MechTwin – Intelligent Digital Failure Predictor

Theme: Smart Automation Solutions

- Predictive maintenance & failure intelligence
- Real-time digital twin for mechanical systems

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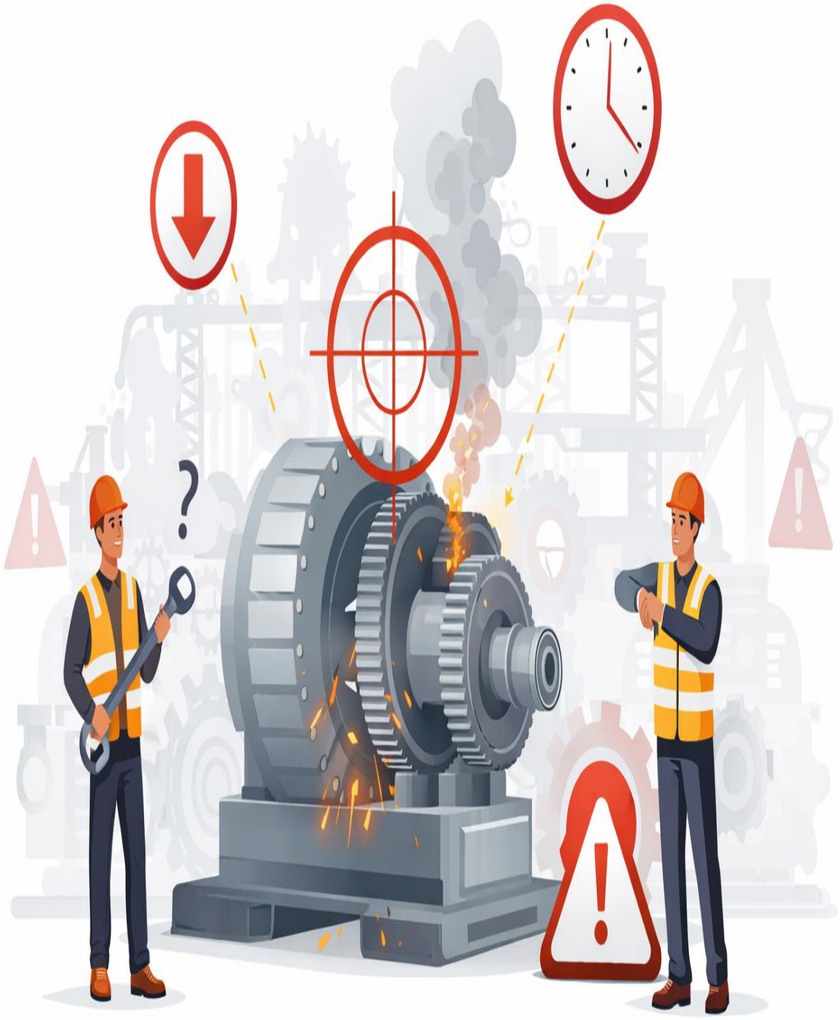
Problem Identified

PROBLEM DESCRIPTION

- ❑ Unexpected mechanical failures
- ❑ Reactive maintenance approaches
- ❑ No real-time visibility of system health

