Risk on Radar

Adaptive Reliability Intelligence for Complex Engineering Systems

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A next-generation B2B platform enabling predictive engineering intelligence, system-level risk analysis, and adaptive reliability assessment for critical assets.

Whitepaper

Author:

Mostafa Gargourimotlagh, PhD

May 28, 2026

1. Executive Summary

Risk on Radar is a next-generation engineering intelligence platform for reliability, failure detection, and operational risk assessment. The platform combines adaptive failure knowledge, system-level analysis, and cross-domain reliability reasoning to support decision-making across complex engineering systems.

Our mission is to help industrial organizations prevent costly failures, reduce downtime, strengthen operational resilience, and improve engineering decisions before risks escalate into operational disruptions.

Engineering failure knowledge is no longer static. The way a component fails today may differ significantly from how the same component failed a decade ago due to changes in operating conditions, software integration, material behavior, manufacturing processes, and increasing system complexity.

As illustrated in Figure 1, Risk on Radar is built upon three interconnected intelligence pillars: a Living Failure Knowledge Engine, System-Level Risk Analysis, and Cross-Domain Failure Intelligence. By transforming fragmented engineering knowledge into adaptive operational insight, Risk on Radar enables organizations to move from reactive maintenance toward predictive and context-aware reliability management.

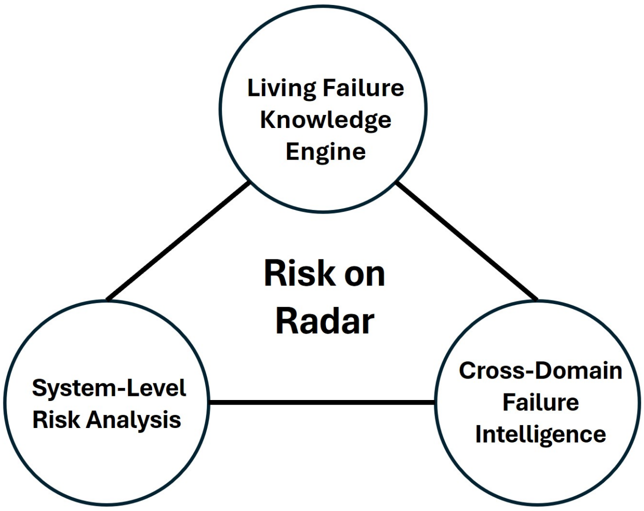

Figure 1: The three foundational intelligence pillars of the Risk on Radar platform.

2. Industry Challenges

Modern engineering systems are becoming increasingly complex, interconnected, and difficult to monitor effectively. Organizations operating critical assets face several persistent challenges:

- Reactive maintenance strategies leading to unexpected downtime and operational disruption
- Fragmented reliability and failure knowledge across teams, standards, and industrial repositories
- Limited visibility into subsystem dependencies and cascading failure mechanisms
- Escalating operational, maintenance, and asset lifecycle costs
- Difficulty identifying weak signals and early-stage degradation patterns
- Knowledge silos across engineering domains, limiting cross-sector learning
- Rapidly evolving failure mechanisms driven by increasing system complexity, higher power density, tighter operational tolerances, and autonomous system behavior

Traditional monitoring systems often focus on isolated components rather than integrated system behavior, making it difficult to anticipate cascading failures, detect latent risks, or understand how changing operational conditions reshape modern failure modes.

3. Limitations of Existing Reliability Approaches

Traditional reliability assessment platforms often rely on highly manual engineering workflows, complex configuration procedures, and significant domain expertise. Although these systems support established methodologies such as Failure Mode and Effects Analysis (FMEA) and reliability-centered maintenance (RCM), they typically provide limited integration of structured reliability knowledge, weak adaptability across domains, and minimal automation of engineering reasoning workflows.

In many industrial environments, reliability analysis remains heavily dependent on expert interpretation, fragmented documentation, and isolated software ecosystems. As engineering systems become increasingly interconnected and operationally dynamic, these approaches introduce growing engineering analysis burden, long deployment cycles, and limited scalability across complex systems.

Integrated reliability intelligence refers to the ability to continuously structure, contextualize, and operationalize engineering failure knowledge across reliability workflows. This includes integration of failure evidence, operational conditions, semantic reasoning, subsystem interactions, and adaptive risk assessment into a unified analytical framework.

