Old Instruments/Sensors
- Out of Calibration Sensors Providing Faulty Readings

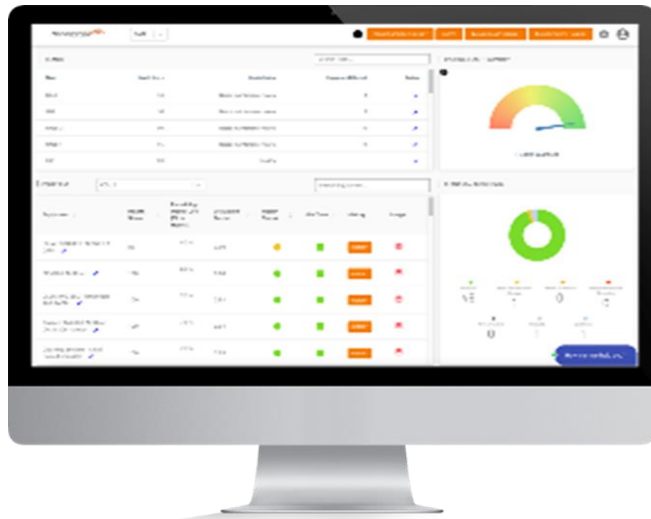


# HONEYWELL ASSET PERFORMANCE

## Quick Connect vibration analytics & sensors

Advanced analytics embedded into Honeywell Asset Performance solutions that uses full-resolution time series data to monitor and predict the health for balance of plant assets or un-instrumented rotating assets in near-real time

### PRODUCT



**Nanoprecise**  
Prediction with Precision

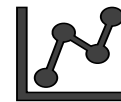
Predictive health analytics  
integrated into Honeywell Asset  
Performance Solutions

### CAPABILITIES



#### Near-Real Time Condition Based Monitoring

Detect faults by monitoring vibration and acoustic  
signatures for a variety of rotating assets



#### Predictive Health Analytics

Advanced fault classification with prescriptive  
recommendations powered by ML-based time-to-failure  
prediction analytics



#### Configurable Alerts

Edge calculations and analytics differentiate between  
process upsets, variation, and actual fault providing you with  
alerts and reports to send to any device

