

## Interactive Mission Design Web Site

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### ABSTRACT

The Access To Space (ATS) Group at NASA's Goddard Space Flight Center (GSFC) supports the science and technology community by facilitating frequent and affordable opportunities for access to space. The ATS Group has developed an interactive Mission Design web site that provides both the information and the tools necessary to assist mission planners in selecting and planning their ride to space. The ATS web site was developed through core partnerships with other government agencies seeking similar tools for their mission planners. Key design features of the site include a searchable mission database and launch vehicle toolboxes. The mission database contains a listing of missions ranging from proposed missions to manifested missions allowing users to interactively search for potential partnering opportunities. Missions can be added to the database by the user community through data input tools. The launch vehicle toolbox section provides the user with a full range of information on vehicle classes and individual configurations. This section has been enhanced to include additional access modes such as RLVs, ultra long duration balloons, sub-orbital rockets, Space Shuttle carriers, and spacecraft buses. Use of the ATS web site has climbed 400% in the last six months indicating widespread usage across the mission planning community.

## 1. INTRODUCTION

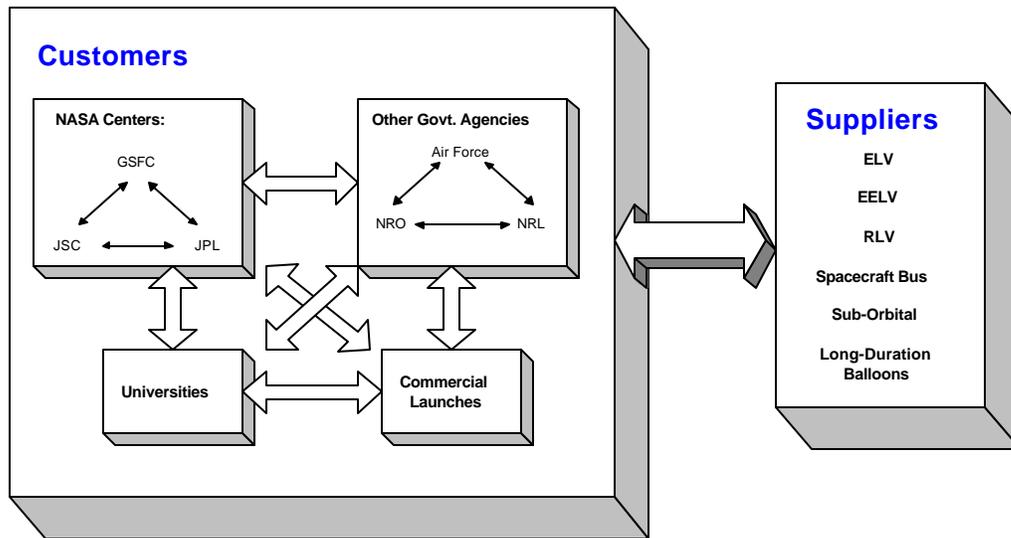
Reducing the cost of access to space continues to challenge mission planners. The ATS Group has addressed this challenge by implementing an interactive web site that provides the information and the tools necessary to assist mission planners in selecting and planning their ride to space. This web application has become an integral part of the planning process for mission designers to assess key issues such as the evaluation of single payloads versus ride-sharing; instrument pairing on a single bus; and trade studies between all access modes (ELV, RLV, Shuttle, sub-orbital rockets, and long-duration balloons).

Mission planners must have timely access to up-to-date information that will enable decisions that minimize the cost of access to space. The ATS web site facilitates the exchange of information between mission planners and access mode suppliers, thus affording more efficient use of access modes and ride opportunities. The ATS Group at NASA's Goddard Space Flight Center, in partnership with NRO OSL, has served as the prime architect for the development of this knowledge base.

## 2.0 MISSION DESIGN CHALLENGE

A significant roadblock working against complimentary missions is a lack of communication across the industry, often because the opportunities and contacts are not known. In addition, the high cost of access to space continues to plague space projects. Mission planners struggle daily attempting to solve this problem. Compounding this problem is a trend in the reduction of mission cycles and, for Government payloads, a trend towards smaller missions with shorter life cycles. Today's mission planners need timely access to information that can help them establish a baseline access mode trade space. Prior to the development of the ATS web site, there was no single location for acquiring or sharing access mode related information that encompassed: ride share opportunities, technical and programmatic access tools, process and technology changes, and industry/government points of contact.

