



The future of gas turbine
technology
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A digitalized approach for combining diagnostic capabilities and maintenance risk-based insights to improve machine operation

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Summary

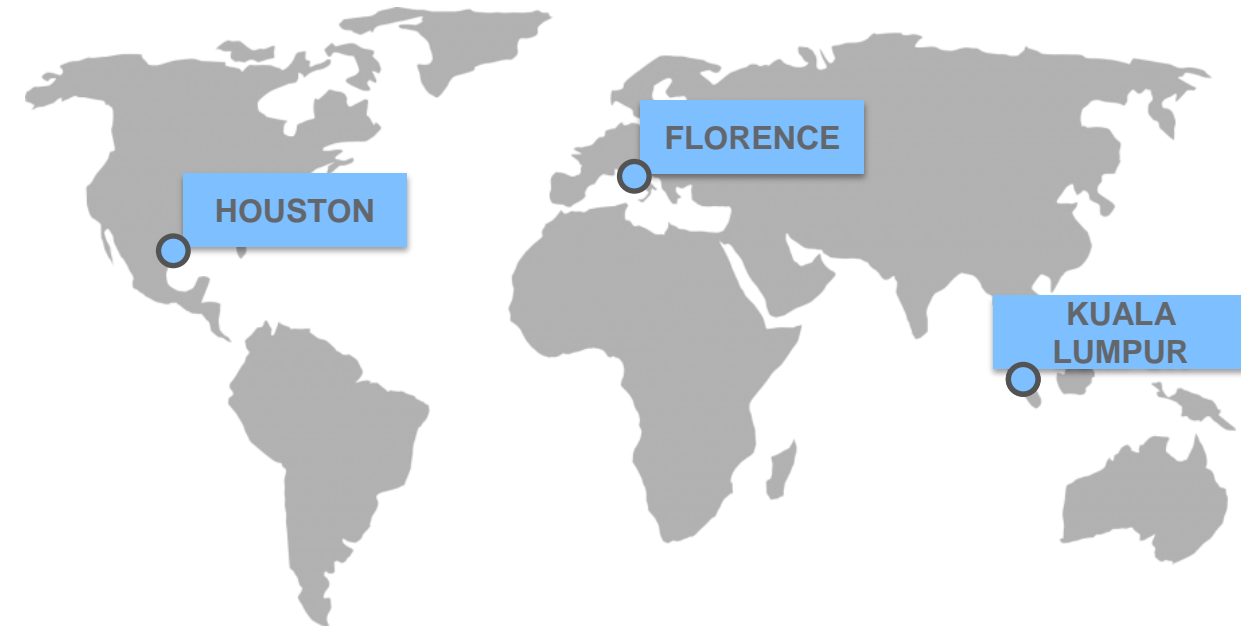
- Operational framework
- Problem statement and proposed solution
- The Case Study
- Outcomes



