



FreeFlyer
by a.i. solutions



ANALYSIS SOFTWARE
FOR SPACECRAFT
MISSION DESIGN

www.ai-solutions.com



A SINGLE COMPREHENSIVE TOOL

FreeFlyer® is a single, integrated COTS tool that supports the entire mission lifecycle. Initially released in 1997, FreeFlyer stands out as the most comprehensive, flexible, and powerful mission analysis and design tool on the desktop today. Developed by a.i. solutions, FreeFlyer has successfully supported ten years of NASA, NOAA, Military and DoD missions. Its superior analytical abilities are designed to solve problems—any problem. In fact, it is so adaptable and powerful that its problem-solving ability is virtually limitless. Plus, it is totally scalable to fit any requirement or budget. Three versions of the product are available:

FreeFlyer® Design™

FreeFlyer Design is the perfect analysis tool for mission concept development and preliminary design. It allows users to quickly and accurately define trade spaces for optimum mission profiles. Tasks such as optimum orbit design, ground station location and coverage times, propulsion system sizing and sensor modeling can be performed quickly and easily.

FreeFlyer® Engineer™

FreeFlyer Engineer provides comprehensive mission analysis and design functionality. It gives the user more flexibility, more integrators, more complex sensor and antenna modeling, and more precise propulsion system modeling. Its full-featured scripting language allows users to implement even the most complex logic for mission-unique analyses. No recompiling. No pricey add-on modules.

FreeFlyer® Mission™

FreeFlyer Mission is the most advanced turnkey mission design product on the market today, providing the ultimate in complete spacecraft mission design and operations functionality. From automation to orbit determination to seamlessly integrating with any ground system or other third-party software; FreeFlyer Mission's flight-proven heritage makes it the best tool available for total mission design.

EXPERT TECHNICAL SUPPORT

Our customers demand exceptional support. That is why our team is staffed only by experienced engineers. a.i. solutions' aerospace engineers use FreeFlyer everyday for space mission analysis and design, providing real solutions to real mission problems. Through our training courses, on-line help, web-accessible library and knowledgeable staff, we are committed to the success of your mission.

COMPATIBILITY AND INTEROPERABILITY

FreeFlyer comes standard with resident out-of-the-box interfaces, enabling users to expand functionality by easily integrating with other applications.

- FreeFlyer's Database Interface allows connectivity to any Structured Query Language (SQL) Database.
- The easy to use MATLAB® Interface allows streamlined communications between MATLAB and FreeFlyer.
- A resident TCP/IP Socket Interface allows for straightforward data exchange with other computers.
- Users can run external applications from FreeFlyer such as Perl scripts, VB/Excel or other custom applications.

FreeFlyer's compatibility is unparalleled, allowing the customer to choose the best total software solution for their mission.

FREEFLYER WILL IMPROVE YOUR BOTTOM LINE THROUGH:

- Comprehensive Analysis In a Single Tool
- Proven Accuracy to Safeguard Mission Success
- Customer-Centric Technical Support
- Complete Mission Design Functionality
- Interoperability with other Tools
- More Power for Better Solutions

SYSTEM REQUIREMENTS

Minimum

- Microsoft Windows 2000 or newer
- CD-ROM drive (for installation)
- 1 GHz Processor speed or faster
- 150 MB Hard Disk Space
- 256 MB RAM (512 MB if more than 10 satellites are modeled)
- 32 MB Video Memory

Recommended

- Microsoft Windows 2000 or newer
- CD-ROM drive (for installation)
- 2 GHz Processor speed or faster
- 150 MB Hard Disk Space or greater
- 1 GB RAM or more
- 64 MB accelerated graphics card or better



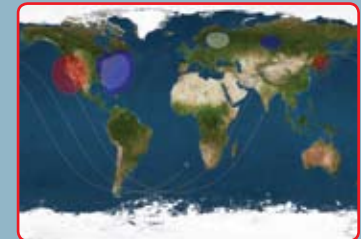
VERSATILITY

FreeFlyer[®]'s versatility is matched by its proven ability to accurately model flight scenarios. From basic coverage analysis to high-fidelity propagation and complex trajectory design, FreeFlyer's accuracy and dependability are demonstrated every day on every mission that it supports.

HERE ARE JUST A FEW OF *FreeFlyer*[®]'s KEY FEATURES:

Coverage and Visibility Analysis

Access and coverage data (AOS/LOS times, durations, angles, distances, rates) can be computed and displayed in real-time for inter-visibility access between any objects or groups of objects. Each access calculation can be constrained using field of view constraints such as sensor obscurations, antenna exclusions or ground station masking. Revisit statistics, percent coverage and sun/shadow times are all easily and rapidly calculated, displayed and reported. Complex sensor and antenna fields of view are easily modeled.



