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Fourth Generation Maintenance Management

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Fourth Generation Maintenance Management

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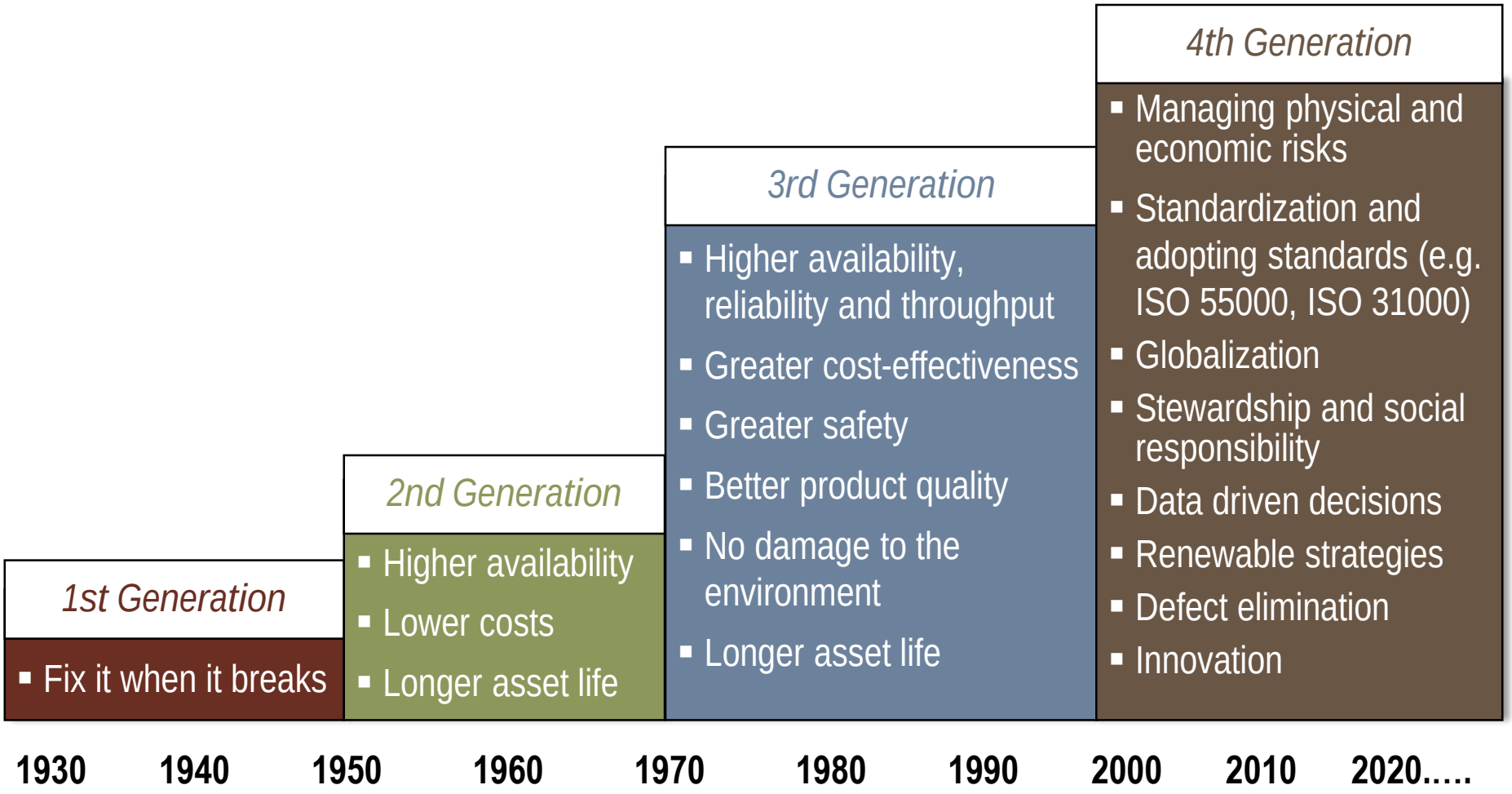