### ANTICIPATED BENEFITS

#### 1 Increase Reliability & Reduce Unplanned Downtime

Detect issues earlier in near-  
real time with fewer false  
positives

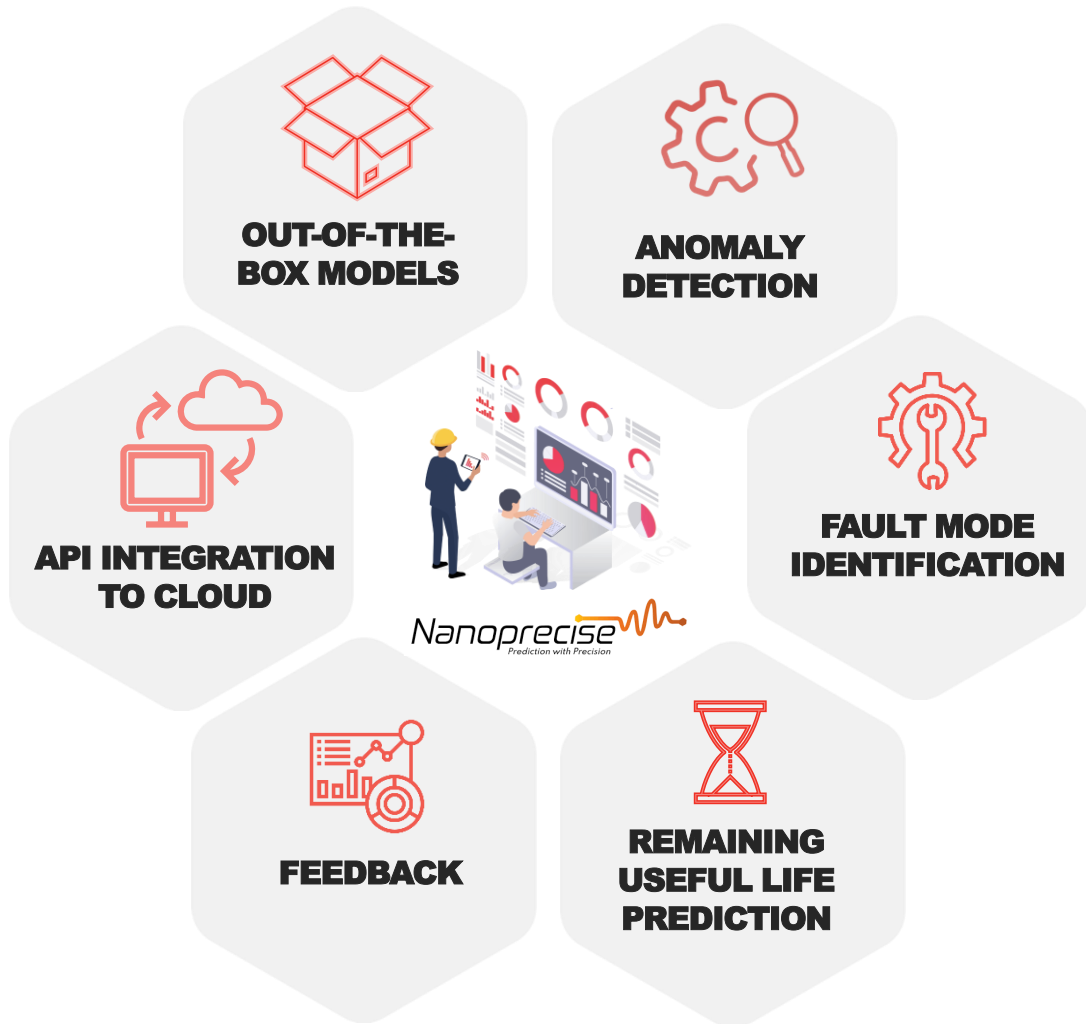
#### 2 Optimize Asset Life

Leverage predictive analytics to  
determine useful life and  
recommendations to optimize  
uptime and use

#### 3 Reduce Maintenance Costs

Shift to a predictive  
maintenance strategy

# VIBRATION ANALYTICS



## OUT-OF-THE-BOX MODELS

- Physics based + AI models

## ANOMALY DETECTION

- Automated Anomaly Detection
- Optional User Thresholds

## FAULT MODE IDENTIFICATION

- Machine Dependent Fault Modes
- Algorithms to evaluate condition

## REMAINING USEFUL LIFE (RUL)

## FEEDBACK

- Machine Data Details
- Maintenance action input: Manual or CMMS integration

## API INTEGRATION

- API for easy integration: CMMS for equipment health and Data historian (data)
- Manual export possible

1

**ADVANCED FAULT CLASSIFICATION**

2

**TARGETED RECOMMENDATIONS**

3

**ML-BASED PREDICTIVE ALGORITHMS FOR RUL**

4

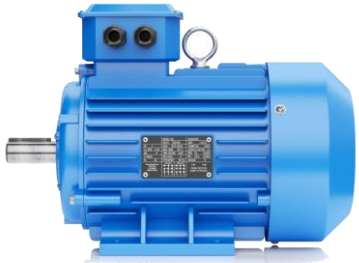
**ADPATIVE FAULT THRESHOLDS LEARNED ON THE FLY**

5

**FEWER FALSE POSITIVES**

# MOST COMMON ASSETS MONITORED

## MOTOR



- Unbalance
- Misalignment
- Bearing Problem
- Rotor Bar Problem
- Winding Problem
- Phase Related Problem

## FAN



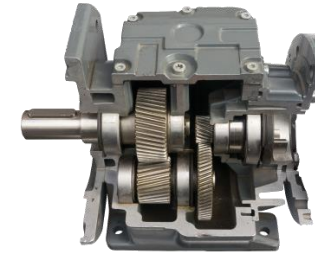
- Unbalance
- Misalignment
- Bearing Problem
- Impeller Related Problem
- Looseness Problem

## PUMP



- Unbalance
- Misalignment
- Cavitation
- Blade/ vane Failure
- Flow Related Problem

## GEARBOX



- Unbalance
- Misalignment
- Bearing Problem
- Gear Problem

## COMPRESSOR



- Unbalance
- Misalignment
- Bearing Problem
- Screw Mesh Problem
- Lobe Mesh Problem
- Looseness Problem

**MORE ASSET TYPES CAN BE MONITORED**

# Traditional corrosion monitoring methods are cost prohibitive and ineffective



## No Time-Based Insights on Corrosion Rates

No insights for when the corrosion takes place



## Limited Operational Flexibility

No insights on what will happen if the process conditions or feedstock changes



## Cost of corrosion monitoring

Deploying sensors to monitor corrosion is expensive



## Quality of Manual Inspections

Qualitative inspections do not provide accurate or predictive corrosion insights



## Suboptimal Integrity Strategy

Maintenance work and corrosion inhibitor expense based on a fixed schedule or reactive

**SOFTWARE-BASED CORROSION MONITORING SOLUTIONS OVERCOME THESE CHALLENGES**

# HONEYWELL CORROSION ADVISOR

An asset integrity suite of offline and online software providing Upstream O&G and Downstream O&G operators predictive corrosion insights for asset management and selection by utilizing empirical models developed from 20+ years of research from joint-industry programs valued at \$30M