Coverage Analysis

2D & 3D Visualization

FreeFlyer comes complete with a powerful 2D and 3D visualization environment for displaying data in real-time. It provides an intuitive and user-interactive view of all simulation objects. Items such as orbit geometry, spacecraft position and attitude, sensor projections, ground stations and their associated masks and ground area targets are all available for viewing. Each view can be preset to user-defined viewpoints or changed in real-time by interactive user panels. FreeFlyer supports unlimited window tiling to allow multiple views of the same problem from different perspectives—all updated in real-time.



3D Visualization

Orbit/Trajectory Computations

FreeFlyer employs a dynamic computational engine, thereby giving users real-time results to over 150 pre-defined orbit/trajectory computations and unlimited user-defined variables. Plots, reports and 3D graphics are dynamically updated at each integration step, and because FreeFlyer is not batch-processed, users can pause at any point to evaluate data.



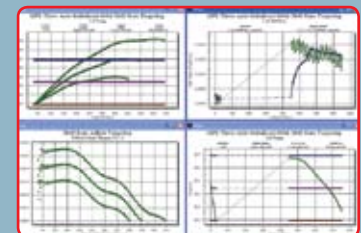
Mission Design

Reporting & Plotting

FreeFlyer allows unlimited customizable reports and plots to be generated on any data calculated. With over 1,300 pre-defined parameters available plus unlimited user-defined variables, the data reporting and plotting capabilities are infinite.

Maneuver Analysis, Planning & Calibration

FreeFlyer supports high-precision modeling and analysis for maneuver and ascent planning, optimization and calibration. FreeFlyer enables users to build precise models of spacecraft propulsion systems through its robust tank and thruster models. Targeting is accomplished via a rigorous differential corrector.



Maneuver Planning

Customizable User Interface

A customizable user-interface allows users to create mission-specific dialogs or bypass the GUI entirely by use of a command line interface.



FreeFlyer

FEATURES OVERVIEW

OUTPUT/VISUALIZATION

	DESIGN	ENGINEER	MISSION
Full 2D and 3D visualization with customizable view points	■	■	■
Customizable view points		■	■
Custom/user defined XY plots, polar plots	■	■	■
Custom/user defined ASCII reports	■	■	■
Monitor window for "strip chart" type data	■	■	■
Watch window for real-time constraint checking		■	■
Over 1300 parameters available for reporting and plotting	■	■	■
Ground station masking and sensor swaths	■	■	■
3D control box for station keeping/relative motion visualization		■	■

SPACECRAFT MODELING

Full mass properties definition	■	■	■
Sensors (see sensor features for more information)	■	■	■
Tanks (spherical, interpolated, or electrical)		■	■
Thrusters (mono-propellant, bi-propellant)		■	■
Antennas (conical FOV)	■	■	■
Antennas (irregular polygon FOV, obscuration masking)	■	■	■
Transceivers			■
Collision avoidance calculations (Proximity Zones)		■	■
Multi-spacecraft	■	■	■
Formation modeling		■	■

SENSORS

Simple conic	■	■	■
Complex conic, irregular polygon, rectangular	■	■	■
Obscuration masking	■	■	■
Scanning sensor		■	■
Custom/user-defined sensor patterns		■	■

ATTITUDE

LVLH (nadir pointing with orbit-normal constraint), Mean of J2000 Earth Equator, Geodetic (geodetic pointing with orbit-normal constraint)	■	■	■
User defined / Custom Coordinate Systems		■	■
Euler angles	■	■	■
Quaternion, Attitude matrix, Spinner	■	■	■
Target pointing attitude		■	■
Attitude history file (AHF)	■	■	■

MANEUVERS

Impulsive maneuvers	■	■	■
Finite maneuvers		■	■
Maneuver targeting/optimization	■	■	■

ORBIT PROPAGATION

Fixed or Variable Step (step size is user definable)	■	■	■
Runge Kutta 4(5), VOP, Two Body, NORAD/SGP4	■	■	■
Runge Kutta 7(8), 8(9), Bulirsch Stoer, J2 Mean Elements		■	■
Use Air Force Space Command supplied SP & SGP4 DLL			■
Planetary ephemeris (DE200 or DE405)	■	■	■
SPICE ephemeris		■	■
Atmospheric drag/lift, Solar radiation pressure	■	■	■
Atmospheric density – Analytic	■	■	■
Atmospheric density – Jacchia Roberts, Harris Priestler		■	■
Earth potential & Moon potential up to 100x100	■	■	■
NORAD two line elements, FreeFlyer ephemeris/state, STK ephemeris/state	■	■	■
User-defined ephemeris/state			■

ORBIT CALCULATIONS

Over 150 orbit/trajectory parameters calculated at each integration step	■	■	■
Unlimited user defined parameters using embedded math libraries or MATLAB connection		■	■
Dynamic real-time feedback available during each run	■	■	■

GROUND STATION MODELING

User defined location and masking or read from geodetics file	■	■	■
Station bias parameters			■
Station antenna parameters			■
Ground Network Modeling		■	■