Aladon The Risk & Reliability Global Network

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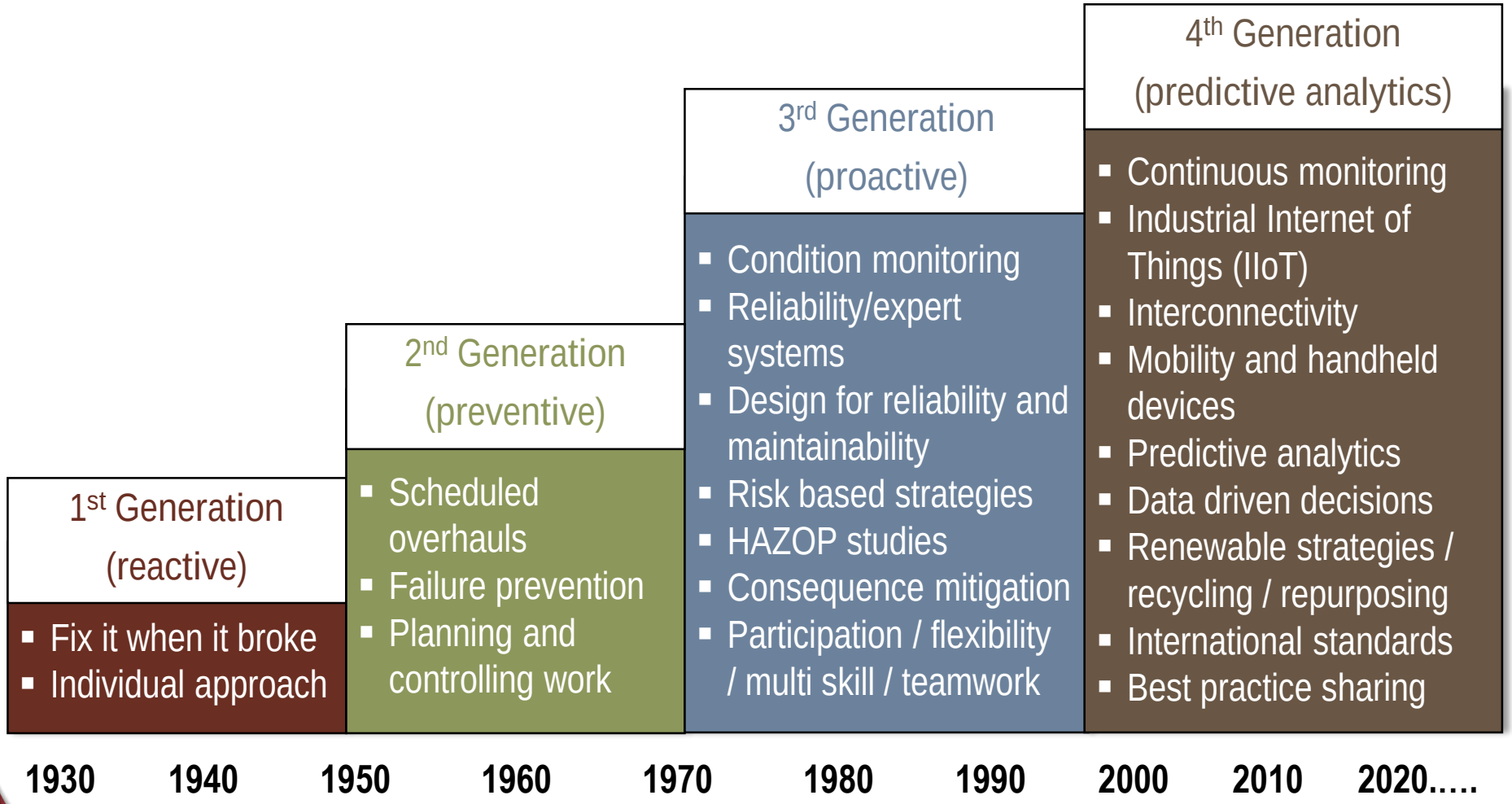

The Role of Maintenance in the 4th Generation

Modern plants and operations

- Much higher requirements for availability, reliability, quality and low cost maintenance
- Value engineering
- High availability requirements
- Product quality

Equipment complexity increases further

- Few requirements for availability
- Low cost maintenance

Equipment complexity increases

Equipment simple of design

Demand on equipment

High

Low

1940 1980 1990 **2000.....**

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From "Maintenance Management" to "Physical Asset Management"

Maintenance Management

1950 → 2000

- Low level of mechanization
- Low availability requirements
- Simplistic designs
- Inherent reliability
- Breakdown maintenance

- Need for mechanization and automation increased
- Higher equipment availability
- Preventive maintenance
- Maintenance requirements
- Planning to reduce cost
- Computerized maintenance management systems (CMMS)

Fix it when it broke

Fix it when it broke

Preventive maintenance

Physical Asset Management

2020…

- High level of mechanization and automation
- Increased dependency on equipment availability and reliability (uptime)
- Requirement for improved safety, environmental integrity and quality
- Complex designs and Innovation
- Maintenance technology and analytics
- Interconnectivity and Industrial Internet of Things (IIoT)
- Data driven decisions – acting on informtion
- Enterprise Physical Asset Management (PAM) systems
- ISO Standards – Risk based asset management

Predictive maintenance
Preventive maintenance
Failure-finding
Functional checks
One time changes
Run to failure
Defect elimination

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Maxim 1

Old

The primary objective of maintenance is to optimise plant availability at minimum cost.

