Methods to Extend Asset Life

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SYSTEMS AND ENGINEERING TECHNOLOGY

FRAZER-NASH CONSULTANCY

Frazer-Nash Today

- Systems and Engineering Consultancy
- Core engineering skillset
  - Mechanical, EC&I, electronics, software, civil
- Specialist groups
  - Modelling, HF, cyber, TEA, fire, info. systems
- Experience of regulated industries
- Reduce risk, improve resilience
- 80% of income is repeat business
- Prefer to sell solutions … not man hours
- Established market sectors:
  - Transport, industry & infrastructure
  - Power & energy
  - Defence

Adelaide, Melbourne & Canberra (Australia)

Institute of Physics Accredited Company Training Scheme

IET Accredited Scheme

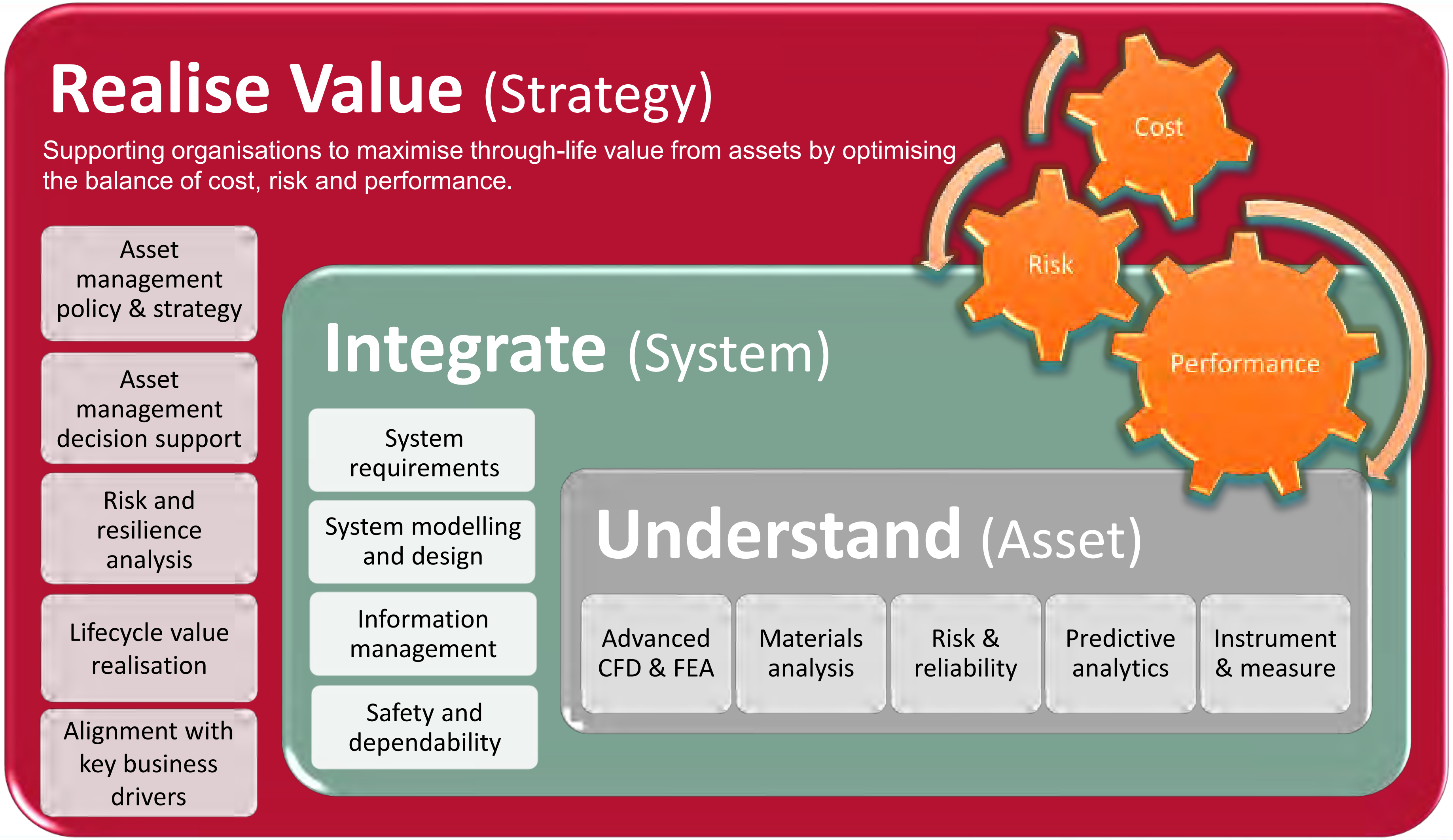
Institution of Mechanical Engineers

Investors in People

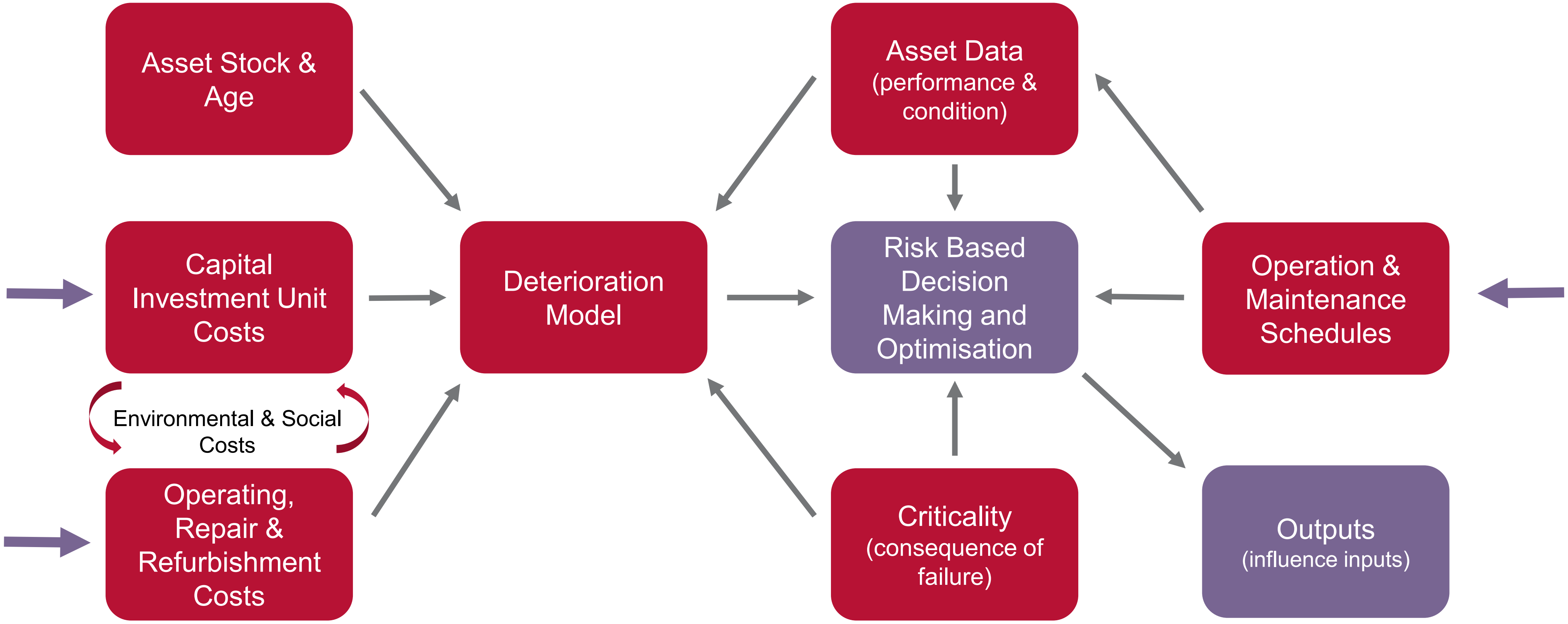
ISO 14001 DNV Registered

