The National Virtual Observatory Web Interface: Science Usability

A Report from the Science Advisory Resource Project #13 (12/2005-3/2006)

Executive Summary and Recommendations

The National Virtual Observatory (NVO) was conceived to allow scientists to access data from multiple astronomical observatories including ground and space-based telescopes. For the past five years, NSF has funded the information technology research that has set in motion the creation of the NVO. Current NVO funding supports collaboration to produce a distributed computing framework for an integrated infrastructure for astronomical researchers. At this juncture, the NVO is ready to begin a move to an operational facility. If successful, this implies that the NVO will emerge as the preferred interface to astronomical data, associated information and related services. Accordingly, the NVO now has an opportunity to consider in detail users needs and expectations as input to the organization of NVO facility proposal and subsequent work.

This report is a compilation of feedback from a structured process that probed the environments of researchers likely to use the NVO. The technique for accumulating input was through a *User Needs Assessment* methodology sometimes referred to as *Fly on the Wall (FOW).* This approach uses interviews, observations, and written survey material to acquire data. FOW observers captured user experiences with the target technology (NVO in this case) in their own workspaces, conducting routine operations relevant to their work. Additional material was collected by email and through verbal interchanges with users.

User Expectations:

Researchers hope that the NVO is or will be an infrastructure with appropriate interfaces that make available in a prompt and seamless manner the wealth of astronomical data acquired in electronic form. Most users already make extensive use of web-based astronomical services and archives; they have expertise in manipulating these services and will only make extensive use of the VO if it offers competitive advantages to what is currently available. They expect NVO to provide all multi-wavelength online data products and thereby be the central source for accessing information on all detectible astronomical targets through one portal. Users assume that the VO will enable easy acquisition, use, and inter-comparison of multiple data sets including catalogs. Scientists anticipate that the NVO will offer them discovery capability that extends beyond what they can capture from individual archives and sources.

Recommendation: In order encourage users to take advantage of the capabilities of NVO, the NVO must allocate resources to improving interfaces and also grapple with the challenge to provide improved governance in how data is presented by individual data providers and registry owners. For example, lists of observations from different sources found through DataScope provide links to disparate services requiring further user action to acquire and accumulate images of different resolutions and coverage. Users want to be able to acquire data much more simply, collate data of different types and merge a variety catalogs together and with their own lists. If they were able to do this, then we believe that large numbers of researchers would aggressively exploit the capabilities that are inherent in the underlying NVO architecture.

User Needs Assessment and Recommendations

Users voiced their needs through survey material and verbal interchanges at the beginning and end of the observation period during their FOW session. Observers/interviewers monitored scientists attempting to use the NVO for problems relevant to their research. A wide variety of activities were pursued and detailed results are provided later in this document. Clear patterns did emerge in these sessions leading to a basic core of recommendations. More detailed clarification of recommendations is provided later in this document.

Recommendations:

In moving forward on the recommendations SAR #13 advises the NVO project to obtain user feedback while producing prototypes and periodically throughout implementation. Our principal recommendations are to:

- Simplify the main user interface. Use an approach ("like Google") with a simple search and the ability to make more complex searches through an advanced search mechanism and/or links in smaller fonts.
- Improve the DataScope interface (see details later) and eventually replace it with something more intuitive and visual.
- Remove the registry from the main page and modify the registry search results to link directly and more obviously to tables and results. Demote or move the registry maintenance functions.
- Move and/or demote all links pertaining to the development team, and separately for stakeholders (meeting notes, annual reports, etc.) to other pages. Insure the main page focuses on science users and research with some clearly delineated area for education/outreach. Clearly mark the path for the other audiences (NVO team, stakeholders, etc.)
- Insure that all interfaces provide name resolution and that search results pages contain the target name, coordinates and radius of search at the top in the same format.
- Improve services to accommodate large lists of user-supplied objects and multiple user-supplied lists.