Operational framework: BHGE Monitoring & Diagnostic Centers

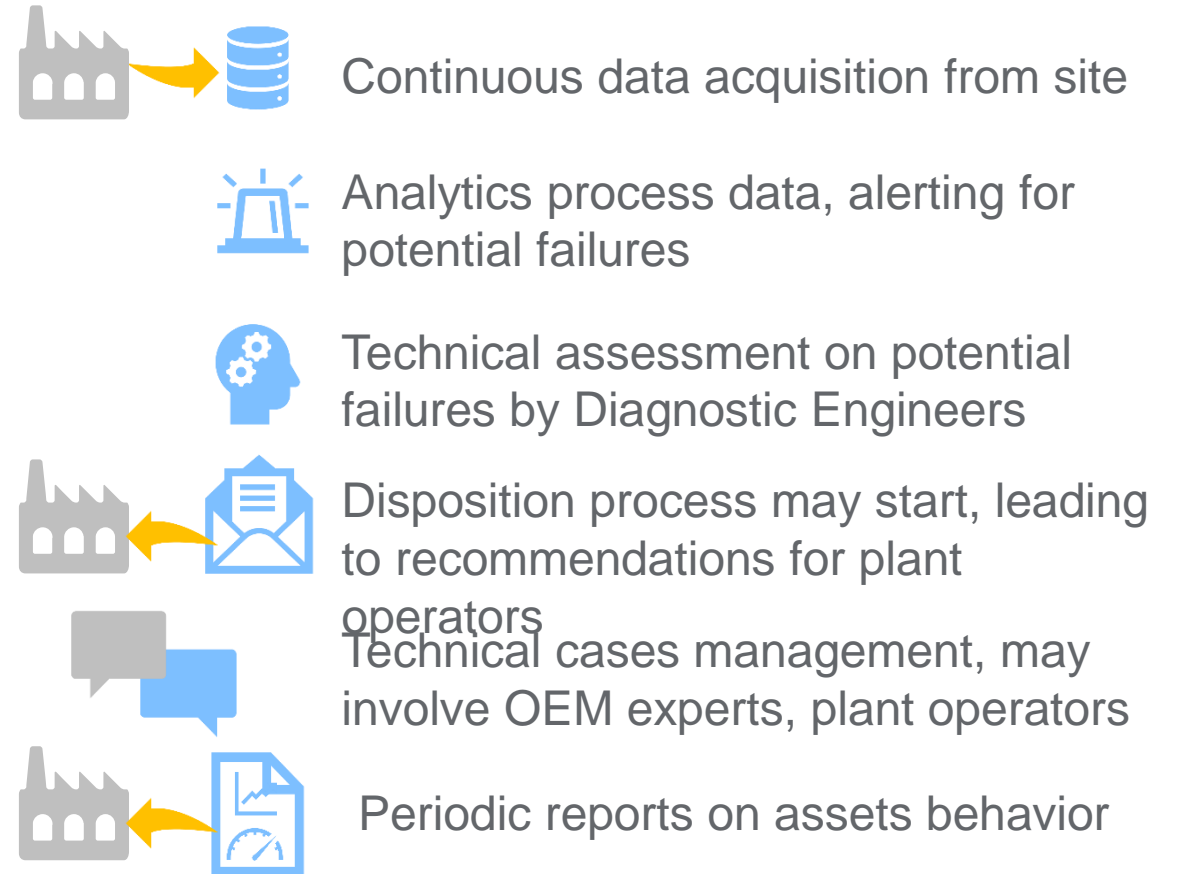
From increasing assets availability and reliability to maintenance optimization.

numbers ...



- ✓ **3 Hubs** - Florence, Houston, Kuala Lumpur
- ✓ **24/7** Engineering support from OEM experts, **365 days**
- ✓ **~1250 assets** under monitoring

process ...



Problem Statement

A man in a blue shirt is sitting at a desk with multiple computer monitors, talking on a phone. The scene is dimly lit with a blue tint. The man is looking at the monitors and has his hand to his chin, appearing thoughtful. The desk is cluttered with keyboards, a mouse, and a calculator. The background shows a typical office environment with a window and some papers on the wall.

Problem statement

From a site operator standpoint, M&D services not fully integrated with other processes taking place in site, maintenance planning and execution in first place.

High level purposes

- *integrate* diagnostic with Operations & Maintenance site activities
- *extend* service, supporting plant operators in maintenance planning and execution

Case study goals

1. maintenance plan revision (risk analysis)
2. design and deliver an integrated M&D service
3. maintenance analytics

An integrated process for asset management

Risk analysis

Base for maintenance strategy. Integrates M&D recommended actions and helps prioritization.