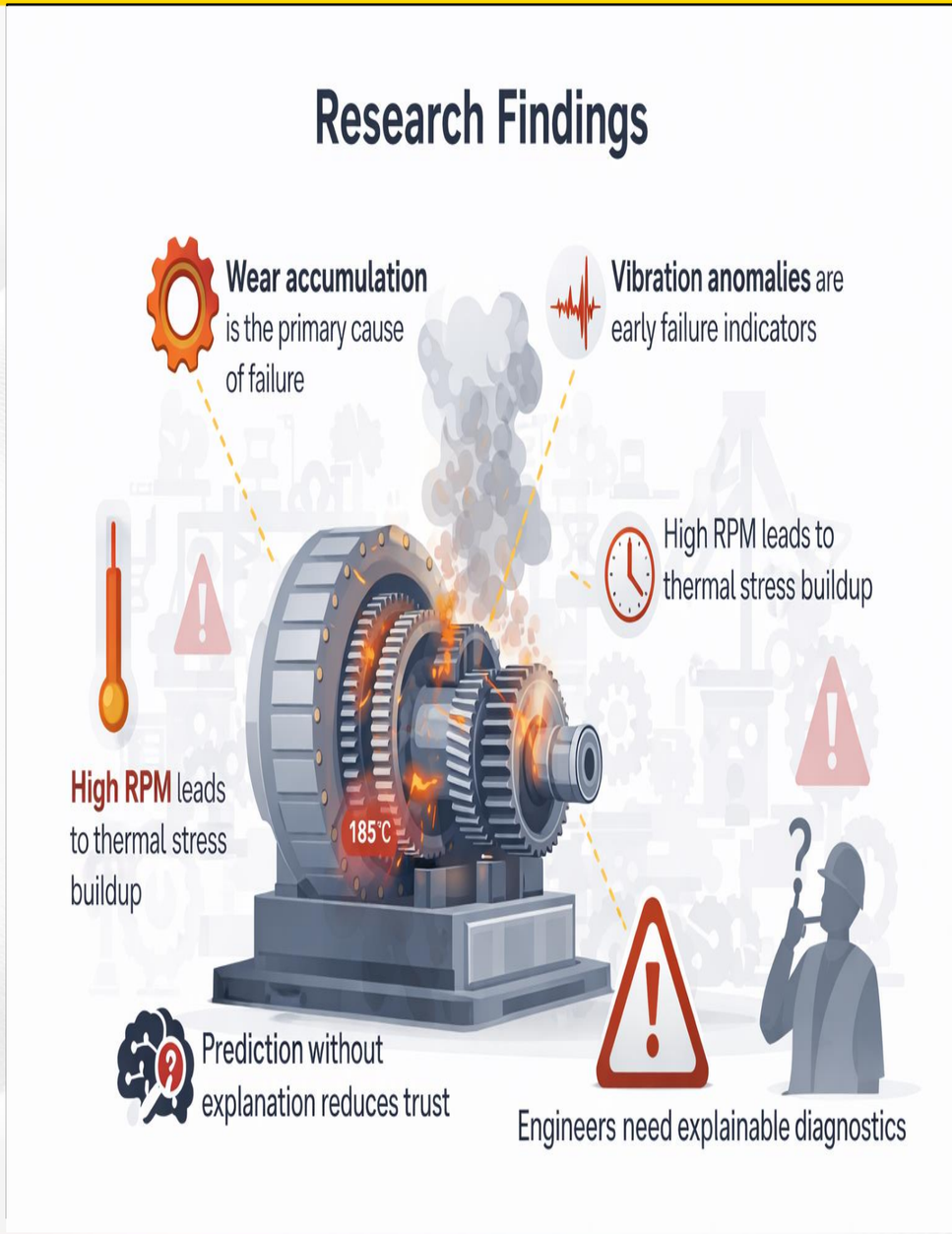
Background:

- ❑ Existing systems only monitor raw parameters
- ❑ Failures are detected only after breakdown
- ❑ Engineers lack explanation for failure causes



Research findings

- ❑ Wear accumulation is the primary cause of failure
- ❑ Vibration anomalies are early failure indicators
- ❑ High RPM leads to thermal stress buildup
- ❑ Prediction without explanation reduces trust
- ❑ Engineers need explainable diagnostics