New

Maintenance affects all aspects of the business safety, environmental integrity, energy efficiency and product quality, not just availability and cost.

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Maxim 2

Old

Maintenance is about preserving physical assets.

New

Maintenance is about preserving the functions of physical assets and managing the risk associated with failure.

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Maxim 3

Old

Most equipment is more likely to fail as it gets older.

New

Most failures are *not* more likely to occur as equipment gets older.

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Maxim 4

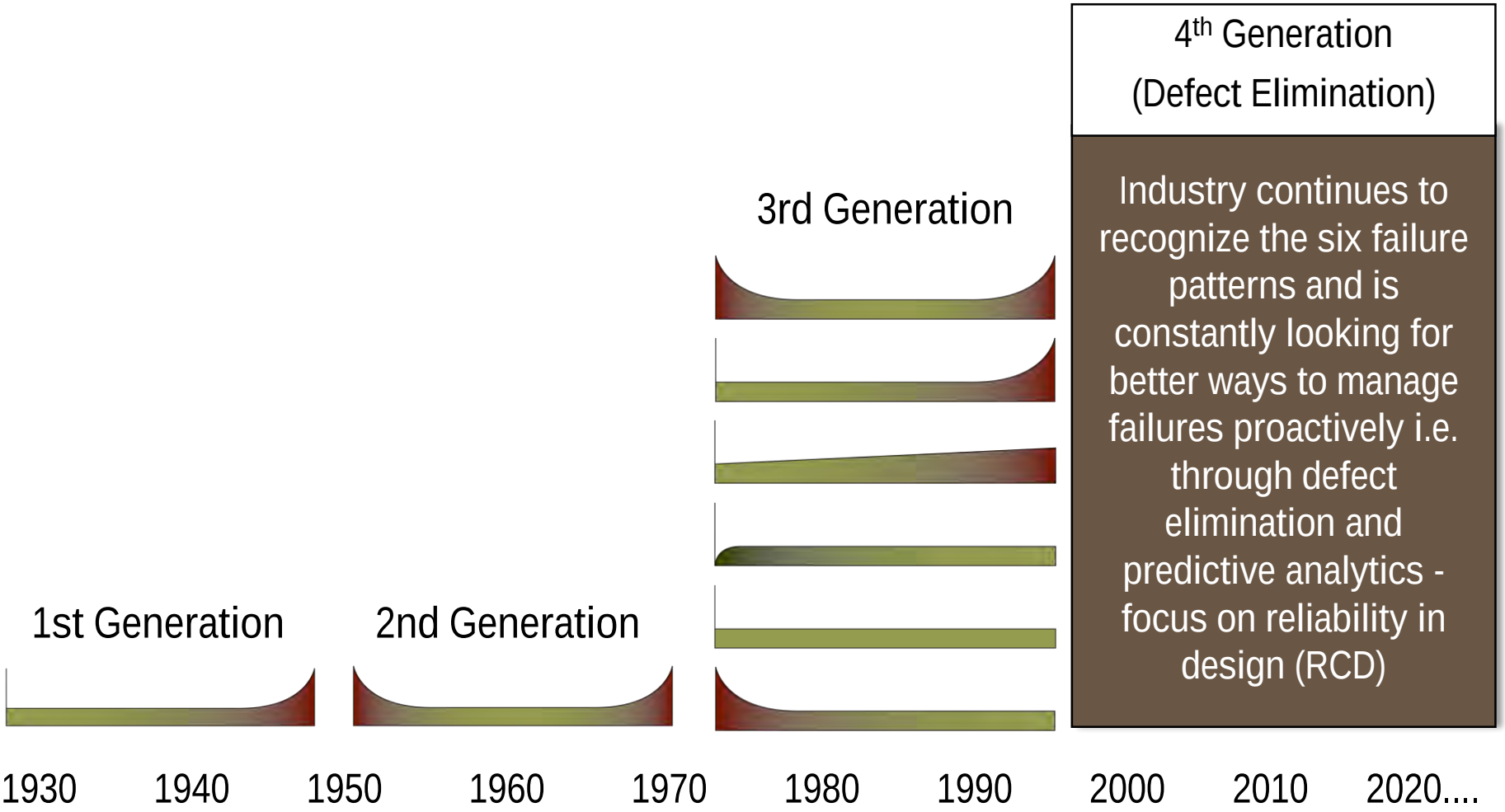
Old

Proactive maintenance is about preventing failures.