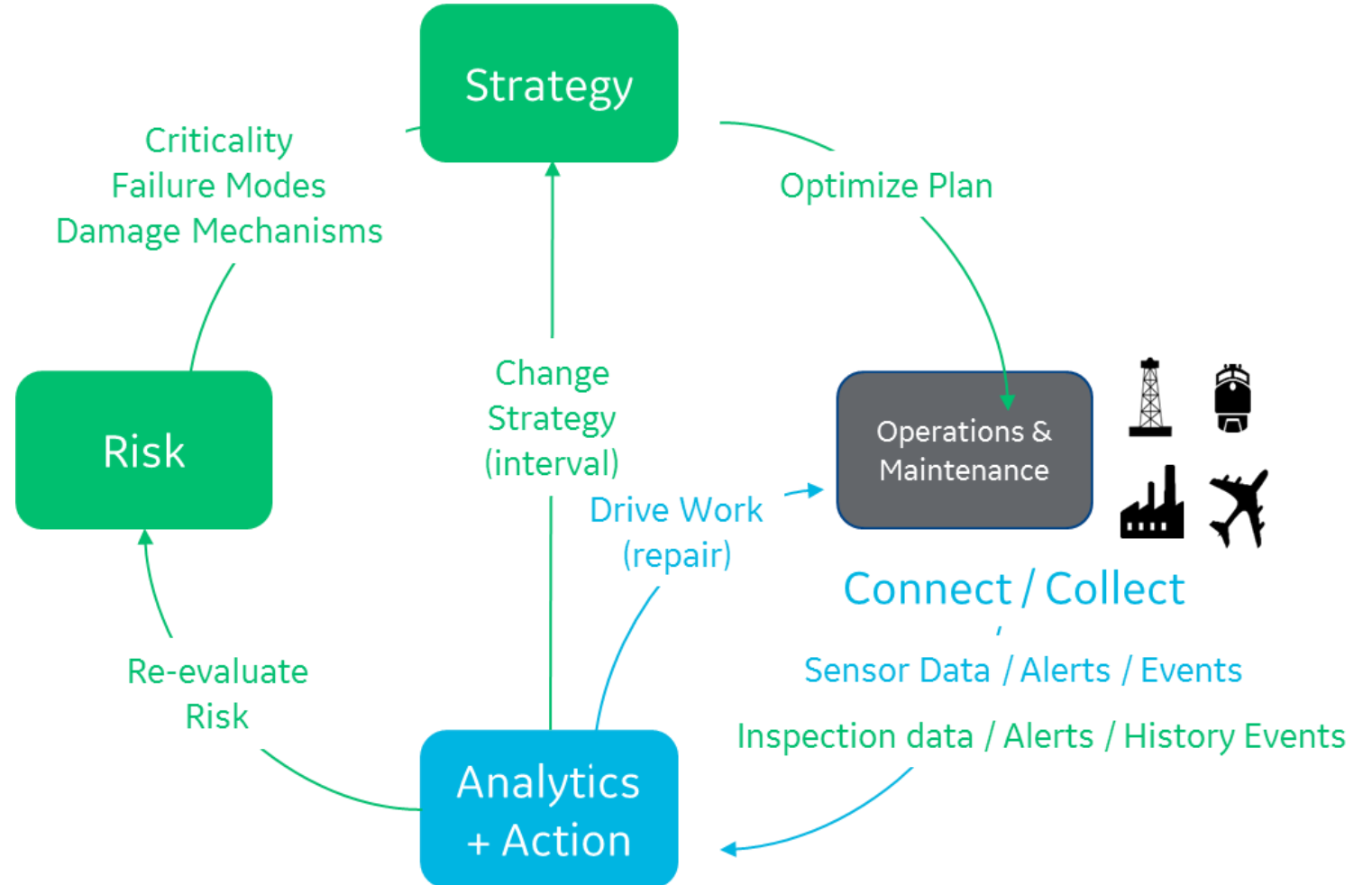
Maintenance strategy

Determined by risk and data analytics. Chance for optimization in a risk-cost frame.

Maintenance analytics

If CMMS* is used as a normal practice, insightful data from site (activities, findings, spares parts, costs).

