IDA Research Summary

Orbital Debris Projects Proliferate Following Welch Award

10th Anniversary Larry D. Welch Award

IDA's Welch Award annually recognizes the best external publication by IDA researchers. This year marks the 10th anniversary of the award, named for retired U.S. Air Force General Larry D. Welch, who served as president of IDA from 1990 to 2003 and again from 2006 to 2009. This summary is the second in a series reflecting on the 10 winning publications since the award's inception in 2011. The Welch Award winner for best external publication in 2020 was "Characterizing the Orbital Debris Environment Using Satellite Perturbation Anomaly Data" by four authors from different research components of IDA's organization.

Joel Williamsen, Daniel Pechkis, Asha Balakrishnan, and Stephen Ouellette had crossed paths before in the course of their work on space-related issues for IDA's government sponsors, including the Department of Defense (DOD), the White House Office of Science and Technology Policy, the intelligence community, and NASA. What brought them together this time was their shared expertise and a proposed concept that could help fill gaps in understanding the space debris environment in low Earth orbit (LEO). To that point, much had been written about the risk that untracked orbital debris posed to the thousands of new satellites that were expected to enter into LEO from 2019 to 2021.

Independent NASA teams had found the possibility of serious errors in then-current orbital debris predictive models. At the same time, the newly formed U.S. Space Force and private companies, such as Space X, were calling for even more space assets that could suffer from or create orbital debris. It appeared that the time was ripe for studying the problem.

September 2021 NS D-22786 The team felt that a more accurate and timely manner of predicting the orbital debris environment was needed. They realized that predictions could be improved by monitoring sudden movements of the proliferating satellites themselves—movements caused by impact with tiny yet powerful orbital debris. A solution found through research could improve the orbital debris failure prediction process and help the space community get a handle on the growing risk to orbital assets.

Funding secured in 2018 through IDA's independent research program allowed the team to flesh out their concept. In 2019, they submitted a paper to the <u>First International Orbital Debris Conference</u>. Held in December 2019 in Sugar Land, Texas, the conference was organized by the Lunar and Planetary Institute, Universities Space Research Association, and NASA. The paper was published first in the <u>conference proceedings</u> and later as an <u>article</u> in Journal of Spacecraft and Rockets.

Through their research, the foursome revealed that NASA's orbital debris models could be based on overly conservative predictions of orbital debris mass, contributing to a potential overestimate of orbital debris risk to satellites in LEO. This project marked the first time Joel Williamsen led an interdisciplinary team of researchers from different parts of IDA. "I was deeply gratified both with the results and with receiving the Welch Award following its publication," he said. Williamsen noted that publicity since winning the award has prompted renewal of some professional relationships he had forged years earlier while designing orbital debris shielding for the International Space Station and other NASA spacecraft.

Before joining the project, Ouellette had for years been deeply embroiled in research on sensitive topics, the results of which were distributed solely to government sponsors. For him, the space debris research, conference paper, and subsequent <u>article</u> published in Journal of Spacecraft and Rockets allowed him to participate in public discourse on innovative solutions to issues of national and international importance, something he had been missing given the nature of his other work at IDA.

Since the paper was published, Pechkis and Balakrishnan have also been involved in IDA projects with a strong orbital debris connection. Pechkis supports the Director, Operational Test and Evaluation (DOT&E) at the Pentagon on operational effectiveness, suitability, and survivability of spacecraft and space surveillance systems, including tracking orbital debris. Balakrishnan leads a project reporting on orbital debris research needs for the Office of Science and Technology Policy.

Interest in the topic of orbital debris prompted IDA to host the <u>virtual forum</u> "Orbital Debris Risks and Challenges" in October 2020. Attendees included representatives from NASA, DOD, Department of Commerce, Federal Communications Commission, Federal Aviation Administration, and other government organizations as well as members of IDA. Some of the issues brought up during the forum are being addressed in a series of IDA Ideas podcast episodes. The <u>first episode</u> was released in April 2021.

Following the forum, the team helped to establish a new IDA project to create tools for predicting the effects of small untrackable debris, anti-satellites, and tracked satellites on the growth of the orbital debris population.



For this project, **Joel Williamsen** (jwilliam@ida.org) of the Systems and Analyses Center's Operational Evaluation Division led the team of researchers that included **Daniel Pechkis** (dpeckis@ida.org), a researcher in the Operational Evaluation Division; **Asha Balkrishnan** (abalakri@ida.org), an assistant director in the Science and Technology Policy Institute; and **Stephen Ouellette** (souellet@ida), Division Research was supported

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