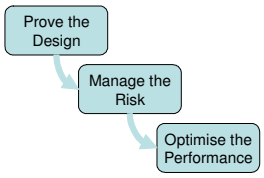
INTEGRATING RAMS ANALYSIS



ARMS Reliability Engineers utilize the latest generation of software tools for managing risk and predicting the performance of simple and/or complex industrial systems. Combining the tools to perform all risk management, performance modeling and optimization allows for common threads to be used, consistent reporting with a common report generator program and smooth integration through common import/export functionality.

These tools incorporate easy to use windows packages, electronic data exchange, risk analysis, simulation modeling, network models, and dynamic failure/inspection data analysis. Special features include the ability to evaluate time-dependent processes such as equipment aging, current age, the dynamic effects of maintenance and operating policies, logistic delays and system-wide equipment interactions.

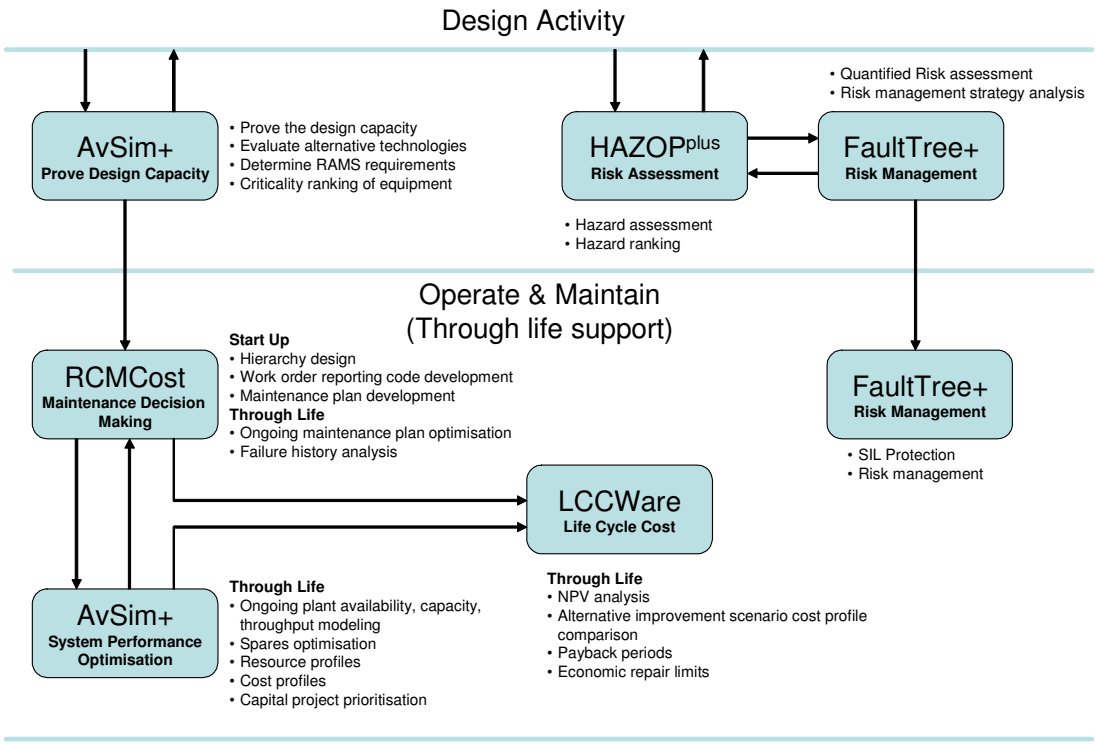
The Applications:

- Evaluate capacity of new facilities, expansions or existing plants
- Demonstrate Risk Mitigation to Insurers by linking maintenance activities to risk levels.
- Plan Capital replacements
- Set budgets
- Assess warranty periods
- Develop start up maintenance plans
- Optimising the setting of preventive maintenance intervals
- Optimising intervals for Condition Monitoring Programs
- Optimising intervals for lubrication routines
- Support Risk Based Inspection programs to extend shutdown intervals.
- Provide audit trail for regulators

The Industries

- The chemical and petro-chemical refining industries
- Power generation, transmission & distribution and OEM (equipment manufacture)
- Communication networks and equipment
- Aviation and defense
- Manufacturing
- Mining
- Facilities

RAMS ANALYSIS AND THE OUTPUTS



AT DESIGN – NEW FACILITY OR EXPANSION

<u>Design Capacity Modeling</u>

Reliability engineering techniques can help evaluate and select alternative process technologies. Specifying Reliability and Maintainability requirements in the equipment procurement process, and specifying the reliability goals in RFQs to vendors, require the vendors to provide substantiated reliability and maintainability characteristics for critical equipment.

Availability models can be used in the design assessment of each technology described in submitted vendor proposals. From that information, we can assess the expected availability of the competing technologies and provide recommendations for availability improvements. That provides the refiner or chemical manufacturer with additional information for selecting the best vendor.

For new or revamped units, ARMS prepares an availability model based on the unit design package and interviews with plant process, operations, and maintenance personnel. ARMS develop the equipment reliability and maintainability data to analyze availability by using operating and maintenance records for similar process units.