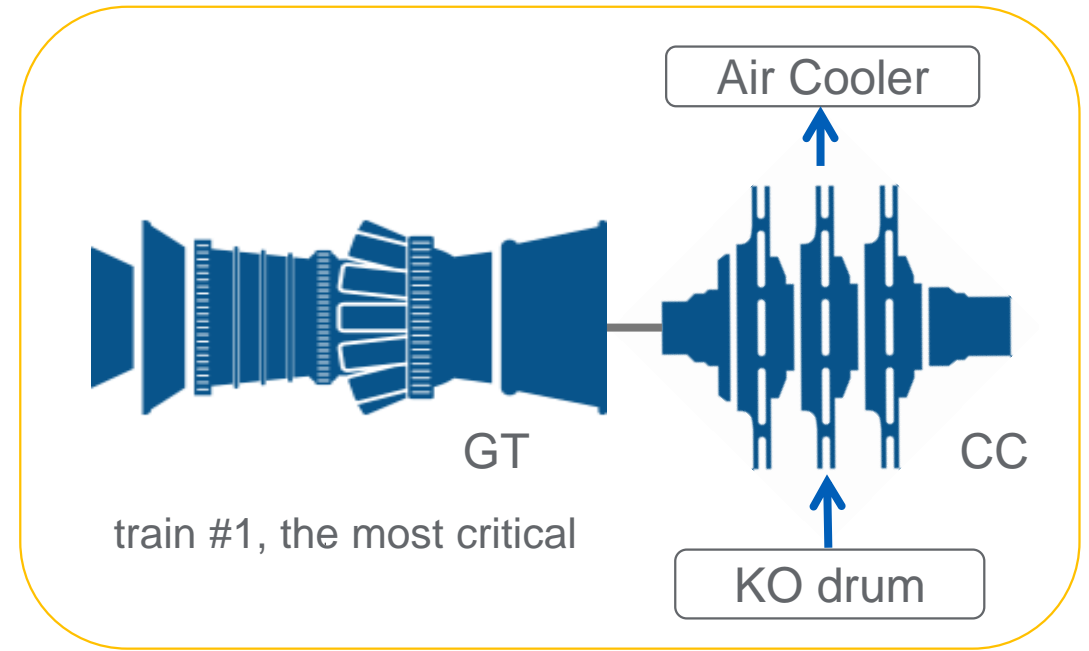
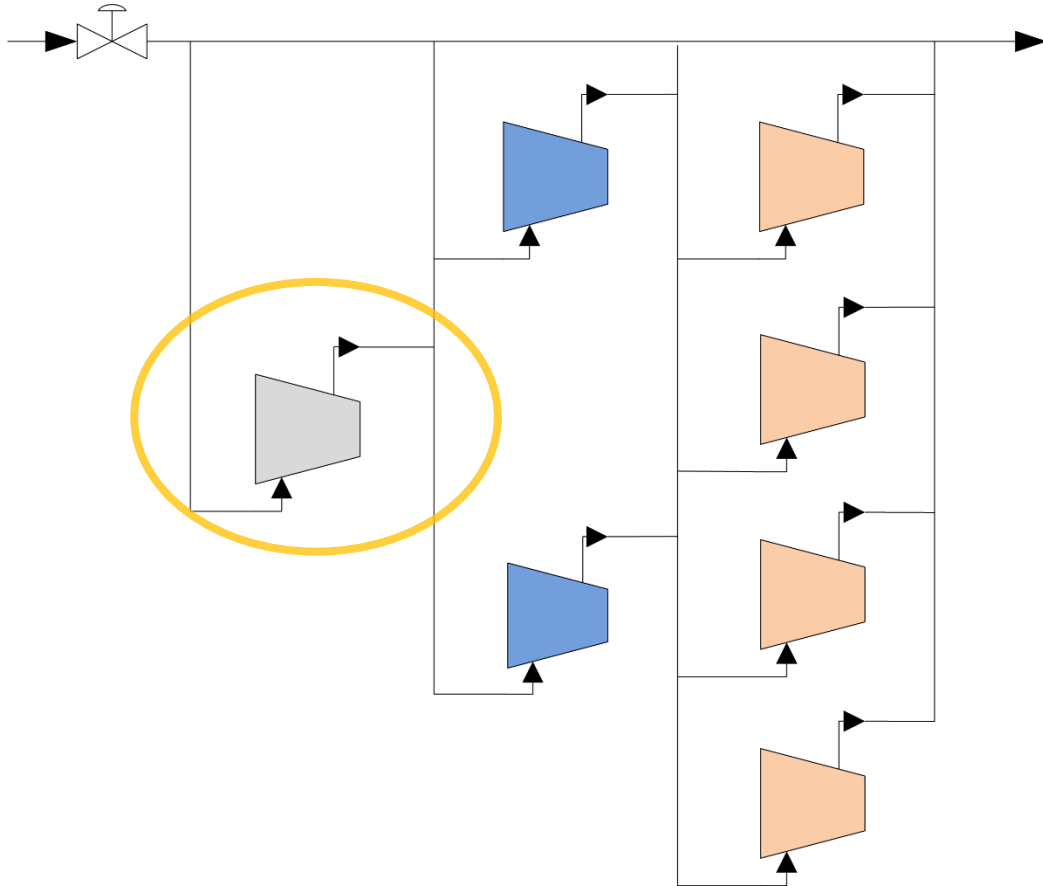
*Computerized Maintenance Management System



The Case Study

Case study asset

Gas gathering application, 3 compression stages.
Asset not previously covered by any diagnostic service.