## PRODUCT



Suite of Corrosion Modeling & Monitoring Software developed from Honeywell Joint Industry Programs equating to:

**20+ YEARS** of research  
**\$30M** of unique IP

## CAPABILITIES

### CORE SUITE CAPABILITIES

For both offline and online software modules



#### Empirical-Based Calculations

Conduct sensitivity and multi-point analysis



#### Soft Sensors and Analysis Tools

Leverage quantitative information to proactively manage asset integrity



#### Expert Support

Leverage 25+ years of expertise from Honeywell Center of Excellence

### APM POWERED CAPABILITIES

Formerly Predict-RT now online software modules available in APM



#### Near-Real Time Monitoring

Online models for predicting corrosion rates in near-real time



#### Integrity Operating Window (IOW) Monitoring

Leverage soft sensors and analysis tools to establish accurate IOWs

## ANTICIPATED BENEFITS

- 1 IMPROVE RELIABILITY**  
*Reduce integrity risk and unplanned downtime by prioritizing inspections and establishing more accurate IOWs*
- 2 IMPROVE OPERATIONAL FLEXIBILITY**  
*Process a wider variety of cost advantage feedstocks without exceeding operating limits or increasing corrosion risk (\$7M/ year customer example)*
- 3 REDUCED OPEX SPEND**  
*Reduce chemical inhibitor expense, increase turnaround intervals, reduce maintenance spend based on actual corrosion rates (\$60M customer unit failure avoided)*
- 4 REDUCE CAPEX SPEND**  
*Eliminate the need for corrosion monitoring hardware and optimized metallurgy selection*
- 5 IMPROVE SAFETY**  
*Reduce failure risk and personnel time in the field with prioritized inspections*

