

Eliminate Track Caused Derailments with V/TI Monitoring & Cluster Analysis

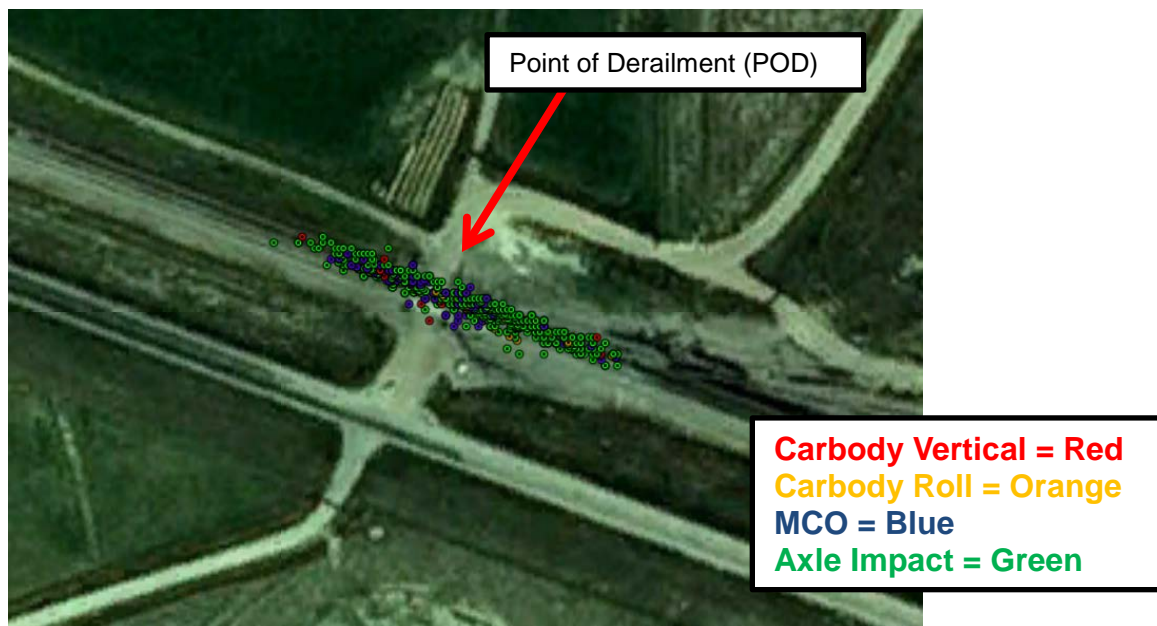


Figure 2. Investigated derailment #10 V/TI data.

ENSCO manually developed an “empirical” algorithm and fine-tuned by trial and error using the investigated derailments and known non-derailment data. This approach was utilized as compared to statistical correlation or regression data analytics mainly because there were a limited amount of training events (i.e. derailments) and the project team wanted to utilize the collective derailment subject matter expertise when evaluating the data and creating the algorithm. Using Microsoft Excel and Matlab, the algorithm was evaluated and adjusted to improve detection of the known derailments. The resulting algorithm took the following architecture:

1. Each subdivision was evaluated individually. First all the V/TI data within a given subdivision was “linearized” to the track. Meaning, the gps latitude and longitude values were converted to high fidelity milepost values. Through trial and error it was found that looking at three months of data performed the best.
2. Next a “hot spot” algorithm was built to identify cluster locations. This process looked at the density of exceptions to identify the center position of each cluster. The minimum cluster size is two exception types with two exceptions each (4 exceptions total).
3. A geo-fence query of all exception data around each cluster center is then performed. During the evaluation, it was found that a geo-fence radius of 60 feet performed the best.
4. The V/TI data deemed to be within the cluster was then evaluated by type, quantity, and locomotive speed at the time of the exception detection. This evaluation resulted in a “strength” value to be calculated for each cluster. An important aspect of the strength calculation is that older data was intentionally made “weaker” in the calculation as compared to more recent data. This was done to give greater strength to recently measured data.
5. Within a given subdivision, the strength values of all the identified clusters were ranked and normalized. This resulted in a final cluster value, which is a “normalized strength value”. Figure 3 depicts example normalized strength values of clusters within a subdivision. Interestingly, a pattern was observed from this analysis, which often times there would be a “knee” in the data with only a few high strength locations. These cluster locations that “poked their head above the crowd”, were matched to the clusters observed in the investigated derailments. These clusters were identified as High severity when they exceeded a 0.1 normalized strength value threshold.