Product specifications

Components required

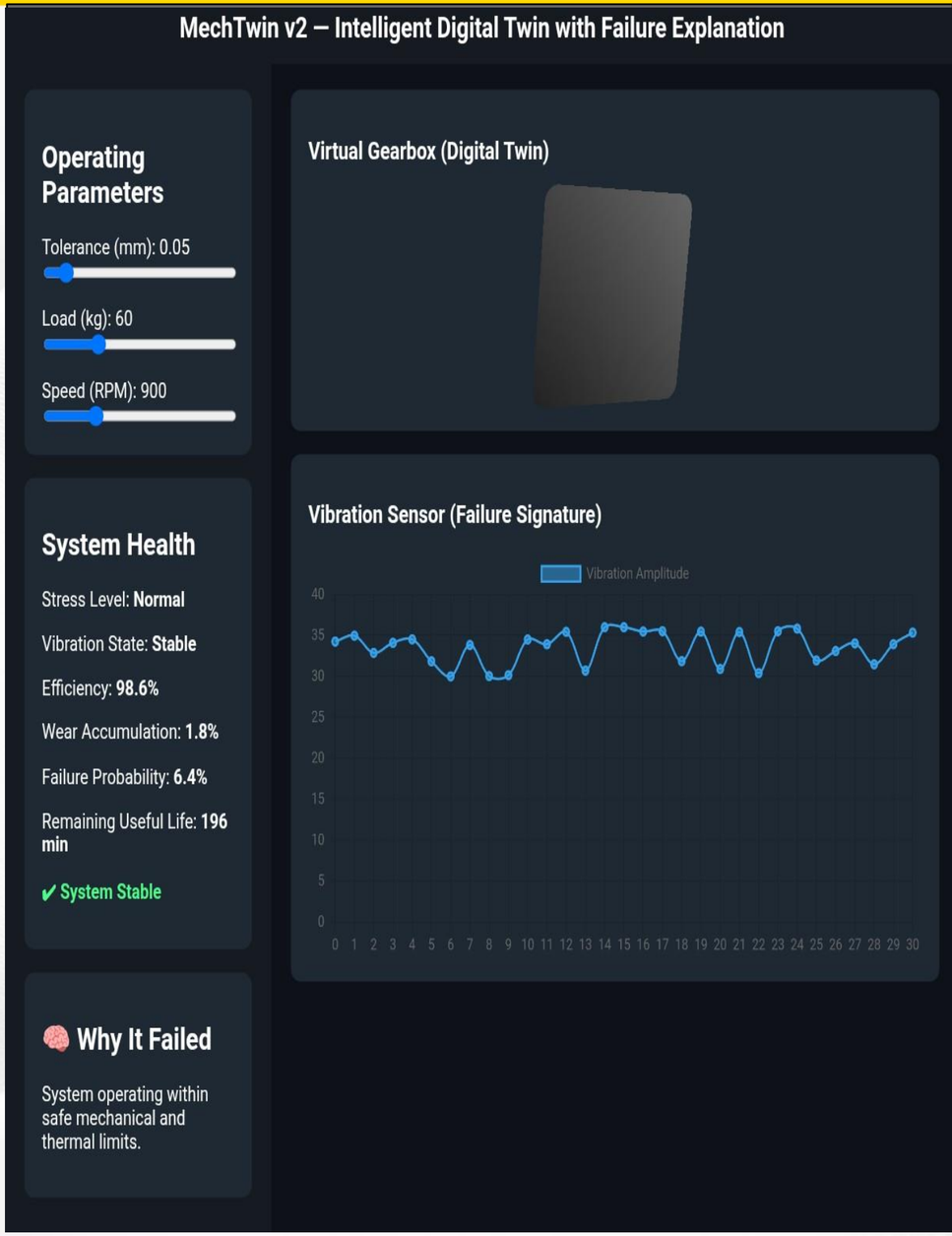
- **Technical :** Digital Twin Simulation Engine, Wear & vibration modeling, Failure prediction logic, Real-time visualization dashboard.
- **Human factors :** Decision support using RUL, failure probability, and health status
- **Constraints :** Real-time computation limitations, Simulation accuracy vs visual clarity trade-off

Final solution and innovation

❑ **Address the Problem:** Our solution uses an intelligent digital twin to continuously monitor mechanical health, predict failures early, and prevent unexpected system breakdowns.