# CORROSION ADVISOR REFINING USE CASES

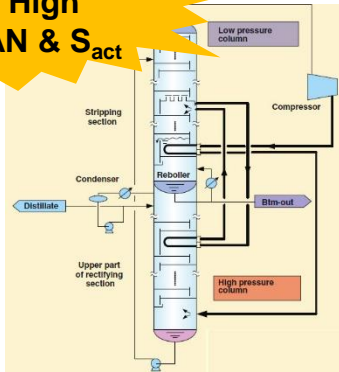


**Crude Corrosivity** (formerly Predict Crude)  
Sulfidation, NAP acid corrosion



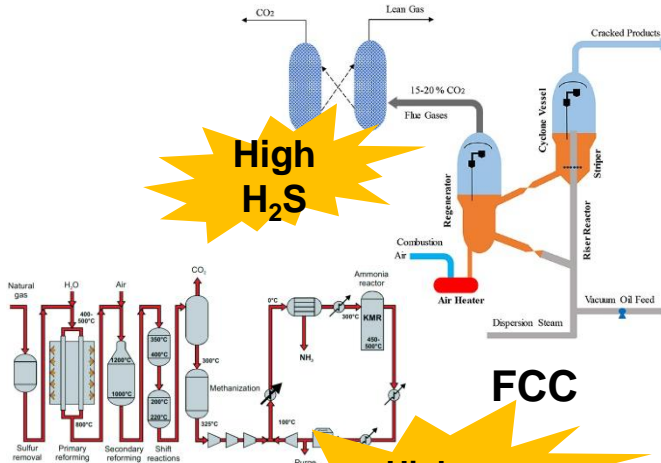
**Predict®-Amine**

High TAN & S<sub>act</sub>



CDU/VDU

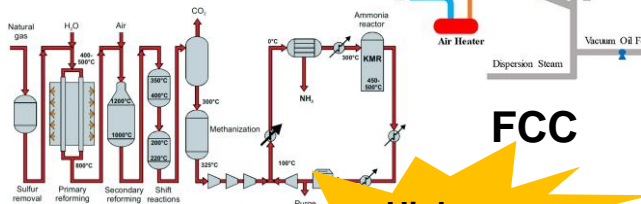
High H<sub>2</sub>S



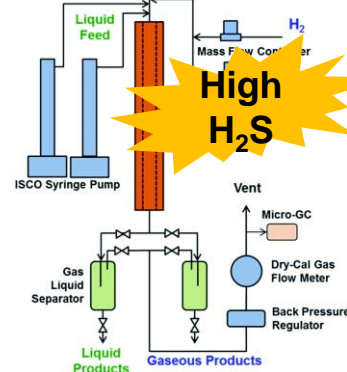
FCC

Reforming

High TAN & S<sub>act</sub>

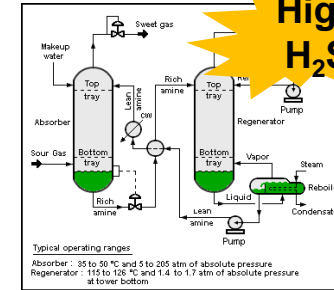


High H<sub>2</sub>S

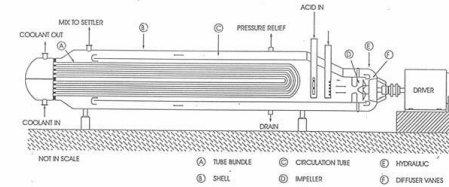


HT/HC/SWS

High H<sub>2</sub>S



Amine Unit  
Lean/Rich amine  
MEA/DEA/MDEA/DGA



H<sub>2</sub>SO<sub>4</sub> Alkyl



**Predict®-CDU OH**  
NH<sub>4</sub>Cl and HCl<sub>aq</sub> corrosion

**Honeywell**



**Predict®-Sour Water**  
Ammonium bisulfide corrosion



**Predict H<sub>2</sub>SO<sub>4</sub> Alkyl**

The background of the slide is a night-time photograph of an industrial refinery or chemical plant. The scene is filled with tall distillation columns, storage tanks, and various piping structures, all illuminated by warm yellow and orange lights. Overlaid on this scene is a complex network of white lines and glowing nodes, resembling a data network or a digital overlay, which adds a technological and digital feel to the industrial setting.

# RELIABILITY COPILOT

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**GUIDED ASSET MONITORING**

**Honeywell**

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# RELIABILITY COPILOT

## WHY DO WE NEED IT?

### What are limitations of today?

Seemingly unrelated problems in an asset could be linked to the same underlying cause. The “Bigger picture” may not be obvious.

Quickly getting to the core of the problem from an APM alert requires experience and understanding of asset behaviour

Overdependency on humans for decision making, by analyzing high volumes of data, made worse by loss of skilled workforce



AI mines through historical asset data and gets to the root cause of a fault. GenAI then connects the dots across multiple faults.

GenAI will be used to guide the user through the sequence of visualizations most beneficial to quick decision making and prevention of further asset damage.

Guided user navigation learns from APM usage patterns of skilled users, augments that with AI's own insights into the problem and points the novice user in the right direction.

# DEMO

HONEYWELL FORGE | PERFORMANCE +

Asset Health / Asset Details

Malibu | Current Day

## Compressor\_K301

DOWN

Subtitle - More information about this Asset

OVERALL EQUIPMENT EFFECTIVENESS **65%** | AVAILABILITY **78%** | PERFORMANCE **83%** | QUALITY **100%**

### ASSET IMAGE

AI Assistant

Health **2, 4**

- a. High Rotor Vibration
- b. High Bearing Temperature

Performance **1**

Polytropic Efficiency Low

CCC Controls **3**

Excessive Recycling

100% | 3D | 2D

### KEY KPIs

Reliability **72%**

Energy Usage **153kW**

Capacity Utilization **77%**

Performance **65%**

RELIABILITY COPILOT

Good Morning  
How may i help you today?

Type your prompt here

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The background of the slide is a night-time photograph of an industrial refinery or chemical plant. The scene is filled with tall distillation columns, towers, and piping, all illuminated by warm yellow lights. Overlaid on this image is a complex network of white lines and glowing nodes, resembling a data network or a digital infrastructure map. The overall color palette is dominated by deep blues and teals, with the warm lights of the facility providing a strong contrast.

# IMPROVED OPERATIONAL SAFETY

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TURBOMACHINERY ADVISOR WITH COMPRESSOR CONTROLS CORPORATION (CCC)

# AGENDA

- 01** Turbomachinery Challenges
- 02** Turbomachinery Advisor
- 03** Critical Event Analysis
- 04** Excess Recycle Monitoring
- 05** Performance Controller Monitoring

# Turbomachinery Challenges

Maintaining compressor reliability and performance is challenging



## Undetected conditions can lead to downtime or damage

Lack of sensors and/or intermittent monitoring can lead to undetected faults or faults not detected early enough



## Routine maintenance can be suboptimal

Maintaining assets based on a schedule can lead to excess cost, spare parts inventory, and emergency work



## Compressor controls are complex

Limited expertise due to advanced controls, disparate control and monitoring systems, and aging workforce dynamics



## Excessive energy use and emissions

Excess recycle or imbalanced load sharing between parallel compressors cause inefficiencies



## Process instability can lead to critical events

Fluctuations in gas composition, flow, and pressure can lead to surges, choking the machine, trips, and damage



## Lack of data for critical event analysis

Difficult to access and analyze high-resolution time-series data needed to investigate event causes