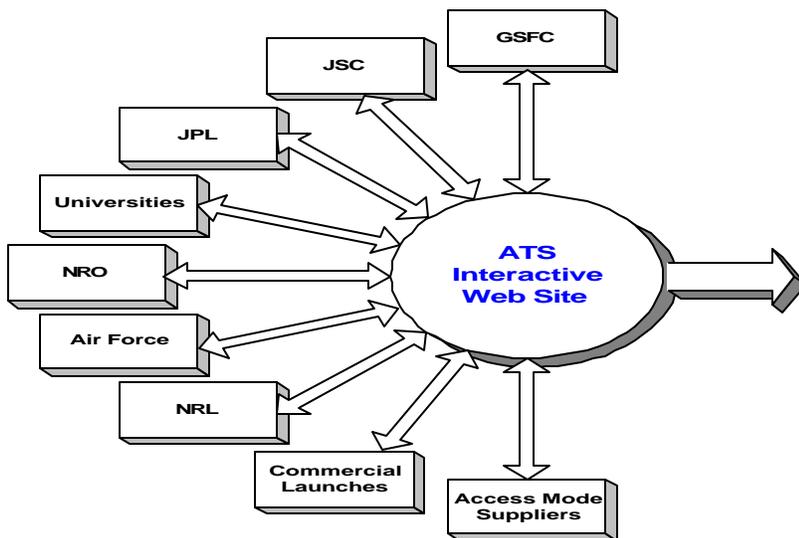
Typical communication of such information was by word-of-mouth or through evaluation of multiple sources of information as shown in Figure 1 below.



**Figure 1.** Traditional Communication Process for Access to Space Information

The communication routes in Fig. 1 are inefficient and cannot meet the demands of current mission development cycles. In addition, they do not support the cost savings required for today's missions. A solution is needed to provide the information quickly and easily to reduce access to space costs across the global space community. The ATS web site

incorporates a portal concept (Fig. 2) allowing mission planners to access a common knowledge base to evaluate missions and access mode information. This capability provides a forum for partnering and sharing of information, thus reducing access mode costs.



- Partnerships
- Access Mode Selection
- Reduction in Cost

**Figure 2.** New Communication Process for Access to Space Information

The NASA GSFC ATS Group, in partnership with other government agencies, has helped solved this communication problem by developing an interactive web site that uses cutting-edge technology to host all access related information in a single location. This site is used by NASA, NRO, Air Force, other government agencies, universities, commercial industry, and the global space community to maintain a focused knowledge base facilitating alliances and reduced access mode costs.

The interactive web site is the central location for proposed/planned mission information as well as access mode information. Each group shown in Figure 2 contains both customers and suppliers of data to the system. The site tools facilitate ride-sharing, co-manifest selections, instrument pairings on a single bus, and access mode investigations.

This system fills the gap by providing customers and suppliers a tool to communicate both the needs and opportunities available throughout the industry, including direct contact information. Additionally, the tools provided assist planners in identifying ride-sharing/matching opportunities and performing access mode trade space studies. This tool also assists both principal investigators and mission brokers in identifying and pairing missions to eliminate all unused vehicle volume and performance. Evidence of this change in the planning process is already occurring. In the latest Small Explorers (SMEX) Announcement of Opportunity release by NASA, the Access To Space site was listed as a reference to be utilized in formulating the access to space plan. Additionally, the Air Force's Space Test Program listed numerous missions on the web site to be referenced as part of a proposal submission.