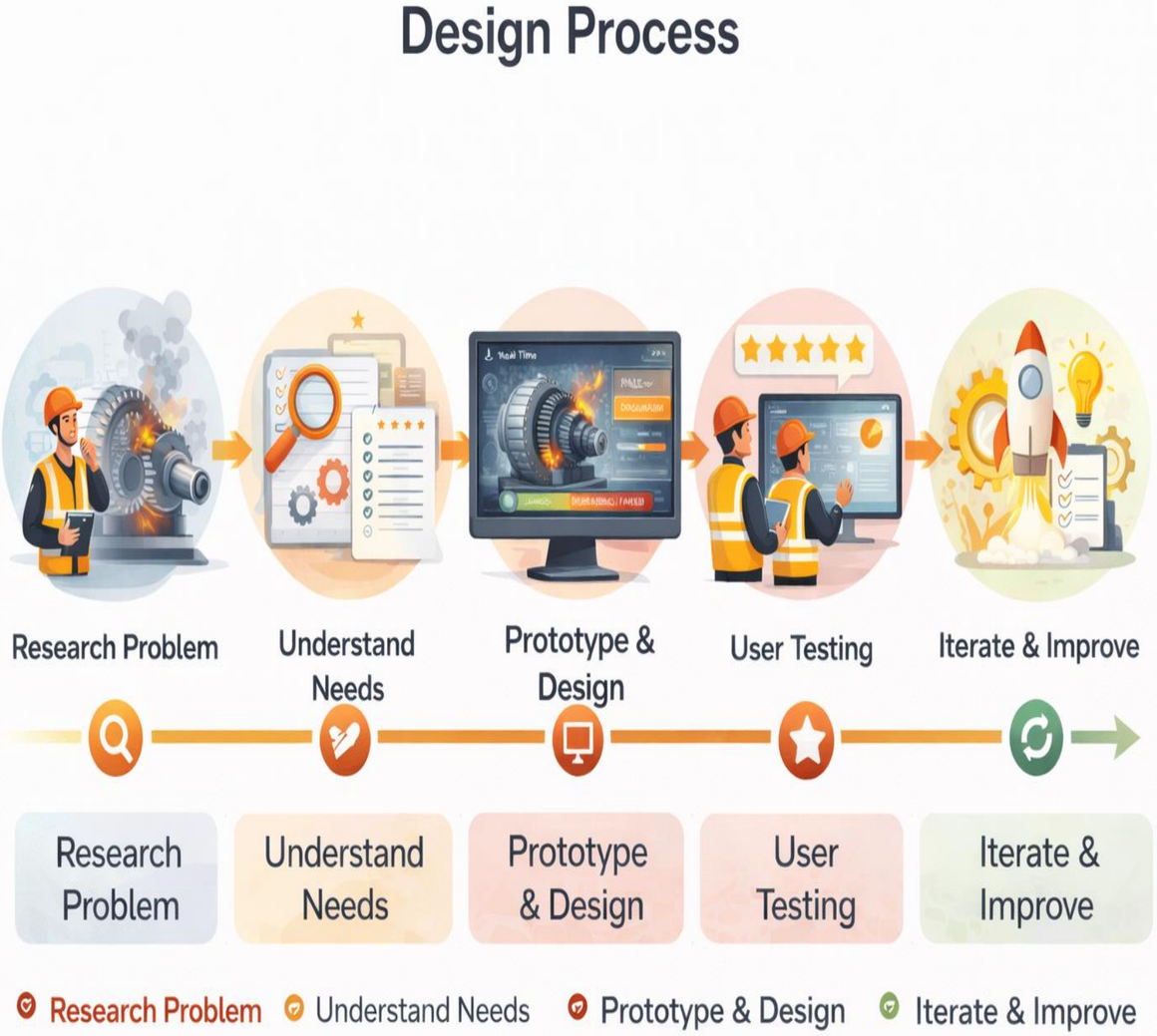
❑ **WHY IT'S INNOVATIVE:** It combines failure prediction with real-time root cause explanation, transforming complex mechanical data into human-readable intelligence.

❑ **BENEFITS:** It reduces downtime and maintenance costs while enabling safer, more reliable, and sustainable operation of mechanical systems.