**COMPREHENSIVE MONITORING OF HEALTH, ASSET PERFORMANCE, AND CONTROL PERFORMANCE IS KEY TO OPTIMIZATION AND RELIABILITY**

# Turbomachinery Challenges

A digitally- Enabled asset management strategy overcomes these challenges



## INSIGHTS TO IMPROVE RELIABILITY & PERFORMANCE

Near real- time health, performance, and control performance monitoring to detect conditions and take action in enough time



## REDUCED EVENTS, DOWNTIME, & MACHINERY DAMAGE

Analytics for health, performance, controller performance, and events to better understand machinery limits and mitigate risks



## SHIFT TO PROACTIVE MAINTENANCE & REDUCE COSTS

Predictive diagnostics based on performance degradation and historical trends to optimize maintenance plan and reduce spend



## REDUCE ENERGY COSTS AND EMISSIONS

Reduce energy use by safely operating closer to the surge limit line, balancing load sharing, and meeting primary control objectives



## GUIDED ROOT CAUSE EVENT ANALYSIS & SUPPORT

High-resolution event data and event management tools enabling better collaboration, analysis, and faster event resolutions

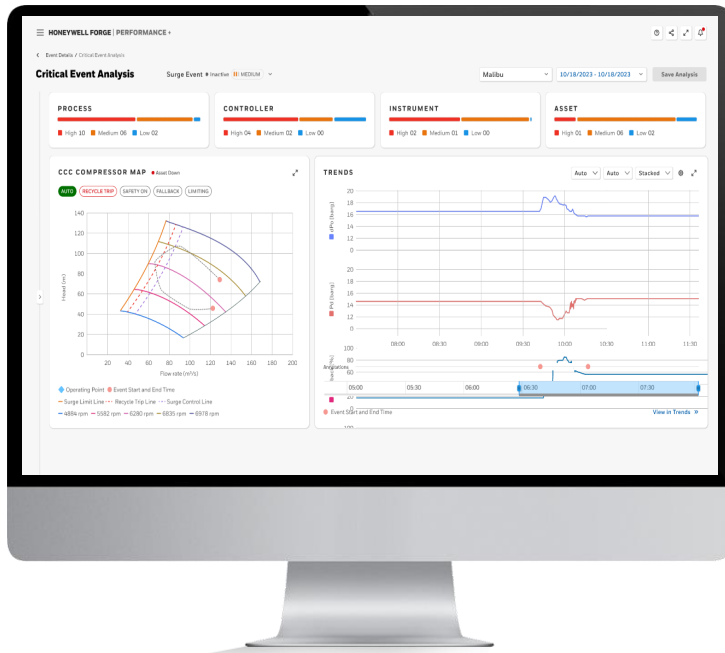
**DIGITAL APM PLATFORMS EMBED TURBOMACHINERY EXPERTISE TO ENHANCE ANALYTICS AND DIGNAOSTIC TOOLS IN A SINGLE PLATFORM FOR MULTIPLE USER TYPES**

# Turbomachinery Advisor | Powered By Honeywell

Asset performance solutions

Turbomachinery Advisor is a built-for-purpose solution on Honeywell's Asset Performance Management platform that embeds 40+ years of CCC know-how providing insights for critical event management, energy monitoring, and control performance monitoring to improve compressor reliability.

## APM ADVANCED ASSET MODULE



Turbomachinery Advisor



by Honeywell



## ADVANCED CAPABILITIES



### CRITICAL EVENT ANALYSIS

Achieve quicker and more thorough event investigations



### PERFORMANCE CONTROLLER MONITORING

Ensure primary control objectives are being met



### EXCESS RECYCLE MONITORING

Minimize and detect energy waste and excess emissions

## OUTCOMES

1

### Increase Reliability & Reduce Unplanned Downtime

- Detect issues early and in enough time to respond before issues occur
- Incorporate controls monitoring to understand impacts the performance controller has on asset health and performance
- Improve root-cause analysis of events to mitigate future event reoccurrence

2

### Reduce Energy Waste and Emissions

- Reduce excess recycling
- Meet primary control objectives
- Safely operate closer to the surge limit line

3

### Reduce Critical Events

- Achieve faster and more in-depth event investigations
- Leverage high-resolution data to pinpoint true causes of events
- Automate preliminary analysis

\*Current capabilities only for compressors and CCC install base

Note: Health and performance modeling from pre-built turbomachinery asset model library in Honeywell can also be add-ons. Additional vibration analytics available as well.