Acquired data

- On-board sensors data
- Alerts and events from control SW
- Vibration monitoring, coming from high scan rate acquisitions processed on premises
- Maintenance data from CMMS recurrent extractions

Risk analysis – ACA and FMEA

Method (SAE JA1012)

- multi-disciplinary approach: plant operators and Subject Matter Experts are key roles
- effective site maintenance capabilities impact the analysis (e.g. spares, tools, resources, costs, delivery)
- 4 risk categories, i.e. Safety, Environment, Operation, Financial
- by category, *risk = consequence · occurrence*, levels defined in risk matrix
- detailed cost model

Work process

Asset Criticality Analysis

On each maintainable item (total 450) to assign a total risk level.



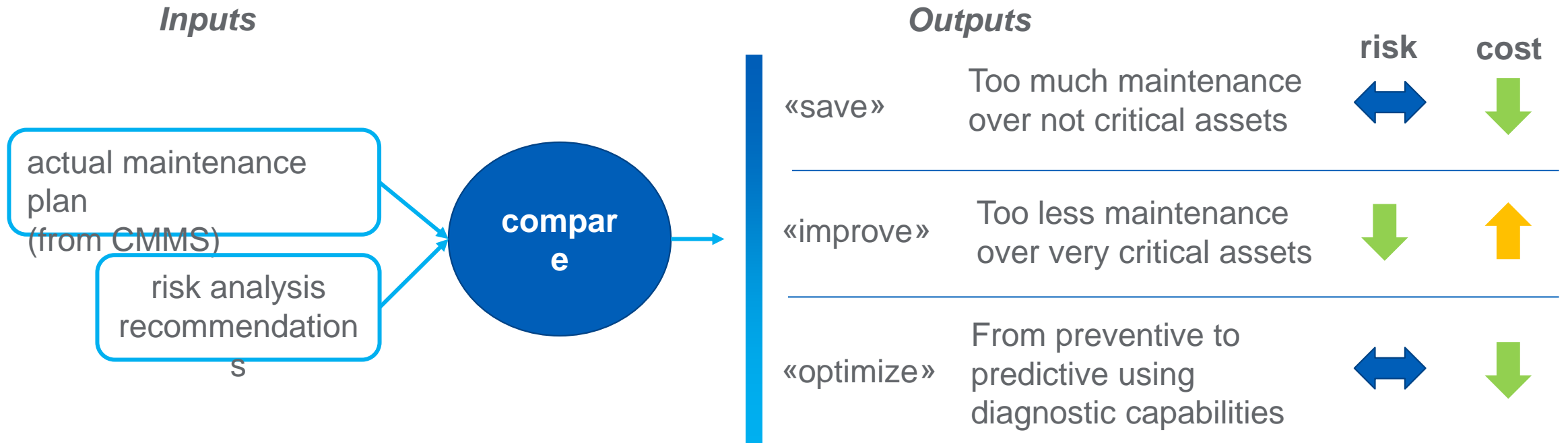
Failure Modes & Effects Analysis

For higher-risk items, are identified:

Failure Modes, Failure Effects and the Recommendations to decrease risk below the acceptable level.