New

Proactive maintenance is about avoiding, reducing or eliminating the consequences and associated risk of failures.

History of RCM and the Reality of Failure



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Maxim 5

Old

Generic maintenance programs can be developed for most types of physical assets.

New

Generic maintenance programs only apply to identical assets with the same operating context, functions and performance standards.

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Maxim 6

Comprehensive data about failure rates must be available before it is possible to develop successful maintenance strategies.

The Resnikoff Conundrum

Many believe that it is not possible to develop a viable maintenance program without extensive data about failures ...

but if we are collecting lots of data about failures it must be because we are not preventing them ...

so large quantities of failure data must be evidence of the failure of our preventive maintenance programs (especially if the failures have significant consequences) ...

so successful preventive maintenance must be about preventing the collection of the information that some people think we need in order to decide what preventive maintenance we ought to be doing!

How to Determine Task Frequencies

Pilots can get out of combat duty if they are mentally unfit, but anyone who tries to get out of combat duty proves he is sane.

"Catch 22": A satirical World War II novel by Joseph Heller, named the situation where someone is in need of something that can only be had by not being in need of it - which is a kind of self-referential paradox.

Similarly, the want for failure data to make informed decisions would require us to allow things to fail (build history) – the need for something that can only be had by not being in need of it.

The Resnikoff Corollary

Maxim 6

Really successful physical asset management is much more about anticipating and/or preventing failures (which matter) than it is about counting them.

Score cards only tell you what you did, not what you should be doing.

For many assets we will have no history or data and in most cases will have to make decisions with inadequate data – more so when failures have consequences….

Operator and maintainer input may be the only information we have.

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Maxim 6

Old

Comprehensive data about failure rates must be available before it is possible to develop successful maintenance strategies.

New

Decisions about the management of failures will nearly always have to be made with inadequate hard data about failure rates.

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Maxim 7

Old

The probability of a catastrophic failure can be almost eliminated by fitting suitable protection.

New

Protection can also fail, so the risks associated with protected systems still have to be managed.

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Maxim 8

Old

There are three basic types of maintenance:

- Predictive
- Preventive
- Corrective

New

There are five types of maintenance strategies:

- Predictive
- Preventive
- Corrective
- Detective
- No-scheduled maintenance

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Maxim 9

Old

The frequency of predictive tasks should be based on the frequency of the failure (MTBF).

New

The frequency of predictive tasks should be based on the P-F Interval.

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Maxim 10

Old

Protective devices are the most important equipment in a plant or facility.

New

Increasing the reliability of protected functions will reduce dependency on the protective devices – making them redundant and even obsolete.

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Maxim 11

Old

Maintenance task frequency is a function of the asset criticality *(more critical assets should be maintained more often).*

New

Maintenance frequency is a function of the characteristics of failure *(as determined by the six failure patterns).*

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Maxim 13

Old

The maintenance department on its own can develop and implement a successful maintenance program.

New

A successful, lasting maintenance program can only be developed and implemented by maintainers and users of the asset working together.

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Maxim 14

Old

Equipment manufacturers are in the best position to develop maintenance programs for new physical assets.

New

Equipment manufacturers can only play a limited – but still important role in developing maintenance programs for new assets.

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Proactive Failure Management Strategies