Continued support and improvement of this innovative approach to mission planning challenges also meets the NRO/OSL Advanced Programs

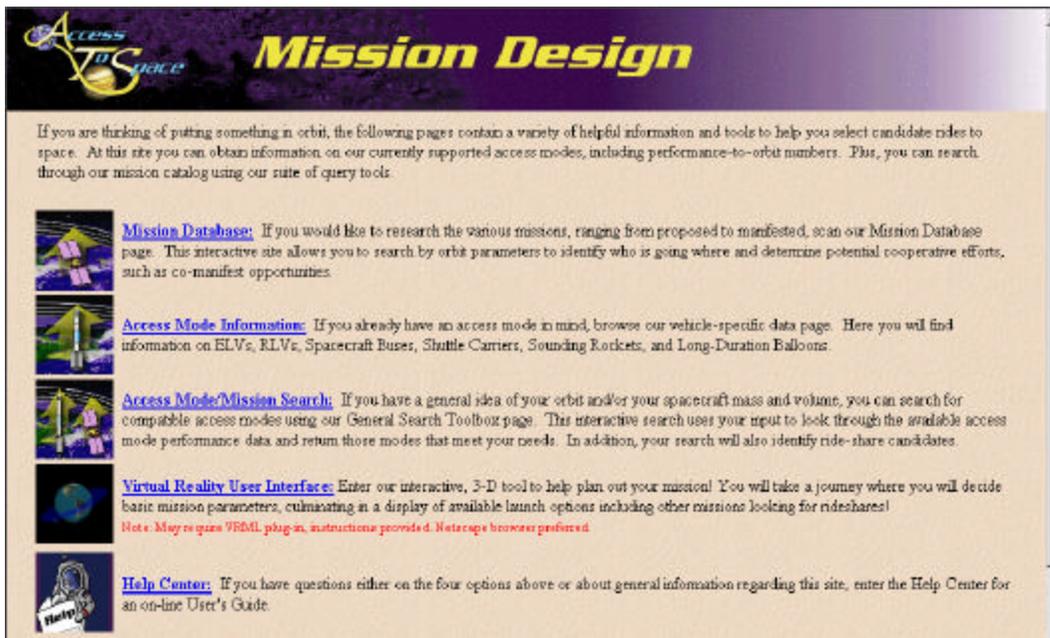
Division's goals. The Access To Space web site presents a central area where both customer and supplier information and needs are shared, thus fostering value-added partnerships. This system is a focused knowledge base where mission planners can access the tools and information to perform access to space trade studies and to identify ride-sharing opportunities.

### **3.0 KEY WEB SITE TOOLS**

The ATS web site portal contains links to access mode technology sites (Tech Space) and manifest/vendor/education sites (Jump Space) giving mission planners access to pertinent information for evaluating future missions. These "link" tools serve to frame the centerpiece of the ATS site which is the Mission Design section. The mission design section currently contains four main tools including: a mission database, access mode toolboxes, a hybrid search, and a 3D virtual reality interface.

Entering the Mission Design section from the ATS home page, you will pass through a login/registration page. You may bypass this page and enter the site as a guest. Registering is the preferred method of entry as it allows the ATS Group to better understand the user community and their needs. In addition, expanded services are provided for registered users. For example, registered users will receive weekly auto-notices of missions that have been added or updated in the mission opportunities database. Registered users will also receive any 'hot-news items', such as ride-share deadlines and Announcements of Opportunities.

Once you have logged in or entered as a guest, you will come to the Mission Design Home Page shown in Figure 3.



**Figure 3.** Mission Design Home Page

### 3.1 Mission Opportunities Database

The mission opportunities database contains a listing of missions containing available space and missions looking for available space. The missions are in various stages of design, ranging from future concepts to manifested launches. The mission types in the database include instruments, spacecraft, and launches. The ride-share opportunities listed include spacecraft bus opportunities and launch opportunities. This database is fully searchable

allowing mission planners to query the database to identify potential ride-sharing candidates by selecting one of the five query options described in Table 1. After selecting one of the five queries described above, a query input panel will appear in the main section of your screen. The data inputs, or filters, are a combination of fill-in fields, pull-down boxes (select from a list), checklist boxes (can check more than one option), and radio buttons (can select only one option). The pull-down lists and checklist boxes default to 'All'. The fill-in fields are initially blank and you only need to fill in the data of interest.