# Critical Event Analysis

## PROBLEM / NEED

- Events like trips, surges, and choking the machine can cause unplanned downtime and machinery damage
- Traditional system integration architecture keeps high-resolution data (milliseconds) at the edge – away from experts and at a high bandwidth cost
- Limited expertise on-site, data availability, and data accessibility can delay and reduce the quality of post-event analysis

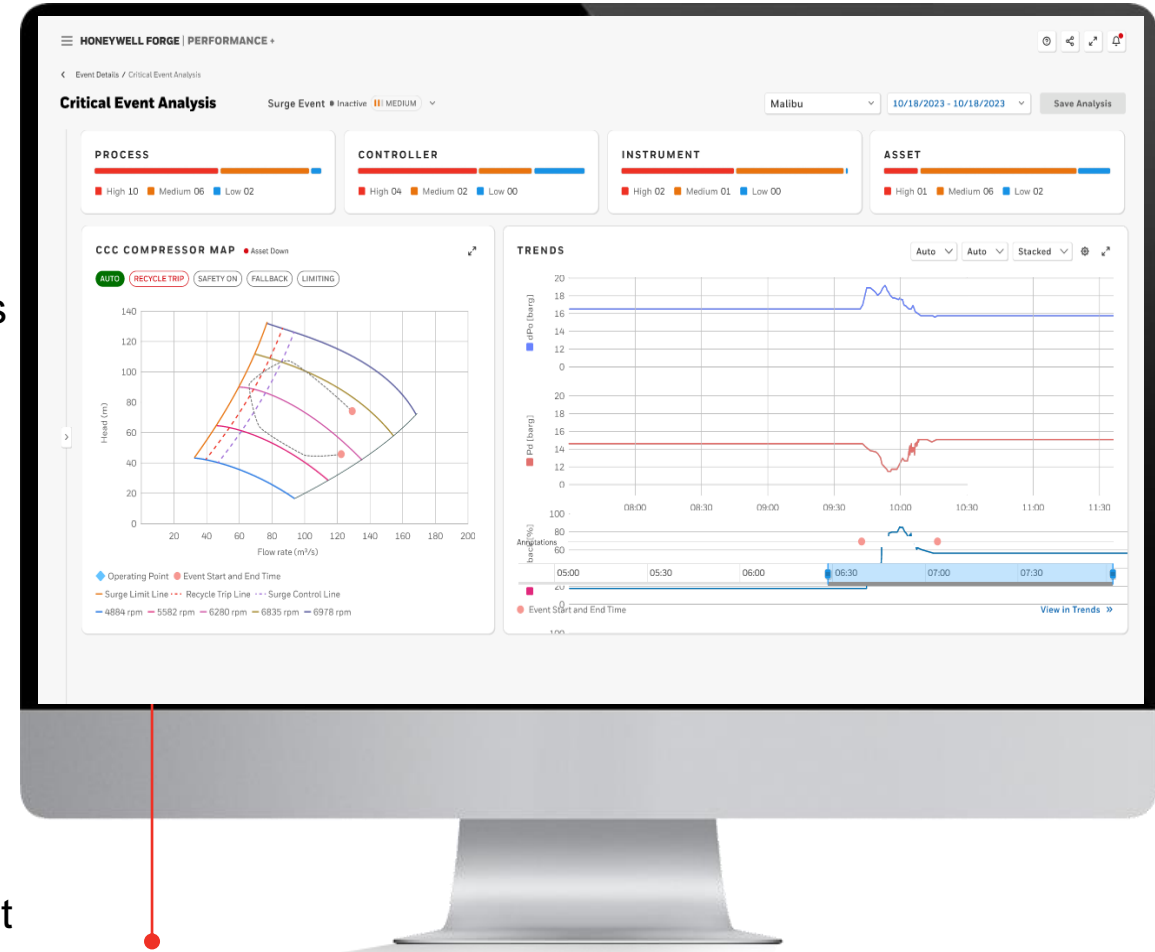
## SOLUTION

- Perform quicker event investigations with high resolution (100+ millisecond data) combined with low resolution data
- Pre-configured trend charts, compressor maps, and expert analysis flagging key moments
- Web-based tool enables playback features, multi-user comment and annotation logging, ease of report sharing

## RESULTS / LESSONS

- Streamline post event analysis for faster and safer process restart and event resolution
- Reduce reoccurrence of critical events

**Honeywell**



## EVENT VIZUALIZATION & ANALYSIS

- High-resolution data for pinpointing event causes
- Automatic expert embedded flagging/annotation of key moments
- Expert preliminary insights embedded
- Playback, comment logging, and annotation features
- Pre-configured trend charts and compressor maps



# Excess Recycle Monitoring

## PROBLEM / NEED

- More precise surge control is the most efficient way to decrease energy use
- Potential energy waste can occur when operating the anti-surge valve in manual mode or the valve is open more than it should – which can potentially choke the machine and limit advanced control functionality and performance