As illustrated in Figure 2, current reliability platforms generally operate with high engineering analysis burden and limited integrated reliability intelligence. Risk on Radar aims to reduce workflow complexity and expert dependency by integrating adaptive failure knowledge, semantic reasoning, and context-aware reliability analysis into a unified operational framework.

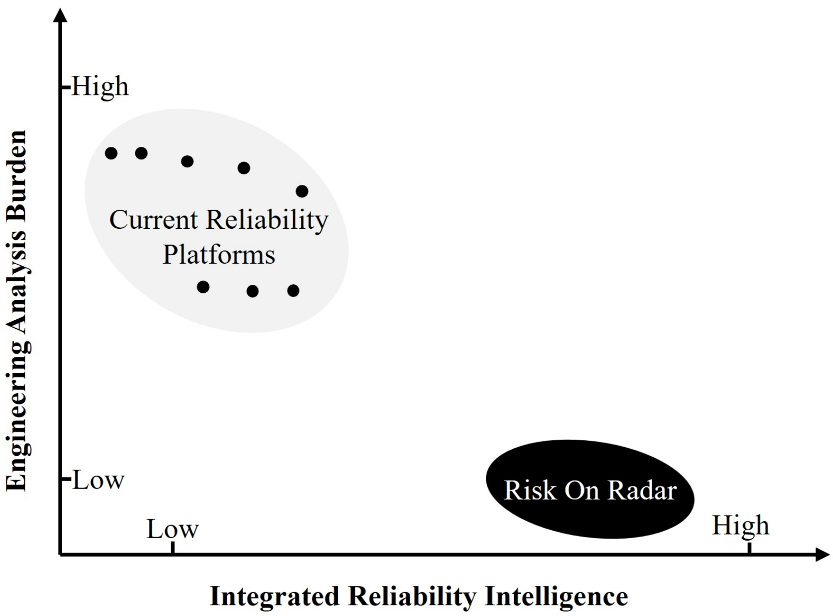

Figure 2: Conceptual positioning of Risk on Radar relative to conventional reliability analysis platforms. Increasing integration of structured reliability knowledge enables lower engineering analysis burden, reduced expert dependency, and more adaptive reliability workflows.

4. The Risk on Radar Platform

Risk on Radar addresses modern reliability challenges through three interconnected technological foundations: a Living Failure Knowledge Engine, System-Level Risk Analysis, and Cross-Domain Failure Intelligence.

The overall architecture of the platform is illustrated in Figure 3. The system continuously transforms heterogeneous engineering data into structured operational insight capable of supporting adaptive risk assessment, system-level analysis, and engineering decision support workflows.

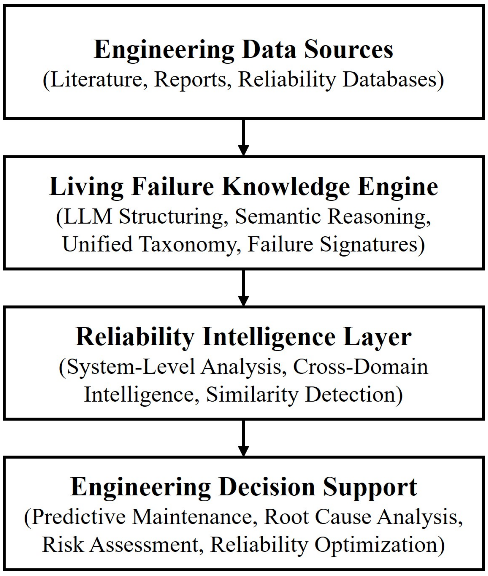

Figure 3: High-level architecture of the Risk on Radar platform integrating engineering data sources, structured failure knowledge, system-level analysis, and engineering decision support.

4.1. Core Platform Capabilities

Capability	Description
Living Failure Knowledge Engine	Continuously structures fragmented engineering failure knowledge using semantic reasoning, unified reliability taxonomies, and adaptive failure modeling.
System-Level Risk Analysis	Models subsystem interactions, cascading failures, and operational dependencies across complex engineering systems.
Cross-Domain Failure Intelligence	Transfers reliability knowledge and transferable failure signatures across different operational domains and environmental conditions.
Context-Adaptive Risk Assessment	Adapts source-domain risk knowledge to target operating environments using operational context and similarity-based reasoning.
Engineering Decision Support	Supports predictive maintenance, root-cause analysis, reliability optimization, and operational risk assessment workflows.

Table 1: Core capabilities of the Risk on Radar platform.