| Query                  | Goal  | Filter Parameters   |
|------------------------|---|---|
| View by Mission Type   | Identify missions by their type and/or sponsor  | Mission Type<br>Mission Sponsor   |
| General Orbit Search   | Identify missions going to a particular orbit in a specified time frame.  | Orbit Information<br>Launch Dates<br>Mass Range   |
| View By Mission Status | Identifies missions by their ride-share status (opportunities available, looking for a ride, etc.)  | Mission Status  |
| Find Mission Matches   | Identifies missions offering opportunities that meet you conditions. Also returns missions looking for a ride to your orbit that may be interested in partnering. | Mission Sponsor<br>Opportunity Type<br>Orbit Information<br>Launch Dates<br>Mass Availability |
| Custom Query           | Catch-all category with all filter parameters   | Mission Type<br>Mission Sponsor<br>Orbit Information<br>Launch Dates<br>Mass Range            |

**Table 1.** Mission Database Queries

For example, a user interested in finding all missions within the altitudes of 500-1000 km, regardless of inclination, would click the LEO orbit class and fill in the ranges for apogee and perigee leaving inclination blank. The query statement would read "Return the missions with apogee between 500-1000 km and perigee between 500-1000 km."

Once all the fields of interest have been filled, a sort option can be selected for the results. These options vary depending on the query being executed, but generally consist of options to sort by alphabetical order, launch date, mission type, or mission sponsor.

Clicking 'submit' sends the request to the database. The results are returned as a table with the mission name and a small subset of pertinent mission parameters. To view the full mission details, one simply clicks on the mission name in the results table and a details page appears in the main area.

The details page is divided into sections, but is one file. You may scroll down through the page or click on the blue links near the top of the page that will jump directly to the section in the page. The detailed information contained on the missions may include: orbit information, spacecraft/instrument characteristics, ride-sharing opportunities, attitude, command and data handling, launch vehicle information, miscellaneous notes, and contact information.

Anyone planning a mission who would like to get their information into the Mission Database needs only to send a request to the ATS group using the 'Contact ATS' link found on most pages. A mission questionnaire will be sent electronically the same day as the request is received.

The data will be added to the database once the filled out questionnaire is received by the ATS Group. Every few months, the submitter must also provide mission updates or a verification that the data has not changed since the last update.

For those with the need to enter/maintain multiple missions, authorization access can be upgraded permitting the addition and editing of missions using

the site's on-line database administration tools that interact with the database from your web browser.

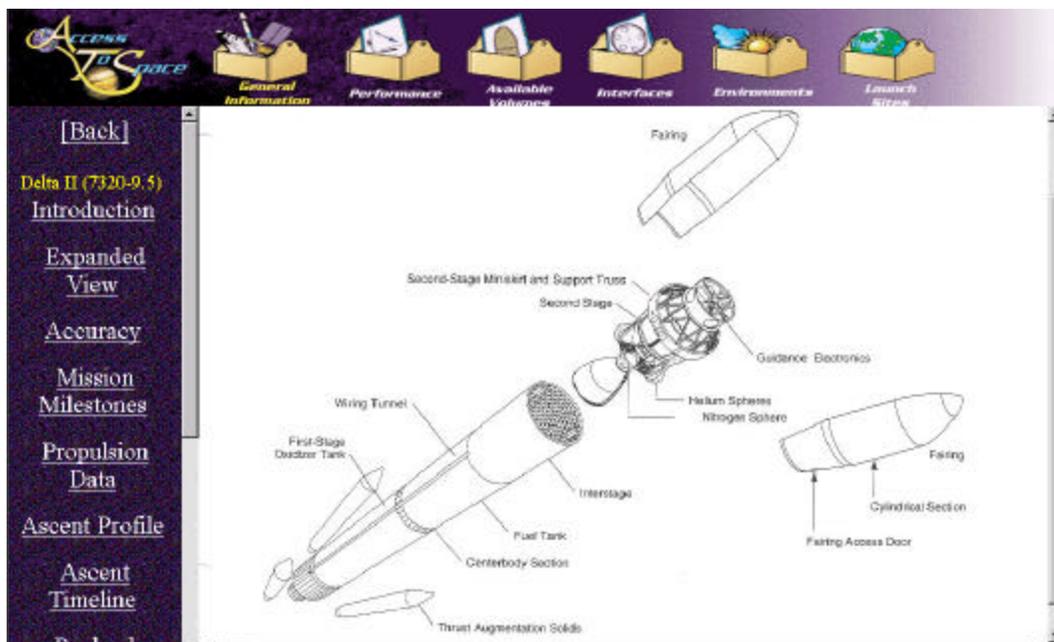
### 3.2 Access Mode Toolboxes

The various access mode types currently contained in the system include Expendable Launch Vehicles (ELV's), Reusable Launch Vehicles (RLV's), Spacecraft Buses, Space Shuttle Carriers, Sounding Rockets (sub-orbital rockets), and Long Duration Balloons. For these access mode categories, users can research a specific access mode by manufacturer and then specific configurations or products.