Predictive Maintenance

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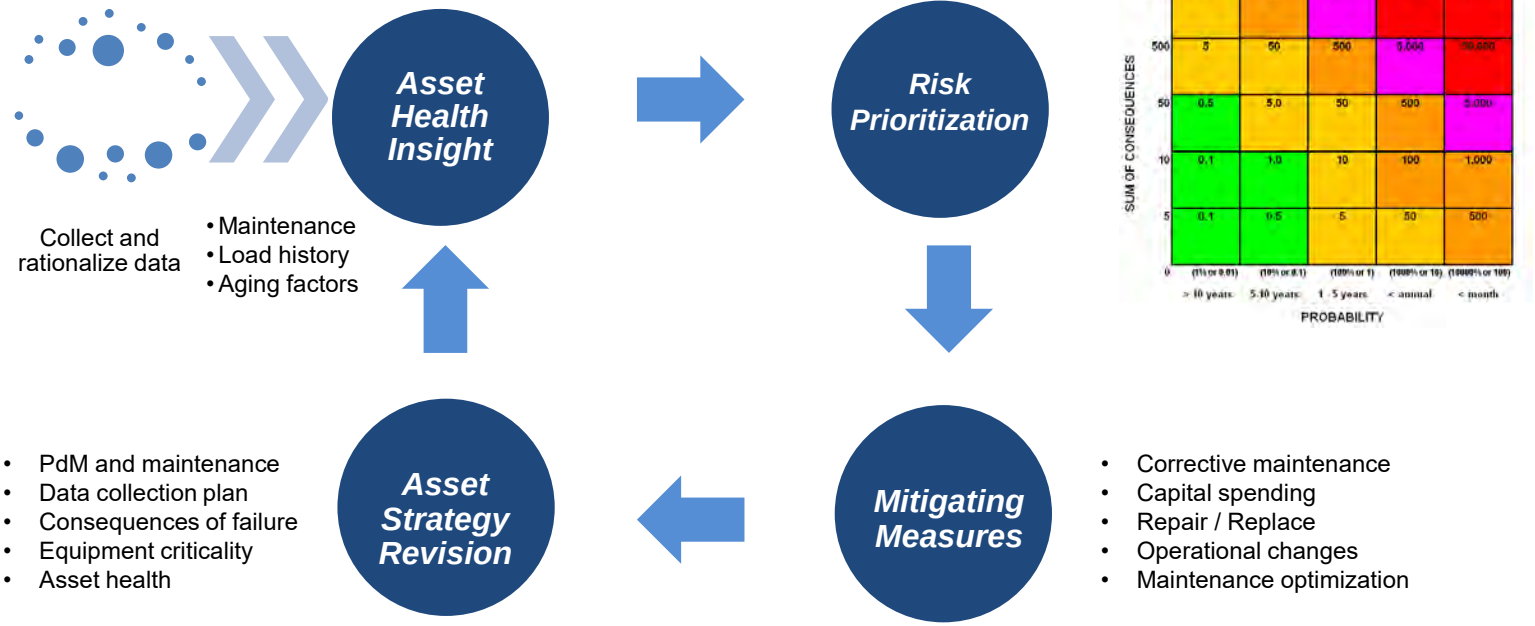
Proactive Failure Management Strategies
Predictive Maintenance

The IoT offers the ability to merge information across multiple platforms to generate deeper analysis and insight but the concept of a P-F curve is still utilized from RCM principles



Proactive Failure Management Strategies
Predictive Maintenance

Predictive maintenance look for *potential failure conditions* at intervals related to the *characteristics of failure or P-F curve*.

- Condition-based maintenance
  - Tasks designed to look for potential failures - items are left in service based on the condition they still meet acceptable performance standards.
- Predictive maintenance
  - Tasks design to predict the conditions (failure mechanisms) leading to failure i.e. increased temperature and vibration, increased particle count, etc.
- Predictive analytics
  - Predictive analytics is the data mining concerned with the prediction of future probabilities and trends.

Proactive Failure Management Strategies
Predictive Maintenance

- Predictive maintenance is looking for failure conditions using *online monitoring devices* for continuous monitoring or *handheld devices* for field inspections.
- Predictive maintenance provides “asset health” information.
- Notification of abnormal conditions would normally be in the form of an *automated alarm* for continuous monitoring devices or *deviations or anomalies* calculated through analysis of “field inspections”.
- Develop performance standards for predictive maintenance tasks.

Proactive Failure Management Strategies
Predictive Analytics

- Predictive analytics is the data mining concerned with the prediction of future probabilities and trends i.e. failed states.
- The central element of predictive analytics is the *predictor*, a variable that can be measured to predict future behavior or states.
- Multiple predictors are combined into a *predictive model* which, when subjected to analysis, can be used to forecast future probabilities with an acceptable level of reliability. In predictive modeling, *data* is collected, a statistical model is formulated, predictions are made and the model is validated (or revised) as additional data becomes available.

Conclusion: Benefits of 4th Generation Maintenance Management Using RCM3

- Aligning physical asset management with business objectives.
- Improved process safety and environmental integrity.
- Improved operating performance.
- Lower risk and greater cost effectiveness.
- Longer useful life of the equipment.
- A shift from asset care to risk management.
- A comprehensive data base and audit trail.
- Greater motivation of individuals and groups.
- A clearer view of resource requirements.
- The foundation for a living program.
- Leverage IoT and analytics

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