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with more data, rather more accurate identification of risk locations. Further work is needed to understand what is the optimum coverage needed for optimum cluster algorithm performance.

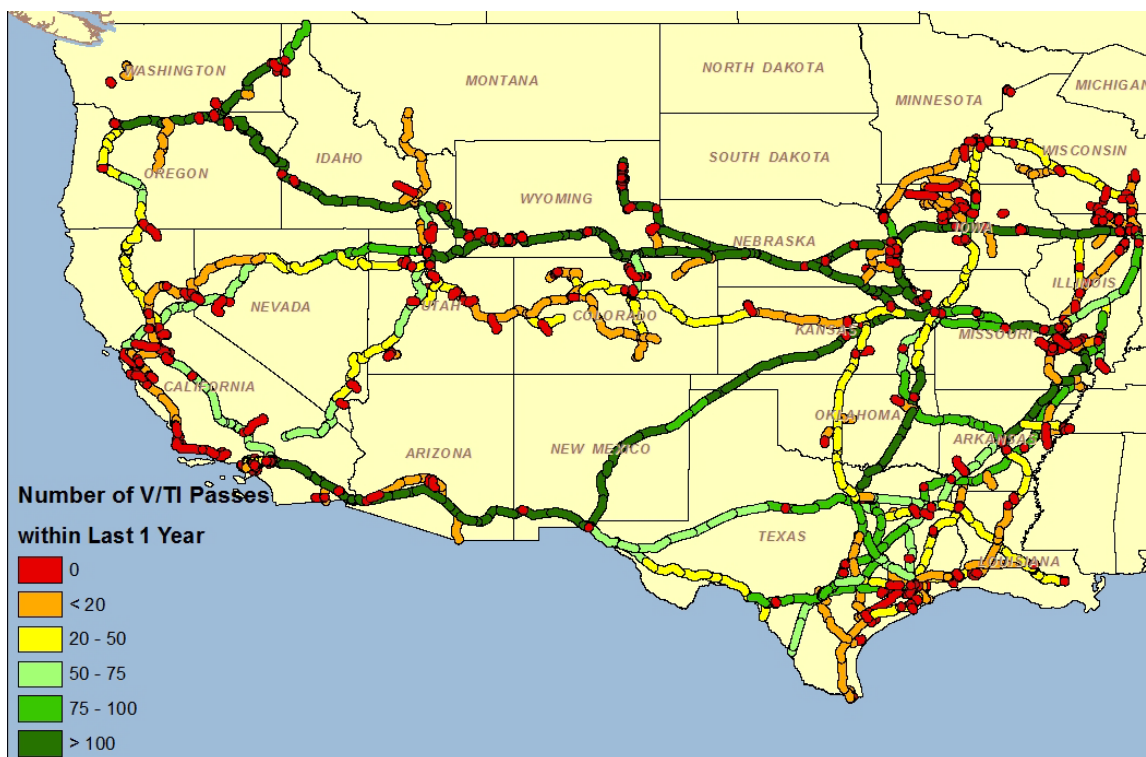


Figure 10. Union Pacific annual V/TI Monitor coverage map.

CONCLUSIONS

In summary, the V/TI Monitor Combo Cluster algorithm has been successfully implemented on Union Pacific and results indicate that it has contributed to a reduction of derailments. This algorithm marks a unique milestone in the rail industry as being the first time that a wide spread network of multiple track inspection systems have collectively identified at-risk track conditions in an automated manner.

REFERENCES

[1] D. Clark, T. Toth, "Vehicle Track Interaction ", *Proceedings of the 2006 AREMA Annual Conference*, 2006

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**For additional information on ENSCO Inc.'s V/TI Monitoring and V/TI Combo Cluster algorithm
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