

**The Orbiter Space Flight Simulator**  
Closed Loop Guidance, Navigation and Control  
Visual Situational Awareness for Instrumented Space Flight

Crosscutting Technologies Request For Information  
National Aeronautics and Space Administration  
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Thomas Lee Elifritz  
The Tsiolkovsky Group  
Madison, Wisconsin 53704

### **Executive Summary**

The **2010 Orbiter Space Flight Simulator** has set new standards in open API free software for tracking of orbital objects in space, including low orbital debris and near Earth orbit asteroids, and the physically accurate simulation and visualization, and indeed *the control* of space vehicle and mission scenarios. It has an immense value as a tool for public outreach and education, and as a generator and an engine for building an enthusiasm for science, technology, engineering and mathematics as a philosophy of living among its users. It is already well established and secure.

The fundamental problem with freeware is that it is unfunded, and thus does not always produce a level of quality and value on par with its capabilities, and the Orbiter Space Flight Simulator is no exception. The graphics engine is several generations out of date as compared to current 3-D game and cinema technology, and only has recently been deconvoluted and extracted from the physics and geometry engine. The API allows almost unlimited numerical and computational feature enhancement, capabilities which are only limited by the amount of time and funding available to write the software and the creativity of the engineers who would then use it, but as yet, the ultimate power of this approach has not been fully developed due to lack of funding. The ability to interact with the real world for command and control has only recently been added, and remains yet to be realized, by full demonstration in the real world applications of space flight.

Our working group intends to continue exploring the add on capabilities of this software system, by developing an object tracking and situational awareness system for instrumented space flight. We also intend to extend its capabilities into a laptop capable space flight avionics system for thrust vector control and pulsing, with real time, closed loop guidance, navigation and control, ultimately leading to onboard orbital trajectory optimization for vehicle launch and rendezvous. We recognize that although this software package is neither ideal, nor specifically tailored to the objectives at hand, the price is unbeatable, and it satisfies all of the basic requirements set forth in this request for information. There appear to be no technical development ‘show stoppers’ and we consider a system of this nature to be a fundamental prerequisite to commercial space flight.

## **Project Impact and Payoff**

The Orbiter Space Flight Simulator is a ‘game changing’ public outreach technology already. What we intend to do with this project is give it agency and industry wide legitimacy through demonstration, by moving it directly and swiftly into launch vehicle and mission simulation, design and optimization, and then closing the loop by actually flying the resulting scenarios.

The value of such a demonstration is that the public can not only observe this process from start to finish, they can actively participate in it through interacting with the software, demonstrating its value to science, technology, engineering and mathematics (STEM) education, by example.

## **Technology Readiness**

The 2010 edition of Orbiter has solved most of the problems that have previously prevented it from being used in parallel and distributed environments, with or without its internal graphics capabilities, and several new graphics clients are in development. It is fully expected that after the bugs have been shaken out, and this version patched, it will be ready for transition to TRL 6.

The respondent has previously proposed Orbiter as a potential foundational software package for the NASA RFI NNJ10ZHD001L – Trajectory Software for Low Earth Orbit and Beyond LEO Analysis, Design and Real Time Operations, and an extensive list of references may be found at the URL : [http://webpages.charter.net/tsiolkovsky/Orbiter\\_Space\\_Flight\\_Simulator.pdf](http://webpages.charter.net/tsiolkovsky/Orbiter_Space_Flight_Simulator.pdf)

## **Potential Partnerships**

The Orbiter Space Flight Simulator partnership base is already quite large and international, consisting of its entire open source development and user base. It is fully expected that once its utility is demonstrated directly in the Heavy Lift and Propulsion Technology Systems Analysis and Trade Studies Proposal and Contract NNM10ZDA001K, NASA, industry and commercial space contracting interests will also consider development of new extensions to this unique and distinctive integrated space flight communications, command, control and display environment.

**Risk** – The development, execution and performance risks for such a software project is low, considering its low entry costs and widespread diverse application potential and general utility. Such a system can be developed incrementally and tested in situ, with a variety of primary and secondary backups, on board the International Space Station, during normal station operations.

**Platform** – It is expected that such a system would find wide application on the ground, in all educational settings, at space ports and launch complexes, in distributed mission control facilities and operations, on board manned launch vehicles, during space station rendezvous, assembly and operations missions, and on deep space earth, orbital, lunar, asteroid and planetary rendezvous, orbit and surface landing missions. The system is particularly useful in all training applications.

**Cost** – The cost of this project is on par with other open source software development projects, defrayed by the freeware nature of the software and its various extension applications and addon modules, and the willingness of people to actively participate in its development and operations.