After selecting the Access Mode link by either clicking on the graphic or the words from the Mission Design home page, users are taken to a page with the various access mode categories listed in the left-hand frame. Placing the web browser's pointer over the category allows the user to view the various manufacturers or sub-categories. Moving the pointer over the manufacturer allows the user to view their products. Clicking any of the products will bring up the detailed information in the right-hand frame.

In the case of ELV's, one can click on either the Vehicle Class (ex: Delta II) or a specific Vehicle Configuration (ex: Delta II 7320-10). Selecting the Vehicle Class serves up the history of the vehicle, a description of the standard vehicle, and an overview of the configurations available. This also includes graphics of the vehicle configurations and a table of the configuration naming conventions.

Clicking on a specific configuration takes the user to the vehicle "toolboxes", shown in Figure 4. The toolboxes are equivalent to an abridged User's Guide for that vehicle. Clicking the toolboxes along the top of the page takes one into that "chapter", or topic area. The menu in the left frame will then change depending on the toolbox selected. Information specific to the left-hand menu items is provided in the center frame.



**Figure 4.** ELV Toolboxes

For example, clicking on the Environments toolbox provides menu items such as acoustics, thermal, vibrations, etc. Clicking on vibrations in the left-hand frame will fill the center frame with text and graphics pertaining to vibration information for that vehicle. In Fig. 4, the user is viewing the General Information toolbox and has selected the expanded view.

### 3.3 General Search Toolbox

This is a hybrid tool for mission planners to perform a first-cut trade space for identifying potential rides to space. By selecting this option, the user selects the target orbit and inputs their desired mission's mass. Based on this information, a query is executed that scans both the access mode database and the mission database and returns a results table in two sections.

The top portion returns a list of ELVs that can carry the mass entered to the desired orbit based on the performance contained in the site. The bottom portion returns potential ride-share opportunities from the mission database. The two types of ride-share listings are 1) missions that have an advertised opportunity that has adequate excess volume/performance to approximately the desired orbit, and 2) other missions with approximately the

same desired orbit that are also looking for a ride that may be interested in partnering.

### 3.4 3D Virtual Reality Tool

The Virtual Reality Interface is an interactive, 3-D tool that guides the user through the basic mission design process. Making use of Virtual Reality Modeling Language (VRML), the interface prompts

the user for basic mission parameters, culminating in a display of available launch options including other missions looking for rideshares.