ARMS use these availability models to evaluate the benefits of design alternatives, such as pump sparing, exchanger bypasses, and equipment modifications. ARMS also develop availability assurance measures, including procurement requirements and maintainability guidelines, for equipment that is critical to unit availability.

ARMS have assessed the design of newly installed capital equipment as part of a plant expansion project. Using availability modeling ARMS were able to advise the optimum configuration and operating plan in order to optimise plant capacity whilst minimising ongoing maintenance and repair costs.

Use: AvSim+

- Prove the design capacity
- Evaluate alternative technologies
- Determine/Specify RAMS requirements for major equipment
- Criticality Ranking of equipment

Risk Based Inspection and Maintenance

RAMS models can be used to demonstrate due diligence and prudent risk management to legislators regulators and owners. The connection between maintenance and inspection plans is quantified against critical failure modes. A HAZOP study can identify areas of risk and provide a high level risk ranking. Faulttrees can then be used to evaluate and quantify the potential for high level events such as fire or explosion to occur. Understanding the importance of plant reliability as contributors or intitiators of these events, provides plant managers with the means to design out critical risks or introduce risk mitigation practices.

The risk level of critical failures can be assessed with quantitative measures and the impact of alternative mitigation, inspection or preventive strategies evaluated over some future period or lifetime.

Use: HAZOP^{plus}

- Risk Identification
- Risk Ranking

Use: FaultTree+

- Quanified risk assessment
- Operate & Maintain

OPERATE & MAINTAIN – THROUGH LIFE SUPPORT FOR NEW OR EXISTING FACILTIES

At Startup (New Facilities, New Equipment)

There are some key advantages of using Reliability Modeling tools for initially setting the maintenance program:

- Initially the modeling process can be used to generate an equipment hierarchy structure along with appropriate work order reporting codes
- It provides a valuable means of educating the maintainers in what the requirements are to ensure reliable plant.
- It provides a systematic process of knowledge capture that can be challenged and updated over the life of the plant.
- It ensures that individual equipment, failures and maintenance action are seen in context of overall plant performance.
- It accommodates the needs of a wide variety of interest groups: - risk managers, plant designers, plant inspectors/maintainers, logistics, capital replacement and procurement.

Use: RCMCost

- Hierarchy design
- Work order reporting code development
- Maintenance plan development

Through Life Analysis & Continuous Improvement

Preventive Maintenance Optimization

To optimize and develop preventive maintenance programs, ARMS analyze plant maintenance history and related information as it is collected to determine equipment reliability performance, failure modes, failure causes, and failure parameters. With the analysis results, we prepare a maintenance plan containing specific preventive maintenance and inspection tasks and effective performance intervals based on reliability-centered maintenance (RCM) criteria. The plans are optimised over a specified lifecycle and each task has a benefit ratio from a cost, safety, environmental and operations viewpoint.

Use: RCMCost

- Ongoing maintenance plan optimisation
- Failure history analysis

Improve Process Unit Availability.

Reliability Engineering methods applied in refining and manufacturing processes, can help organisations increase efficiency by developing availability models of their processing units. Those models are used to identify critical areas for availability improvements. Failure modes and effects analysis helps determine the root cause of failure and identify the critical areas to be addressed. Failure behaviour and current maintenance practices are modeled in a system diagram, improvements are identified to address the root cause, and the model is run with those improvements to assess their impact on process unit availability.

The benefit of the increased availability is compared with the cost of implementing the improvement measures. This methodology is a valuable tool for selecting the most cost-effective availability improvements.

Use: AvSim+

- Ongoing plant availability/capacity/throughput modeling
- Spares optimisation
- Resource profiles
- Cost profiles
- Capital project prioritisation

Life Cycle Costing

To fully understand and evaluate certain improvement alternatives full life cycle costing needs to be completed. This allows for all cost elements to be considered in the evaluation and can be used to calculate Net Present Value for the scenarios.

Use: LCCWare

- NPV analysis
- Alternative improvement scenario cost profile comparison
- Payback periods
- Economic repair limits

Risk Management

Using Faulttrees is a proven methodology for performing and demonstrating risk management. Faulttrees can be used to not only identify and quantify major risk items and their causes, but can also demonstrate SIL protection.

Use: FaultTree+

- Safety Integrity Level (SIL) Protection analysis
- Ongoing risk management

DYNAMIC ANALYSIS – KEEPING PACE WITH CHANGE

In today's dynamic business environment, if the price of commodity or service changes, the impact on the maintenance plan can be updated rapidly. "What if" scenarios can be run to model design changes, capital additions, increased utilisation or cost the consequences of complete asset failure. Changes to maintenance resourcing arrangements can be modeled, or changes to spares holding policies.

This kind of knowledge is available on the desktop ahead of time using simple models and probabilities. The technology has come from industries that cannot afford in service failures. In today's competitive environment not only can most businesses not afford to have failures, but they also cannot afford to over-service their plants through traditional maintenance arrangements.

It is rare that equipment will perform according to the initial assumptions. Feedback from plant inspection, monitoring, work orders, failure logs and incident reports can be used to update the models. This data can be electronically fed and batch analysed, and results electronically imported to the prediction models.

The prediction models can be kept abreast with the performance of the assets to ensure the maintenance policy is continuously reviewed and updated.