4.2. Living Failure Knowledge Engine

Engineering failure knowledge is continuously expanding through scientific publications, industrial reports, reliability studies, sensor technologies, and non-destructive testing investigations. However, two major challenges limit its direct use in engineering risk assessment.

First, failure knowledge is highly fragmented across documents, standards, methodologies, and domain-specific repositories. Second, failure mechanisms evolve over time as engineering systems become more interconnected, autonomous, efficient, and operationally demanding. Time trends increasingly reveal new degradation behaviors, emerging failure patterns, and changing subsystem interactions that were not previously observed under older operational conditions.

Risk on Radar addresses these challenges through a Living Failure Knowledge Engine that continuously integrates and structures engineering failure knowledge using Large Language Models (LLMs), semantic reasoning, and unified reliability taxonomies.

The framework transforms fragmented engineering information into structured reliability workflows aligned with established methodologies such as Failure Mode and Effects Analysis (FMEA), 8D problem-solving, Six Sigma, and reliability-centered maintenance frameworks.

The platform is designed to augment engineering expertise by supporting human-in-the-loop validation, interpretation, and reliability decision workflows.

As illustrated in Figure 4, the platform integrates failure evidence, reliability methods, sensor technologies, and diagnostic techniques into a continuously updated knowledge layer for engineering risk assessment and operational decision support.

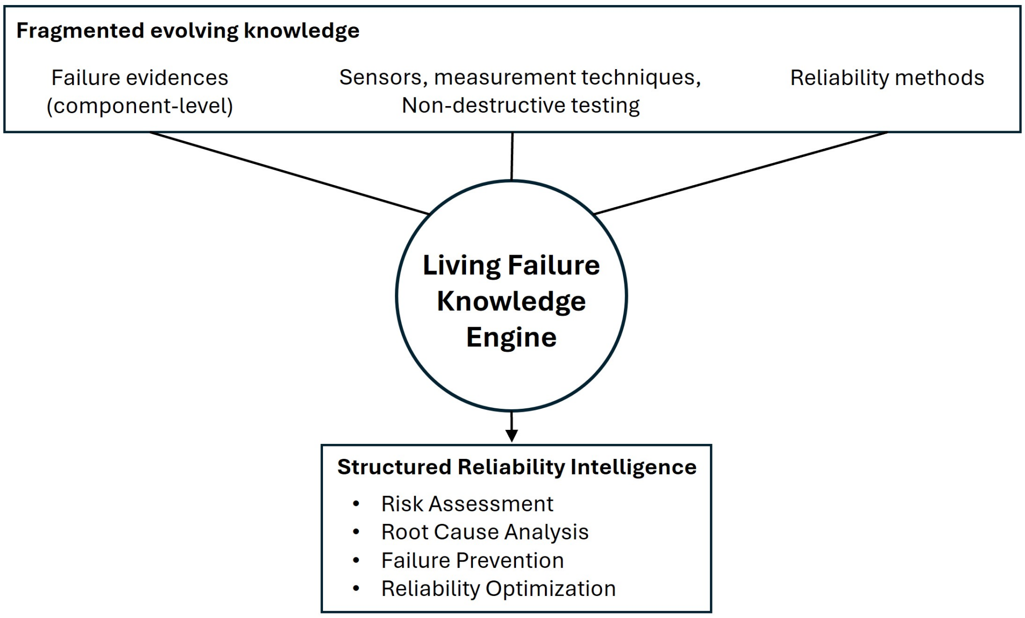

Figure 4: The Living Failure Knowledge Engine transforms fragmented and evolving engineering knowledge into structured reliability insight for risk assessment and operational decision support.

4.3. System-Level Risk Analysis

While component-level reliability analysis remains essential, modern engineering systems operate as interconnected networks of subsystems, dependencies, and dynamic operational interactions. A single engineering asset may consist of dozens of interacting components, each with multiple failure modes and propagation pathways.

Risk on Radar models engineering assets as integrated systems rather than isolated components, enabling analysis of subsystem dependencies, cascading failures, operational bottlenecks, and system-wide reliability vulnerabilities.

The structured knowledge generated by the Living Failure Knowledge Engine enables not only analysis of existing operational systems, but also predictive evaluation of systems operating under previously unseen or extreme conditions, including autonomous systems, underground infrastructure, space operations, high-temperature industrial processes, and zero-gravity environments.

By combining historical failure evidence with similarity-based reasoning, the platform enables engineers to evaluate how subsystem-level modifications, environmental changes, or design decisions influence overall system behavior before failures occur. This capability supports a transition from reactive reliability analysis toward predictive and system-aware operational reasoning.

