JSC Photo 98E07632 by Mark Sowa

A team of JSC employees from the Aeroscience & Flight Mechanics Division, working in coordination with employees from LinCom Corp., has developed a new software tool to analyze space flight trajectories for rendezvous and proximity operations. Team members are (left to right) Jada Davidson, Zack Cruz, David Strack, Eric V. Mitchell, Scott Cryan and Allan DuPont.

JSC team develops new 'OUTLOOK' for rendezvous analysis

A team consisting of members of JSC's Aeroscience & Flight Mechanics Division in the Engineering Directorate and employees from LinCom Corp. has developed a newly integrated software simulation called OUTLOOK. The team is excited to have this newly integrated capability to analyze space flight trajectories for rendezvous and proximity operations scenarios with either the Earth, Moon, or Mars as a central body; develop necessary requirements and budgets for either targeted or piloted maneuvers and timelines, and display simulation results using state-of-the-art, high-speed realistic wall screen graphics – like "Star Wars" only in slow motion.

OUTLOOK was created using a software development environment called TRICK developed by the Automation and Robotics Division. This environment allows engineers to create models for a new vehicle in a very short period of time. The main portion of the simulation came from development work previously done for the Automated Transfer Vehicle rendezvous predevelopment task, a NASA/ European Space Agency task to compare simulations of the European space vehicle, and more recently from work performed for the International Space Station Rendezvous/Proximity Operations and Capture (RPOC) support task. This latter task provides the ISS Program with oversight into the RPOC aspects of vehicles that will fly to or about the ISS (excluding the shuttle). Vehicles such as the European Automated Transfer Vehicle, the Japanese H-II Transfer Vehicle and the Crew Return Vehicle are currently being evaluated.

"The extra feature of OUTLOOK is its ability to allow a user to create a large-screen visualization of the rendezvous and proximity operations trajectories for actual or proposed vehicles," said Eric Von Mitchell, an engineer in NASA's Advanced Mission Design Branch. In addition, OUTLOOK allows users to create a customized basic simulation in a short period of time.

When members of the Aeroscience and Flight Mechanics Division were asked to design reference missions for the Autonomous Extravehicular Robotic Camera (AERCam), the RPOC task manager in the Advanced Mission Design Branch, Al DuPont, stated that the "basic trajectory simulation already existed, and it was a reasonable effort to provide the simulation software with minimal modifications for the AERCam work."

LinCom employees Scott Cryan, Zack Cruz and David Strack were able to spend a portion of their time to ensure that a useable simulation was ported to the Aeroscience and Flight Mechanics Division's Flight Mechanics Lab. Advanced Mission Design Branch engineers Robert Merriam and Mitchell used the simulation to develop early reference missions and maneuver budgets for AERCam. Mitchell had the vision to link many software capabilities into one simulation. The integrated result is a realistic 3-D visualization of the analysis scenarios on a large screen in the Flight Mechanics Lab.

Cooperation and Teamwork

The need to have a simulation to conduct a recent task in support of AERCam and the knowledge that segments of an existing TRICK-based simulation could be used blended well with the realization that this new simulation capability would provide support to several branch and division goals. Although Mitchell provided the vision of linking several software capabilities into one simulation, "actually several people were involved in ensuring that the simulation integration was satisfactory," he said.

Three employees in the Simulation and Graphics Branch in the Automation, Robotics, and Simulation Division were involved in the project. Charles Gott gave his permission for a copy of the TRICK software development environment to be available in the Flight Mechanics Laboratory. Next, because the appropriate visual graphics of the ISS were needed to interact with OUTLOOK, Sharon Goza obtained permission for the graphics software package called ENIGMA and the appropriate vehicle models to be available in the laboratory. ENIGMA's compatibility with the TRICK software development environment was also aided by Duane Johnson and his previous work to convert the Tree Display Manager to be TRICK compatible as well as his work with a software development effort called Replay. Replay allows OUTLOOK users to save analysis data into a file and "replay" the trajectory scenario with visual models. The Replay visualization of analysis scenarios may be played at actual speed or faster.

Merriam and Pete Cuthbert, engineers in the Advanced Mission Design Branch, provided assistance to enable the full display of simulation results. Merriam was involved in setting up simulation runs, developing ISS/AERCam targeting output data, and creating new plotting formats. Cuthbert assisted in obtaining the capability to show simulation results on the wall screen.

Jada Davidson and Rick Rohan of Lockheed Martin created user accounts and kept the laboratory and all of its computers up and running.

Products and Results

"Having this capability to perform analyses across a broad spectrum of projects and vehicles is very much needed and welcomed," said Aldo Bordano, chief of the Aeroscience & Flight Mechanics Division.

This new simulation provides engineers with the capability to set up analysis cases, make analysis runs via batch mode or by using a pilot-in-the-loop, and produce some preliminary results in a day or two. Some of the products expected from this simulation will be vehicle total delta-velocity, vehicle propellant consumption, chaser trajectory relative to target, target and chaser vehicle inertial position and velocity vectors, relative navigation data, and a host of other variables that can be plotted for specific analysis needs.

Since the simulation easily accommodates new vehicles, it may be applied to the ISS Program and to JSC's role in the Human Exploration and Development of Space missions. The capability of the simulation to use high-energy, elliptical Earth orbits is much needed as is its appropriateness for lunar or Mars applications.

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Eric V. Mitchell, an analysis pilot, performs proximity operations for the International Space Station and AERCam.

Additional Simulation Use

Created as an engineering tool, OUTLOOK may also be useful as a rendezvous and proximity operations tool for other areas within JSC. Since scenarios can be "flown" by analysis pilots or even by members of the crew, the simulation may be used by any JSC area interested in obtaining analysis results early in a program. Future applications could include automated rendezvous and proximity operations planning for unpiloted vehicles.

Close

"It's true that other simulations were previously created for rendezvous and proximity operations." said Mitchell, who was task manager and helped develop a similar simulation called the GenEric Vehicle Simulator a few years ago. Since that time, he has pressed for an update of that capability. "The real selling point of OUTLOOK is its ability to allow a user to conduct analysis and create an analytical and visual depiction of the results as they apply to rendezvous and proximity operations trajectories for the development of space."

The creation of OUTLOOK demonstrates what can be achieved though hard work and cooperation.

"A number of people have influenced and inspired me throughout my career, including Sam Wilson of TRW and NASA, the late Ed Lineberry of NASA and Blair Nader, also with NASA in the Cargo Integration and Operations Branch – to name just a few," said Mitchell. "But I think that the most important lesson that I've learned here is to try to keep good relationships with all the folks who I meet and work with and never burn any bridges." ■