Our Approach to (Digital) Asset Management

Frazer-Nash Asset Management Support



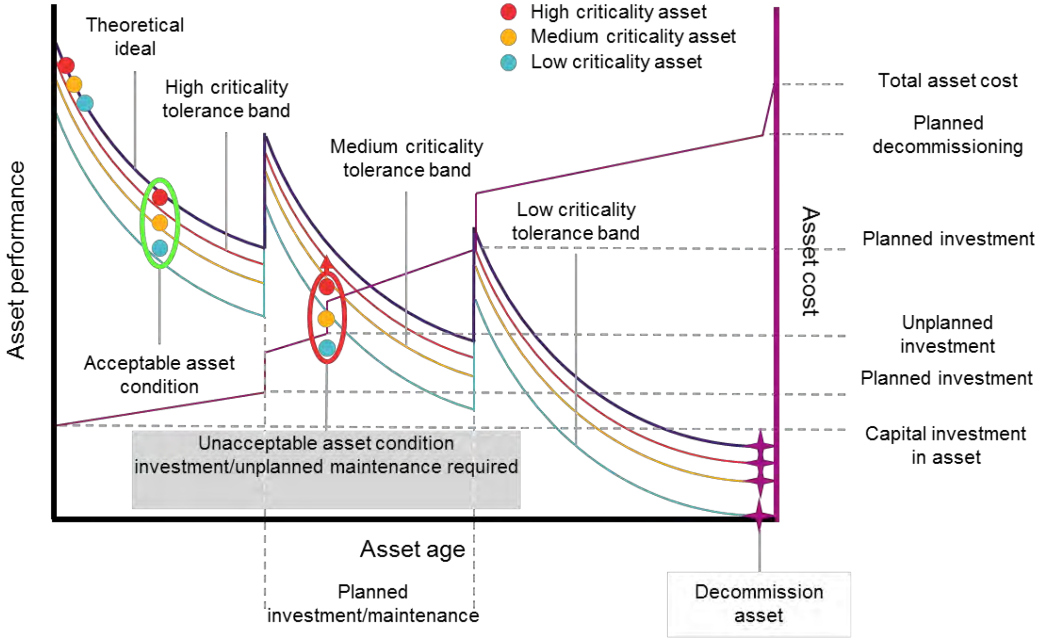
Good Asset Management = Good Decision Making



Life Extension – The Two Fundamental Questions

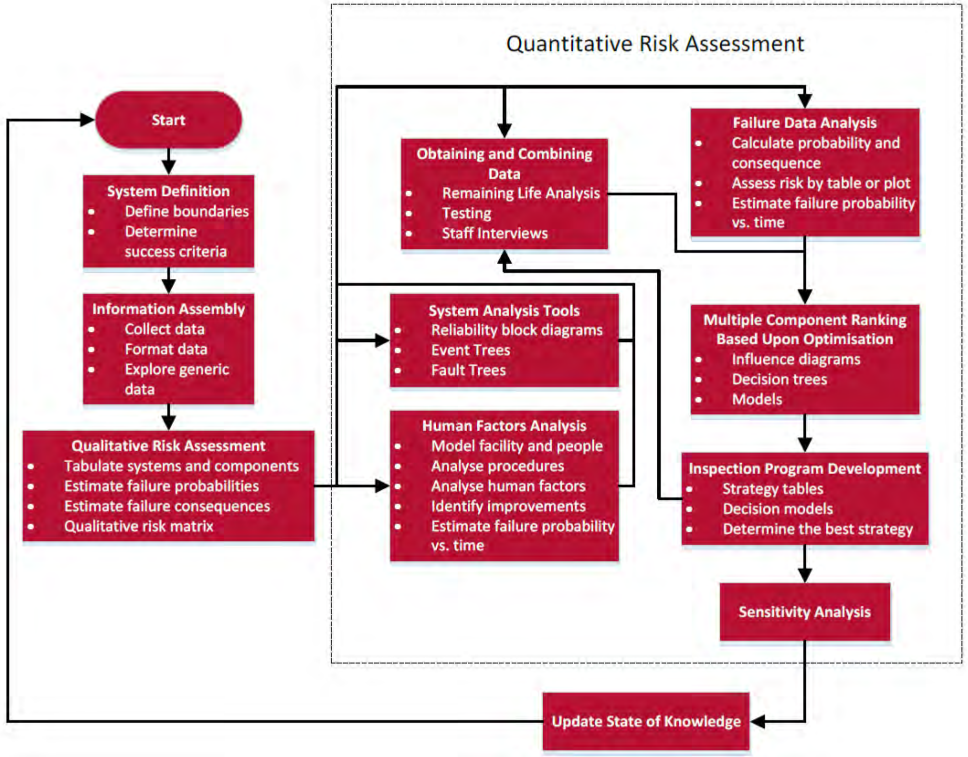
- How long can the Asset operate for?
  - An appraisal of current health and rate of degradation
  - Analysis based on known or assumed inputs
  - Some control over future operations management to extend life