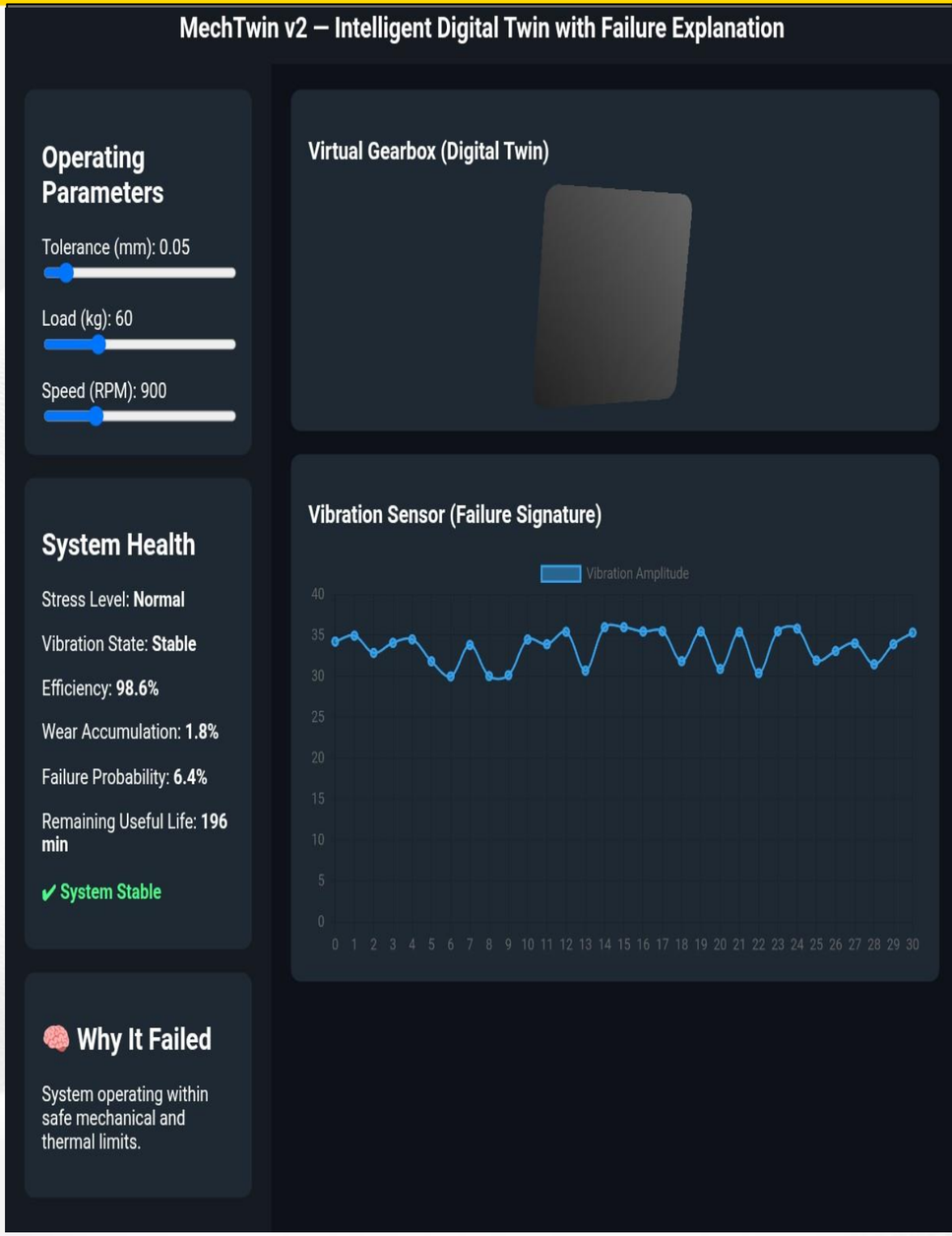
Design process

- ❑ **Research:** Uncovered critical mechanical inefficiencies and system blind spots.
- ❑ **Reframed Brief:** Shifted focus to immersive, predictive, and operator-centric simulation.
- ❑ **Ideation:** Conceptualized interactive dashboards, real-time alerts, and dynamic controls.
- ❑ **Mock-up Testing:** Validated 3D gearbox logic and user interactions for precision and realism.
- ❑ **Final Development:** Delivered a fully integrated, real-time Mech Twin with predictive analytics and immersive visualization.



SIMULATION PROCESS

Input Operating Parameters
RPM, load, and tolerance are defined to replicate real gearbox conditions.
Virtual Gearbox Creation
A digital twin of the gearbox is modeled with interconnected gears and gear ratios.
Dynamic Motion Simulation
Gear rotation is driven by RPM while load and tolerance influence contact behavior.
Real-Time System Interaction
Continuous updates simulate vibration, wear, heat, and efficiency loss.
Vibration & Stress Analysis
The system monitors vibration patterns and stress intensity under varying speeds.
Progressive Wear Accumulation
Mechanical wear increases over time based on operating severity.
Failure Threshold Detection
Critical limits trigger unsafe conditions and failure prediction.
Predictive Output & Visualization
System health, efficiency, and failure risk are displayed in real time.



SUPPLEMENT LINK

https://github.com/Deepak131205/MechTwin---Intelligent-Digital-Failure-Predictor.git

Thank you!

Acknowledgements

Industry Experts

Supporting organizations

References

Industry reports

Market analysis data

Credits

Team member

Project Coordinator