VISIBILITY/ACCESS ANALYSIS

	DESIGN	ENGINEER	MISSION
Visibility period calculations between any objects (s/c to s/c, s/c to ground station, s/c to ground region, etc.)	■	■	■
Field of view, elevation angle, azimuth angle, range & range rate	■	■	■
Solar and lunar constraints /Lighting constraints / Beta angle constraints	■	■	■
Temporal constraints (interval, duration, GMT, mean local time)	■	■	■
Cross track, along track, range, and all associated rates	■	■	■
AOS/LOS	■	■	■
Sensor to sensor, sensor to s/c, sensor to ground station constraints	■	■	■
Sensor tracking		■	■
Magnetic field regions	■	■	■
Celestial object interference (all planets & star catalog)		■	■
Rapid performance coverage analysis for coverage and revisit statistics		■	■
Rapid performance close approach analysis		■	■

LOGIC CONTROL

Logic engine to control actions based on any calculated parameter	■	■	■
Full-featured Scripting Language		■	■
For, If , While, Pause, Stop, Achieve, Target, Vary commands	■	■	■
Fuzzy logic engine for conflicting constraint resolution		■	■

ORBIT DETERMINATION

Extended Kalman Filter, Batch Least Squares			■
Orbit Determination error analysis			■
Tracking Data filtering			■
Ground based range/ range rate/ azimuth/ elevation tracking data			■
TDRS tracking two-way range/ two-way Doppler tracking data			■
GPS tracking data			■
Spacecraft X, Y, Z, Vx, Vy, Vz, Cd, Cr, Transponder delay Solve-fors			■
Ground station location, antenna bias Solve-fors			■

COORDINATE SYSTEM TYPES

Mean of J2000 Earth Equator/Earth Ecliptic, True of Date Earth Equator, NORAD	■	■	■
Launch Vehicle Coordinates (user definable to ELV vendor specs)	■	■	■
Cartesian, Keplerian/nonsingular Keplerian, Spherical/Spherical Lat/Long	■	■	■
True Equator Mean Equinox, Equinoctial, Brouwer-Lyddane Mean/ J2 Brouwer-Lyddane, Mean of 1950		■	■
Conversion functions to convert between systems		■	■
User defined / Custom Coordinate System		■	■

EXTERNAL INTERFACES

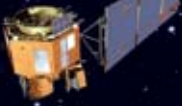
MATLAB interface		■	■
TCP/IP socket interface			■
SQL 92 database compliant interface			■
Run command to spawn external applications			■
Customizable graphic user interface (GUI)			■
Generic ASCII & Binary File Reader			■
Links to external code			■
Automatic e-mail notification based on user defined rules			■

USABILITY/USER INTERFACE

Drag & Drop Mission Design Sequence	■	■	■
Wizards and samples for quick problem set up	■	■	■
Ephemeris browser and compare utilities	■	■	■
Batch run/Command Line capability		■	■
Fuzzy set designer for fuzzy logic problem set-up		■	■

MISCELLANEOUS

Independently validated and verified	■	■	■
On-line help files with context sensitive searching	■	■	■
Automated parametric studies	■	■	■
Monte-Carlo analysis		■	■
Unlimited window tiling output for dynamic user feedback	■	■	■
Any parameter can be set/reset real-time during runs		■	■



Full-Featured Scripting Language

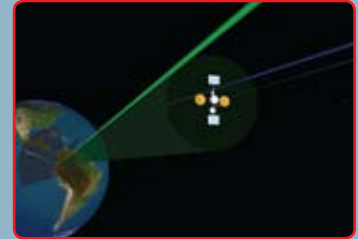
FreeFlyer's natural scripting language allows maximum flexibility for problem setup, control law implementation and product customization. Employing common logic commands such as For, If, Then, Else, While, FreeFlyer's easy-to-use scripting language allows users to write their own equations, define their own variables for reporting and plotting and implement even the most complex control laws. With the scripting language, the product functionality is limited only by the user's imagination.

Collision Avoidance/Conjunction Analysis

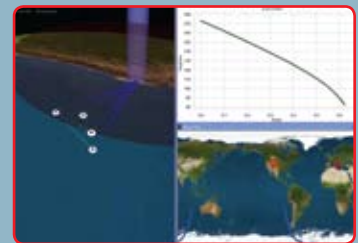
FreeFlyer handily performs conjunction analysis. Using orbit determination data and predicted miss distances, FreeFlyer can be configured to evaluate close approaches and assess the probability of collision. NASA uses FreeFlyer everyday for its Earth Science Constellation to mitigate the risks and uncertainties associated with collision avoidance.

Formation Flying

FreeFlyer's Formation functionality allows for straightforward creation and management of a collection of spacecraft which can be modeled as a constellation or a close formation. Simple to complex relative motion can be modeled to determine how the various member spacecraft move relative to each other.



Advanced Coverage Analysis



Conjunction Analysis with Formation



At a.i. solutions, our corporate commitment is to develop and deploy the best solutions for space mission planning and design. Whether it's software, services or technical support, our expertise always shows through.

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