4.4. Cross-Domain Failure Intelligence

Engineering failure knowledge is generated across multiple industrial sectors including energy, transportation, aerospace, defense, maritime systems, semiconductor manufacturing, electronics, and power infrastructure. Although these industries operate under different environmental and operational conditions, many engineering components exhibit similar degradation behaviors and latent failure characteristics across applications.

However, reliability knowledge cannot be transferred directly between domains because operating conditions, thermal stresses, loading environments, maintenance strategies, and reliability constraints vary significantly between applications. As a result, risk assessments derived from one domain may not accurately represent behavior under different operational contexts.

Risk on Radar addresses this challenge through Cross-Domain Failure Intelligence. As illustrated in Figure 5, the Living Failure Knowledge Engine generates transferable failure signatures, source operating conditions, and source-domain risk knowledge from historical engineering evidence. The framework then adapts this information to target operational environments by incorporating target operating conditions into the risk assessment process.

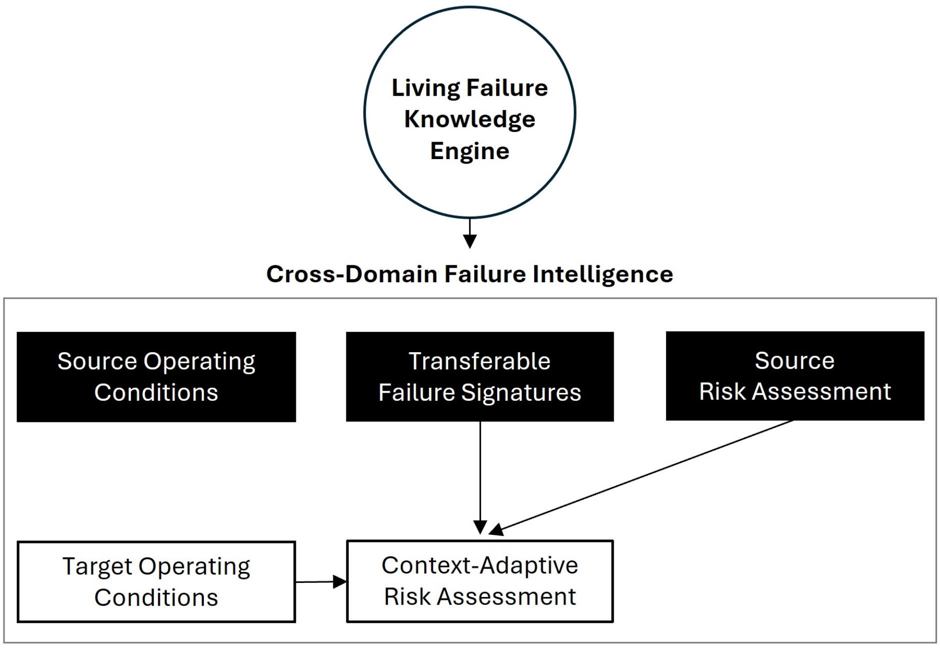

Figure 5: Cross-domain failure intelligence enables context-adaptive risk assessment by transferring failure signatures and source-domain reliability knowledge across operational environments while accounting for differences in target operating conditions.

By combining machine learning, similarity detection, and engineering reasoning models, the platform enables context-adaptive risk assessment for systems operating under unfamiliar, extreme, or previously unseen conditions. This enables organizations to transfer reliability knowledge across domains while reducing uncertainty introduced by changing operational environments.

5. Example Applications

5.1. System-Level Reliability Evolution in Wind Turbines

Modern wind turbines represent a strong example of the growing reliability challenges associated with complex engineering systems. A single wind turbine consists of numerous interconnected subsystems and components, including blades, gearboxes, bearings, generators, converters, sensors, control systems, power electronics, and structural elements. Each component may exhibit multiple degradation pathways and failure modes under varying operational conditions.

Analyzing reliability at the isolated component level is therefore insufficient for understanding the operational risk of the overall system. Failure propagation across subsystems, coupled operational behavior, and dynamic environmental loading make system-level reliability assessment significantly more challenging.

At the same time, wind turbine technology has evolved rapidly over recent decades due to increasing demands for higher power generation efficiency and larger-scale renewable energy deployment. Modern turbines operate at larger physical scales, higher power densities, more aggressive environmental conditions, and increased operational complexity compared to earlier generations. As a result, new critical failure modes and degradation mechanisms continue to emerge over time.