- What is required to achieve additional (25?) years life?
  - An appraisal of current health and rate of degradation
  - What investment decisions are necessary to ameliorate degradation risks
  - Investment options (cost-vs-life extension) decisions
    - Is it cost-effective to replace now, or repair later?
  - Find the ‘Step Changes’ in future investment
  - Monitoring and validation



Risk Based Assessment vs Risk Based Life Extension

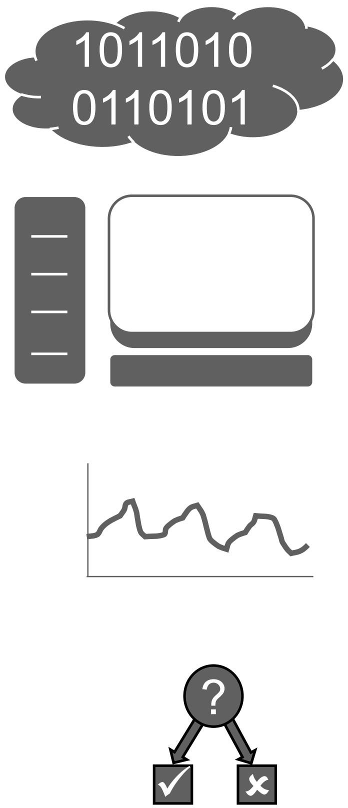
- Risk Based Assessment is already widely adopted across industries
  - RBA programmes typically supported by Risk-Based Inspection programmes
  - RBI programmes have been successfully used to extend inspection intervals of equipment
- Risk-Based Life Extension adopts the same philosophy as RBA, but…
  - Adds techno-economic modelling
  - Adds cost/benefit analysis for appraising different risk-mitigating solutions
    - Repair, replace, re-rate
    - Varying levels of integrity analysis to improve certainty of life estimates
- Integrate any risk models
  - API / ASME / DNV / ISO 31000 / ISO 17776
  - In-house or tailored



So How Does Our Approach to Digital Assets Differ?

The Conventional Approach

- led by the data



Big Data
↓
Big Computer
↓
Simple correlations
↓
Better decisions

No line of sight from the core of the organisation
↓
Data-driven and less agile to changing risk profiles
↓
Reduced understanding of plant behaviour
↓
Sub-optimal asset management

Our Approach to Digital Assets

The Digital Assets Approach

- led by understanding of the risks, system and problem

Understand the system
- Your experts and ours
- High-level visual representation

Identify critical components
- High value / single points of failure

Monitor behaviour and environment
- Identify the data requirements

Create validated simple models
- Detailed models of critical components
- Use detailed models to calibrate RoMs

Establish safe performance limits
- Normal and extreme conditions

Make timely robust decisions
- Assess remaining life
- Early warning of deterioration

‘Digital Twin’
A mathematical model of the system
A surrogate for direct monitoring where required

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110101

Make this as simple as can be
Assess in real time
Remove need for complex analytics

Encourage greater trust in the process and outcome

Condition Based Maintenance

Asset

Data Processing

<u>Data Acquisition</u>
Event Data: cycle, trips, etc

<u>Data Cleaning</u>
Noise Filter
Sensor Validation

<u>Data Analysis</u>
Cycle Definition

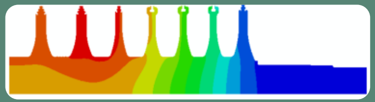
Component Stress and Temperature

<u>Reduced Order Models</u>

Transient Temperature

Transient Stress at Locations of Interest

Real-time Solution



Life Estimate

<u>Creep Life Fatigue Damage</u>

Creep Damage

Fatigue Damage

Creep-Fatigue

Remaining Useful Life

Based on Ductility / Strain Energy / Work

Action

The Condition Based Maintenance approach uses data from individual assets to determine life usage to inform and tailor maintenance actions

