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SPACE DEBRIS SYMPOSIUM (A6)  
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ORBITAL DEBRIS HAZARD INSIGHTS FROM SPACECRAFT ANOMALIES STUDIES

**Abstract**

Since the dawning of the space age space operators have been tallying spacecraft anomalies and failures then using these insights to improve the space systems and operations. As space systems improved and their lifetimes increased, the anomaly and failure modes have multiplied. Primary triggers for space anomalies and failures include space environmental effects and satellite operations. Attempts to correlate anomalies to the orbital debris environment have started as early as the mid-1990's. Early attempts showed tens of anomalies correlated well to altitudes where the cataloged debris population was the highest. However, due to the complexity of tracing debris impacts to mission anomalies, these analyses were found to be insufficient to prove causation.

After the fragmentation of the Chinese Feng-Yun satellite in 2007, it was hypothesized that the non-trackable fragments were causing anomalies in LEO would have increased significantly from this event. As a result, debris-induced anomalies should have gone up measurably in the vicinity of this breakup. Again, the analysis provided some subtle evidence of debris-induced anomalies but it was not convincing.

The continued difficulty in linking of debris flux to satellite anomalies and failures prompted the creation of a series of spacecraft anomalies and failure workshops to investigate the identified shortfalls. These gatherings have produced insights into why this process is not straightforward.

Summaries of these studies and workshops are presented and observations made about how to create solutions for anomaly attribution, especially as it relates to debris-induced spacecraft anomalies and failures.