These evolving operational realities require a more adaptive understanding of reliability behavior that accounts not only for component-level degradation, but also for changing operating conditions, subsystem interactions, and long-term reliability evolution.

Risk on Radar addresses these challenges by integrating continuously evolving failure knowledge with system-level analysis and adaptive reliability intelligence. The platform enables engineers to identify emerging failure mechanisms, analyze subsystem interactions, and evaluate how evolving operational conditions influence long-term system reliability.

5.2. Cross-Domain Reliability Knowledge Transfer

Cross-domain reliability intelligence becomes particularly valuable when engineering systems operate under unfamiliar or emerging operational conditions.

For example, reliability knowledge derived from wind turbine drivetrain failures may reveal transferable degradation signatures relevant to other rotating machinery systems operating under different environments, such as marine propulsion systems, aerospace actuation systems, industrial powertrain platforms, or high-speed manufacturing equipment.

Although the operational environments differ significantly, many systems share underlying physical degradation behaviors including vibration-induced fatigue, thermal stress accumulation, lubrication degradation, bearing wear, and coupled electromechanical failure mechanisms.

Risk on Radar uses transferable failure signatures together with source-domain operating conditions and historical risk assessments to adapt reliability knowledge into target operational environments. By incorporating target-domain operating conditions into the assessment workflow, the platform enables context-adaptive risk estimation for systems operating under unfamiliar, extreme, or previously unseen conditions.

This capability enables organizations to reduce uncertainty, improve reliability prediction, and accelerate engineering decision-making even when limited historical data exists for the target system.

6. Industry Use Cases

Risk on Radar is designed for engineering-intensive industries operating complex, safety-critical, and high-value assets. The platform is applicable across sectors including energy systems, transportation and mobility, aerospace and defense, maritime and offshore systems, industrial manufacturing and automation, semiconductor systems and electronics, as well as critical infrastructure and emerging space technologies.

These industries increasingly operate under demanding conditions characterized by higher system complexity, tighter operational tolerances, accelerated innovation cycles, and growing reliability expectations.

Risk on Radar supports a broad range of engineering and operational workflows including predictive maintenance optimization, fleet and asset reliability management, failure analysis, root-cause investigation, operational risk assessment, reliability-driven system design, and engineering knowledge management.

The platform is particularly valuable in environments where failures propagate across subsystems, operating conditions evolve dynamically, and historical reliability knowledge must be adapted to emerging technologies or unfamiliar deployment conditions.

7. Business Value

Risk on Radar enables organizations to transition from reactive reliability management toward predictive and intelligence-driven operations.

By integrating adaptive failure knowledge, system-level reasoning, and context-aware risk transfer across domains, the platform helps organizations reduce unplanned downtime, improve operational resilience, accelerate root-cause analysis, and strengthen engineering decision-making under uncertainty.

The framework also enables earlier identification of emerging risks, improved understanding of cascading failure mechanisms, and more effective optimization of complex systems operating under demanding conditions.

As engineering systems continue to increase in complexity, Risk on Radar provides a scalable operational intelligence layer capable of transforming fragmented engineering information into actionable reliability insight.

8. Technology Vision

Risk on Radar represents a new generation of engineering intelligence platforms capable of learning from global failure knowledge, operational environments, and evolving system behavior.

Our long-term vision is to build an adaptive reliability ecosystem that combines structured engineering knowledge, semantic reasoning, machine learning, and system-level analysis into a unified operational framework.

The platform is designed to support future engineering workflows where reliability assessment, risk analysis, and operational decision-making become increasingly adaptive, context-aware, and intelligence-driven.

As industrial systems evolve toward greater autonomy, interconnectedness, and operational complexity, Risk on Radar aims to provide the foundational intelligence layer for next-generation reliability engineering and resilient system design.

9. Conclusion

Engineering organizations are entering an era where reliability challenges can no longer be addressed through static knowledge, isolated component analysis, or purely reactive maintenance strategies.

Risk on Radar introduces a new approach to engineering reasoning by combining adaptive failure knowledge, system-level analysis, and cross-domain reliability intelligence into a unified operational framework.

By integrating these capabilities, the platform enables organizations to anticipate failures earlier, reduce operational uncertainty, strengthen resilience, and improve engineering decision-making across increasingly complex systems.

Risk on Radar

Engineering Intelligence for the Future of Reliability