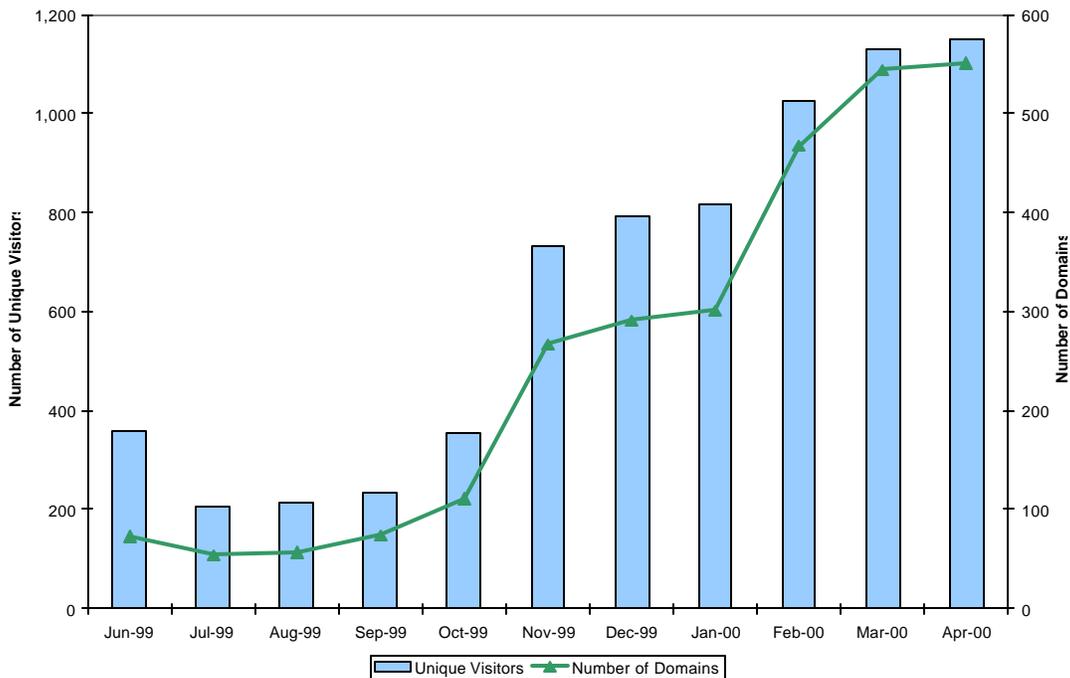
Upon entering the Virtual Planning world, the user will enter an orbit design scene, providing a virtual representation of the user's desired orbit and how it changes as the orbit design parameters are changed. The user then proceeds to the satellite laboratory to create his/her satellite. Finally, the user proceeds to the transport terminal where launch options including ride-shares will be posted based on the design parameters. Submitted options can then be explored in more detail through the direct connection into the other dynamic web pages in the site.

## 4.0 WEB SITE METRICS

With all of the site's powerful tools in place, there still remains the question of "will the user community use the site?" To answer this question, the ATS Group, in conjunction with *a.i. solutions*, has collected a wide variety of metrics on web site performance since the site went online in May 1999. Since one of the key goals of the site is to expand communication between different groups across the science and technology space community, one of the

main metrics tracked is the number of unique visitors per month and the total number of domains, or organizations, that visit the site per month.

Figure 6 shows the metrics collected since the initial release through April 2000. The site has shown steady increases since the initial release last year. Specifically, the latest metrics indicate over 1,100 unique visitors from 550 different domains which comprises a 400% increase in users over the last 6 months.



**Figure 6.** ATS Web Site metrics: unique visitors and total domains per month

Other key observations in the metrics collected include the following: an increase to over 60,000 hits per month; an average of over 30 countries accessing the site per month, and over 25% usage from US Government mission planners. Additionally, since the site registration feature was introduced early this year, over 250 people have already registered with the site from a wide range of government, commercial, and educational institutions.

## 5.0 FUTURE ENHANCEMENTS

The ATS Group continually seeks input from users, customers, suppliers, and partners in an effort to build upon the current capabilities of the site. This interaction has led to several of the current capabilities and is apparent in the development of future enhancements. Some of the key enhancement areas are for added mission design tools and expanded access mode data.

One tool set currently in development is a series of web-enabled flight dynamics tools. Sponsored by the Guidance, Navigation, and Control Center at NASA's Goddard Space Flight Center, these tools allow the user the ability to perform standard analyses such as lifetime runs, shadow predictions, station contact pass data, and XY plots of up to 6 variables.

Using a standard web browser, the user is presented with the web tools control panel interface shown in Figure 7. In the top portion of the panel, the user enters spacecraft and state data that is then visually displayed in the top right-hand box. The user then selects the run type from the tabs at the bottom of the screen and fills in the remainder of the data panel with the run-specific information. Then the user enters a title for the run and their e-mail address. After, the user clicks 'submit', the run begins on the server. All calculations and results are computed using **FreeFlyer®**, *a.i. solutions'* mission planning and operations software. Once the run is complete, the graphical and tabular results are e-mailed to the user.