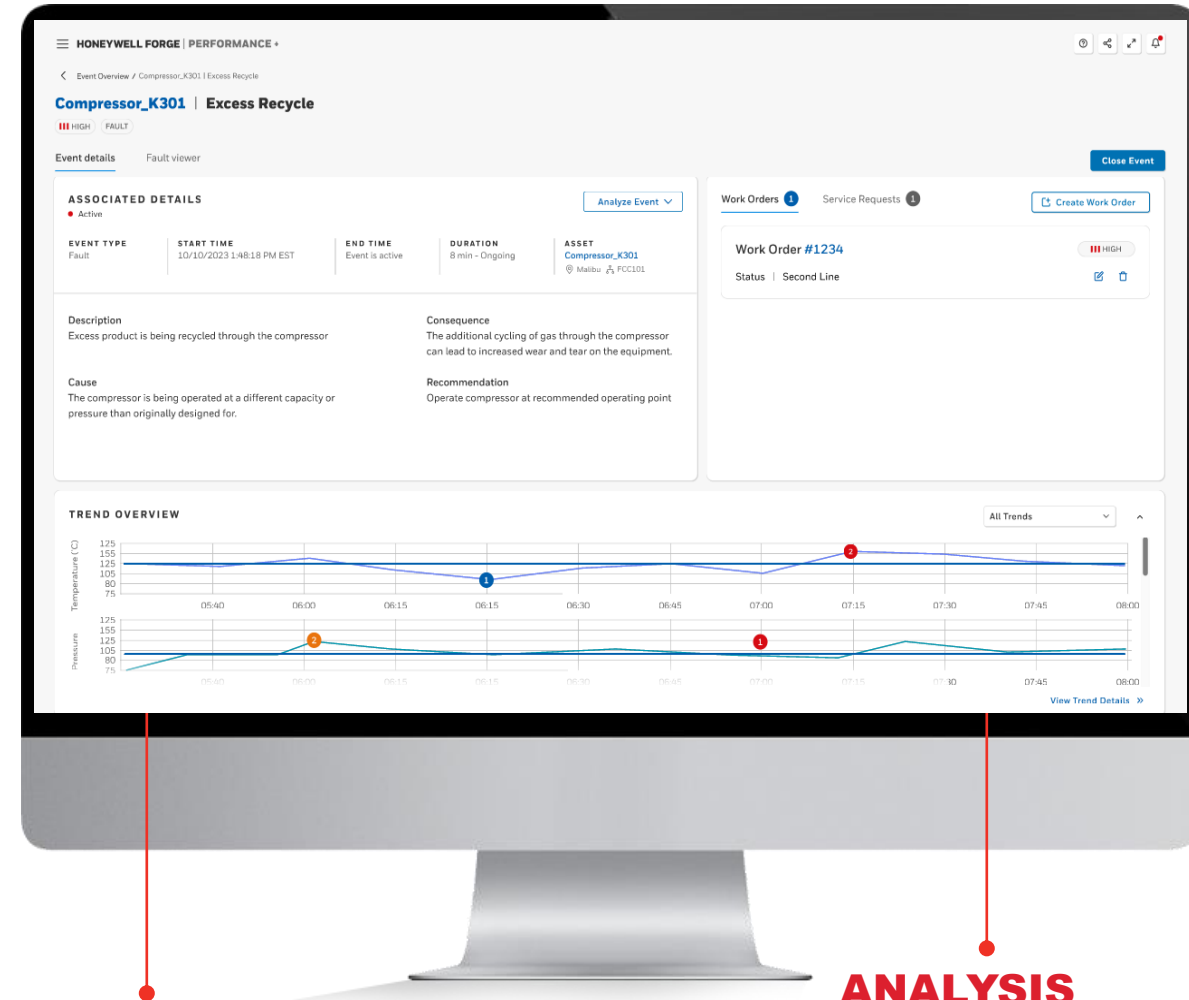
## SOLUTION

- Automatically monitor compressor valve open/closed status, process characteristics, and surge limits to identify machines where recycling rates can be reduced
- Leverage automated calculations for energy savings and emissions equivalents to identify improvement areas
- Identify optimum balance between anti surge recycle flow and energy consumption/emissions

## RESULTS / LESSONS

- Operate closer to surge line while maintain a safe operating zone
- Reduce energy consumption and emissions

**Honeywell**



## VIZUALIZATION

- Monitor all recycle rate and anti-surge valve open/close status, process characteristics, and trends
- Flags compressors operating in excess recycle and provides causes, consequences and corrective actions

## ANALYSIS

- Equivalent emissions calculations
- Energy savings calculations
- Advisory notifications

# PERFORMANCE CONTROLLER MONITORING

## PROBLEM / NEED

- As environmental, process, and equipment conditions change over time, they can impact the quality of performance controls and key process metrics (uptime, throughput, yield).
- Primary loops are often the only loops tested during commissioning so limit loops maybe poorly tuned.

