1.1 Project Description

Our project is to design a way to collect and store data involving high fatigue components on Wabash trailer coupling components to help understand the life span and highest risk actions. The absence of this data and technology has made it difficult for Wabash to accurately inform their customers of the life span of the trailers sold. The benefits of this project's completion would result in optimization of the trailer design and safer operation of the trailer.

2.1 Review of the Problem Area

The problem area that the Wabash National team highlighted the most was the lack of real-world performance information on the coupling. The Wabash National team specified that their data is exclusively from test rigs and simulations. The desire is to move past simulated high-cycle fatigue and gather actual performance data for the part of interest in operation. It was additionally specified that the data should be live/near live, and that the project can be in two parts. Part 1 being a new form of test-rig for them with fewer restrictions on forms to gather data, and part 2 is for wider application with higher barriers to entry and restrictions on what can be done.

2.2 Review of the State-of-the-Art

Current commercial and patented technologies show that there exists technology for tracking truck trailers, but none directly address the measurement of high-fatigue areas in Dry Van trailers like the Kingpin.

One current commercial product is the Nexxiot Kingpin Monitor, which is a field sensor system that detects kingpin engagement status and transmits this information via a cloud-based platform. Its design emphasizes durability with IP66/IP67 rated protection, multi-year operational battery life, and simple installation. These features are key to making a reliable product for monitoring discrete engagement events and providing fleet-level feedback.

Similarly, a patent by Saf-Holland (WO2019142137A2) describes a sort of "smart trailer system" with embedded sensors in the kingpin assembly to detect rotation, loads, and hitch engagement. This patent essentially describes the exact situation that we are attempting to figure out. This system's data collection combined with the rugged, long-term low-maintenance solution from Nexxiot would help to define a new industry standard for truck trailers.

Despite each of the individual strengths found within the commercialized product and the patent from Saf-Holland, both fall short of identifying high-fatigue regions across the kingpin. Their focus is mainly on the discrete connection of truck trailer to tractor rather than measuring and recording the structural forces acting on the kingpin. The current state-of-the-art does not provide

continuous measurements of strain, vibration, fatigue, temperature, humidity or fatigue across the connection points on the kingpin, sidewalls, floor joints, or corner posts. Also, the current state-of-the-art technologies rely on low-frequency data recordings to record data for as long as possible. A high frequency data recorder would allow for more detailed fatigue analysis for the engineering team.

These solutions do however carry valuable features that should be retained in our design solution. The rugged hardware design, wide environmental tolerance, long operational lifetimes, and simplified installation processes are foundational to ensuring that our solution remains and defines the newest state-of-the-art. The use of edge intelligence and event-triggered data reduction as demonstrated by the Nexxiot trigger engine, offers a practical model for reducing redundant data transmission while still capturing critical events. The Saf-Holland approach of embedding sensors into trailer assemblies will improve the installation process and accuracy of data recorded. To improve upon these solutions, future designs should incorporate some additional levels, such as strain gauges, accelerometers, temperature / humidity sensors, or rotary encoders on to help gather data on localized fatigue accumulation. These sensors must collect the data needed and convert them to a low-power data packet for efficient data transfer. Some sort of software interfacing must be developed to aid in data collection, transferring, and visualization. To start, the solution must be able to have a lifecycle fitting of a typical route for trucks starting and stopping at the Wabash facility.

Table 1: Comparison of Existing Solutions

Feature / Metric	Nexxiot Kingpin Monitor	Saf-Holland Patent	Relevance to "High-Fatigue Area" Measurement
Sensing Target	Kingpin engagement / hitch status	Kingpin assembly with rotation sensor & load sensing	Focused on hitch, not distributed trailer structure
Data Type	Discrete states, triggers, low-rate telemetry	Mechanical rotation, force/load at kingpin	Useful for hitch fatigue only; insufficient for fatigue mapping
Ruggedness / Lifetime	IP66/IP67, 6–10 year lifetime, energy harvesting / long battery	Mechanical housings; durability depends on implementation	Positive precedent for rugged sensors
Communication & Cloud	Connect portal, alerts, NFC pairing	Patent does not cover comms	Cloud pipeline exists in product; needed for fleet analytics
Detects Localized Fatigue	No	Partial (local mechanical sensing only)	Gap — neither provides distributed strain/fatigue analysis across Dry Van panels

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