Maintenance plan revision

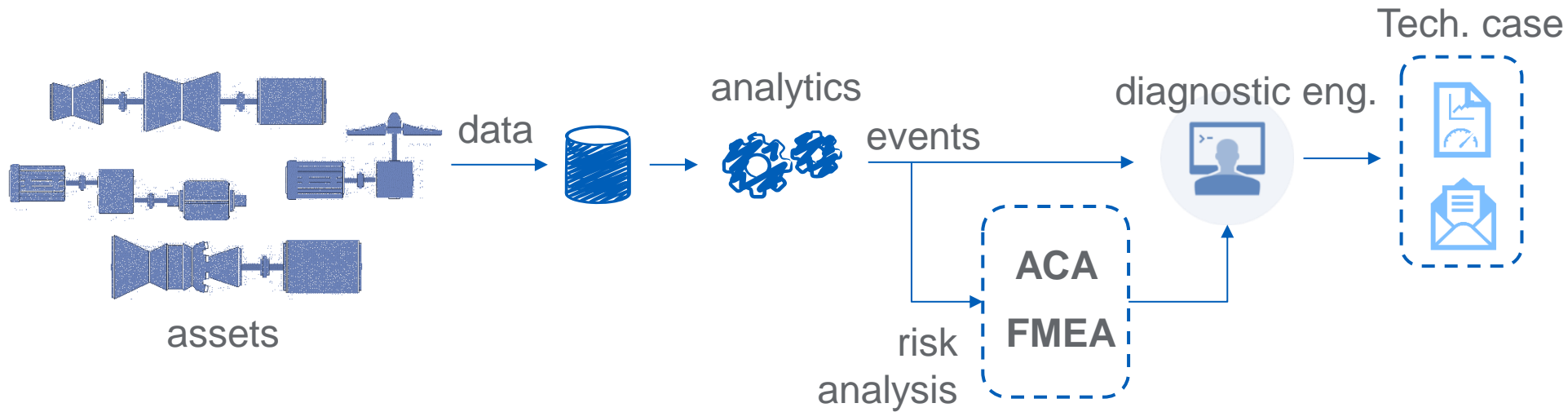
From scheduled to risk-based maintenance plan, leveraging on risk analysis.



Example on GT lube oil system. New maintenance plan can lead up to **-12%** cost and **-40%** risk.

Simulation to be evaluated against real data over a significative time interval.

The integrated M&D process



Analytics

- Physics based
 - Funcional Systems
 - Anomaly patterns
 - Design models
- Data driven

Additions from risk analysis

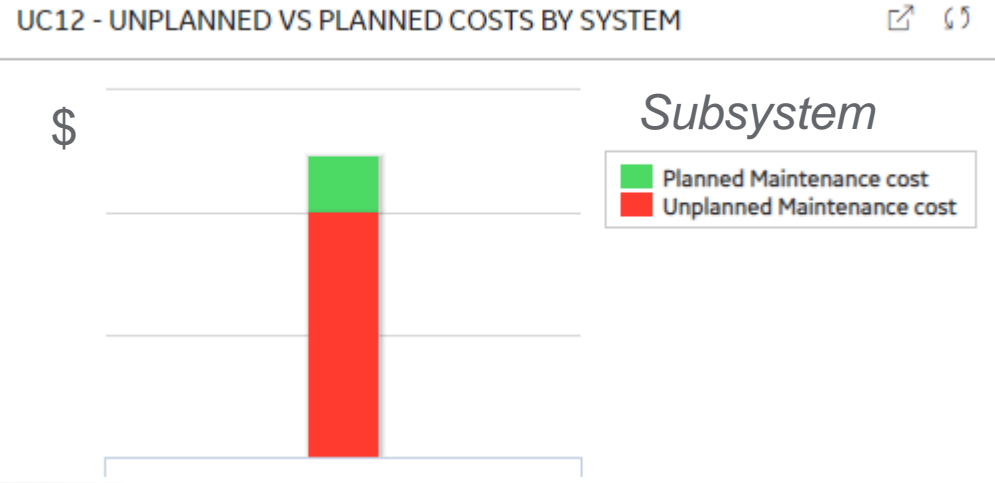
For a possible issue, Failure Modes, Effects, Recommendations and related risk levels can be associated (semi-automatic way).

Helps diagnostic engineer in troubleshooting.