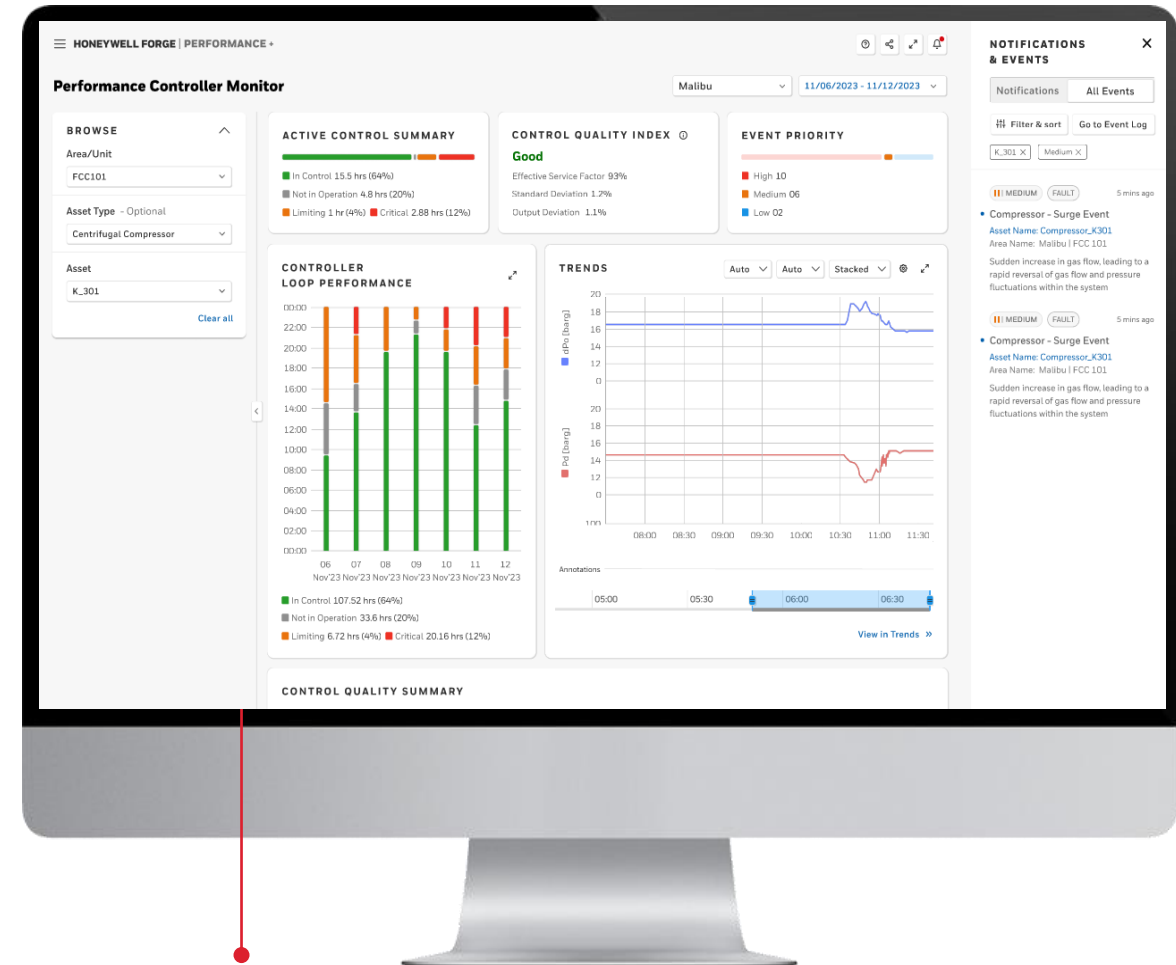
## SOLUTION

- Control quality index to measure overall performance controller
- Identify limiting loops and potential causes and corrective actions
- Visualization to identify, analyze, and correlate patterns based on select time periods

## RESULTS / LESSONS

- Operate optimally by meeting primary control objectives
- Avoid process losses and downtime

**Honeywell**



## Visualization & Trend Analysis

- All key process parameters, KPIs, control objectives, and events in a single dashboard
- Trending of primary and secondary variables
- Automatic alerts and insights for potential causes to investigate

# SUMMARY

- 01** Incorporation of Vibration Analytics, Real-time Corrosion Monitoring and Turbomachinery Advisor into APM significantly widens the scope of things one can do with APM
- 02** The Reliability Copilot leverages the true potential of generative AI into asset monitoring
- 03** The benefit for the end user is the sustenance of peak performance of assets



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