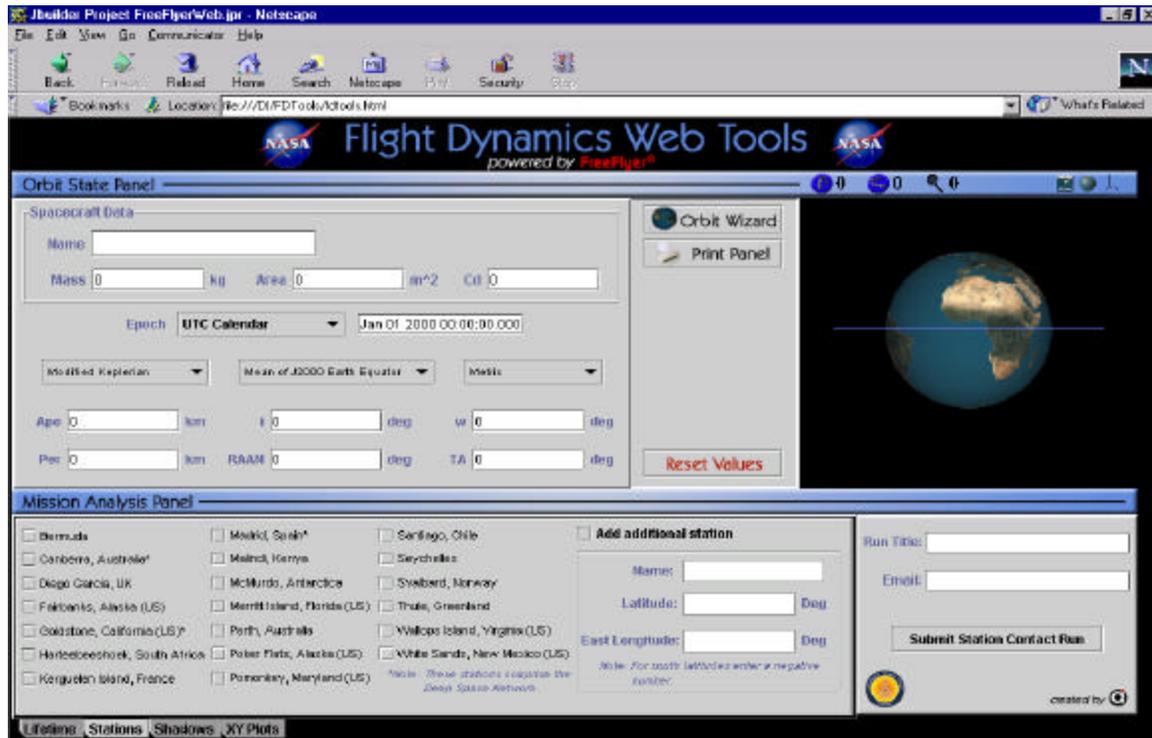


Figure 7. Flight Dynamics Web Tools powered by **FreeFlyer®**.

Other planned enhancements to the site include 3D visualization tools for displaying multiple instruments in a spacecraft bus and multiple spacecraft inside a vehicle fairing. For example, the spacecraft bus tool will allow the user the ability to transfer the results of mission database query results to a worksheet environment. In this worksheet, a portion of the screen will contain query results including numeric data such as orbit, mass, power, and dimensions. The remainder of the screen will contain a 3D interface with 3D wire-frame representations of a selected spacecraft bus and up to three instrument representations. The instruments will be moveable through a drag-and-drop interface and the entire scene may be rotated and zoomed.

Enhancements to the access mode data include capturing complete datasets for interactive information on the Shuttle, Shuttle carriers, sounding rockets, and long-duration balloons. These sections will contain a series of indexed pages that collectively comprise an abridged User's Guide for suppliers. These pages will include diagrams, interfaces, documentation, and processing information.

In addition, the user will be able to access contact information for each supplier in the database as well as perform trade space searches based on orbit, mass, and other relevant parameters.

The above enhancements take the ATS web site to the next level of mission design by encompassing a comprehensive set of tools required by mission planners in designing their ride to space. Once these enhancements are established online, the ATS site will have capabilities allowing mission planners to do full-cycle mission planning. This includes the input parameters of a single instrument to obtain technical and contact information on other instruments going to similar locations. Then the user can view search results of spacecraft buses that can accommodate the instrument complement, see 3D visualizations of the instruments on a spacecraft bus as well as inside a launch vehicle fairing, evaluate technologies that may enable their mission, and link to technical contacts and vendors with detailed information. This approach to mission design gives planners access to all the information they need to form baseline trade studies as well as form partnerships. In summary, the ATS mission design web site removes obstacles to efficient mission design, thus streamlining the process and reducing the cost of access to space.

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