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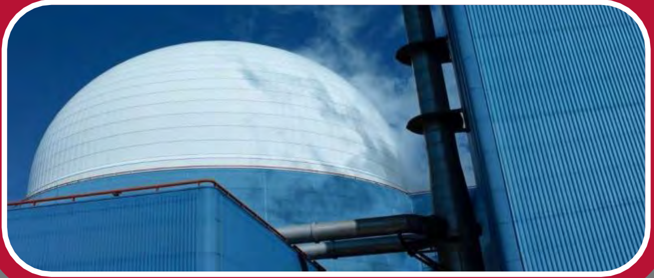
Case Studies

Nuclear



Energy

Maritime

Oil & Gas

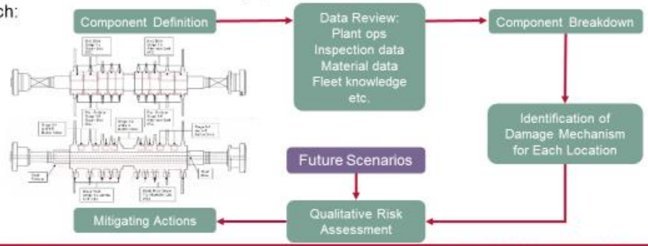
Munitions

Case Studies

Case Study 1

Case Study 1:
Qualitative Risk Assessment for Managing Ageing Plant

- Problem:
  - Forecasting integrity issues for ageing plant to minimise outage risk
  - 40+ individual LP rotors with variable usage profiles
- Approach:



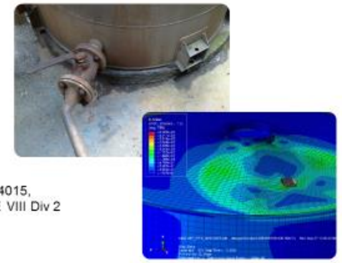
Case Study 2

Case Study 2:
Review of Life Extension Case for Pressure Vessels on an Oil Platform

- Problem:
  - Provide guidance to ensure all potential degradation threats have been considered for life extension of oil platform pressure vessels
  - Provide technical assurance on the validity of the risk based inspection approach when considering asset life extension.
- Challenge:
  - The large number of assets meant it was inefficient to perform individual analyses. We developed an approach to simplify the problem.
- Solution:
  - An asset inventory was created and threats relevant to asset life extension were identified.
  - Asset population was reduced when considering where these threats were applicable. Analyses were performed on these assets only.

Case Study 3

Case Study 3:
Chemical Storage Tanks



- Problem
  - Client operate ~275 chemical storage tanks (~100 te)
  - 173 tanks had been identified as not having been designed to recognised design standards
  - HSE has challenged the basis of design of these tanks
  - Separate to a condition assessment, is the design acceptable?
- Approach
  - Extensive site based survey to collect and confirm data
  - Comprehensive software tool to assess designs against BSEN 14015, API-620, API-650, BS2654 and ASME VIII, and analysis to ASME VIII Div 2
- Outcome
  - Detailed appraisal of code shortfalls
  - Robust information to support site area RBI plans
  - Complex finite element modelling: non-compliance with design codes is not necessarily a safety limitation

Case Study 4

Case Study 4:
Gas Turbine Generator Problem

- Problem
  - Poor availability of aging GTG system
  - Serious failures of multiple systems and prolonged outages
- Approach
  - Review operating conditions to assess system criticality (FMECA)
  - Develop reliability predictions
  - Assess maintenance activities
- Outcome
  - Identified a number of single points of failure
  - Identify systemic maintenance issues including:
    - Uncoordinated maintenance activity
    - Incomplete preventative maintenance schedule
    - Unavailability of critical spares
  - Recommend support improvements

We extend the operating life of an asset by combining operational data with cutting edge engineering methods

Digitisation enables an organisation to learn and store knowledge about how its assets behave in order to improve operational strategies

Our approach has been proven

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Thank you. Any questions?

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