Quantitative feeling of recommendations impact.

benefit/cost

Maintenance analytics



Outcomes

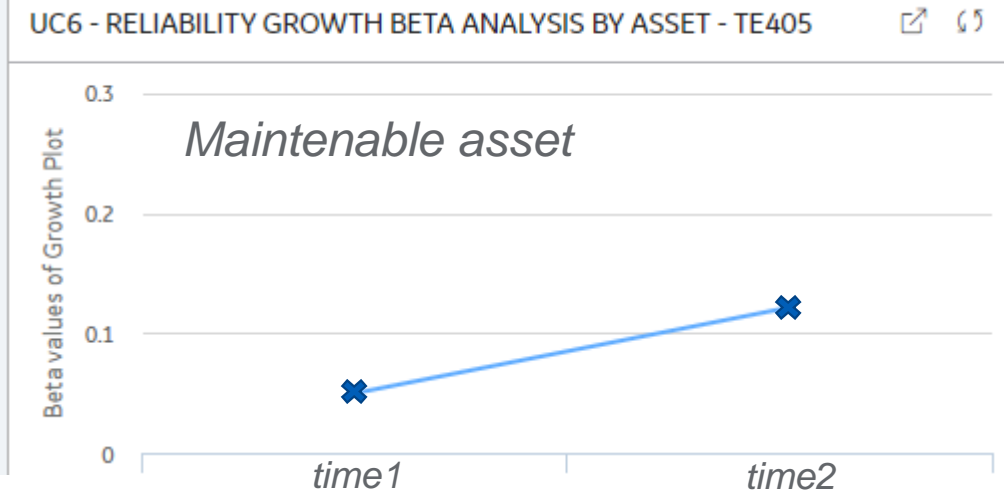
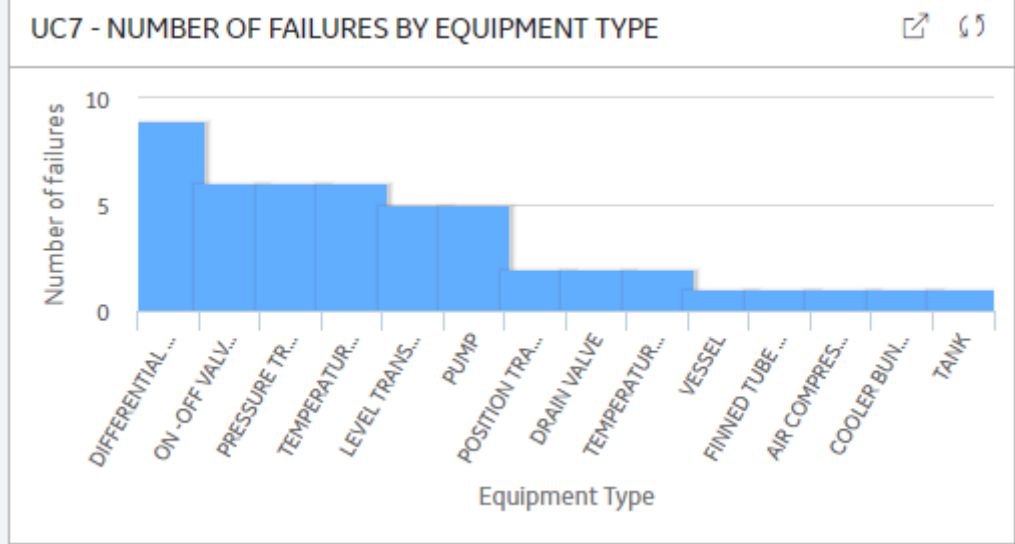
Developed 20+ use cases using CMMS and/or risk analysis data.

- update risk analysis
- update/manage strategy

Outlook

- *Optimization (on-going):*
 - risk/cost simulation
 - arrange additional actions within actual plan

Seeding future integration...



Conclusions



Outcomes

M&D service

- 10+ technical cases, 30+ recommendations
- recommendations benefit calculated using method derived from risk analysis
- risk reduction: theoretical 75 hours of equivalent production per year

Maintenance

- risk-based plan applied on selected systems, comparative cost analysis is on-going

Pros

- extended service
- methodology for risk-cost optimized maintenance plan
- opportunities for maintenance opt. using data and analytics

Cons

- risk analysis effort
- CMMS data quality
- new maint. plan benefits to be evaluated in a multi-year framework

BAKER
HUGHES
a GE company