Summary

Users have high expectations for the NVO both to make the research they do easier and to enable new types of projects. However, to gain broad acceptance by the astronomical community and more importantly to realize the scientific potential of NVO, barriers to use of NVO must be small. This is achievable through careful attention to user needs and research habits. By incorporating user feedback throughout the specification and implementation of the NVO facility, the NVO has the potential to realize its promise in providing a preferred and agile astronomical research environment. A key element of the success of NVO, particularly early on, while most users are not NVO experts is the fashioning of a very simple user friendly interface.

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Background:

The National Virtual Observatory is moving from a development and experimental project to an operational facility. The recommendations from the NVO Science Steering Committee included a number of items for NVO work, specifically:

- Redesigning the website, aimed at science users
- Concentrating on introducing the average astronomer to NVO
- Produce good interfaces to simple, useful tools.

STScI is one of the principal institutions for the NVO leadership and the home of NVO project management and outreach efforts (including community outreach). Accordingly, STScI was the logical organization to take on an activity to investigate further science usability and make recommendations to the NVO project. The internal STScI mechanism for accomplishing such activities to enable community science is the Science Advisory Resource (SAR).

The NVO SAR Project #13, entitled "Usability of the NVO Science User Interface", was intended to:

- Determine a strategy for getting user feedback, including interviews of local STScI and JHU scientists and feedback from the community *via* opportunities at the AAS
- Obtain user feedback using the chosen methodology
- Compile recommendations

This report describes in detail the SAR activities and the resulting recommendations intended to improve science productivity with NVO as it evolves to an operational facility.

Preparation

Scientists from STScI volunteered to join the SAR Project as interviewers and to collaborate on writing the recommendations. The SAR members are

Carol Christian and Brad Whitmore (co-chairs)
Alberto Conti
Knox Long
Marco Sirianni
Eva Villaver

The SAR agreed upon the data collection methodology – to use survey material and *in situ* observations to capture how people now use or in the future may use the NVO for research and what scientists expectations are for the NVO as a research tool. Other information such as the responsiveness of the system, ease of use, documentation and other relevant information would be collected.

Additional scientists from the STScI/JHU community volunteered to be observed. Originally, 18 local scientists volunteered for the effort, but several declined as time pressure prohibited their interaction with the SAR. In addition to the local scientists, interviews and observations with a few scientists were accomplished at the January 2006 meeting of the American Astronomical Society in Washington DC. These interviews were conducted at the NVO booth – not an optimal environment but informative nonetheless.

Methodology

User Needs Assessment is a methodology used in a variety of situations and its application to software usability, education resources, and digital library development is common (c.f., the MIT

Libraries Project http://macfadden.mit.edu:9500/webgroup/userneeds/index.html, and the Berkeley Digital Libraries Project http://elib.cs.berkeley.edu/user-needs.html).

The method combines a variety of tools to focus on user needs and work procedures and how they will employ a system to support tasks they need to perform. Typical tools are surveys, usability testing, interviews of key personnel, literature, focus groups, testing, and direct observation. The SAR chose to use a pre-interview survey as well as probe usability through direct observation/interviews conducted in a volunteer's office.

The direct unobtrusive observation methodology ("Fly on the Wall" or FOTW: c.f., http://www-128.ibm.com/developerworks/java/library/us-fly.html) allows the observer/interviewer (called interviewer herein) to watch over the shoulder of the user as they use a system in their daily routine, in their own work environment. This enables the interviewer to capture information that usually does not emerge in a survey. The spirit of the "observation" is that the interviewer in general does not intervene while the volunteer uses the system. In practice, with the NVO, interviewers interceded occasionally so the user would not be foiled in using the system or grow unduly frustrated. Also, the interviewer could probe more deeply what the user was intending rather than just watching, such as on a video camera.

Pre-Interview Survey Questions

- What web-based tools do you use for your research, in order of most frequent use?
- Have you used the NVO for research? If so, please briefly describe what services you have used.
- Describe your idea of the purpose of the NVO, that is, what is the goal of NVO?
- Websites are generally used in two basic modes: 1) general surfing, 2) looking for specific information or services. We are interested in testing both modes. Which mode is applicable for your research and generally, what you might be interested in looking for on the site?
- Please give some examples of good and bad websites you have encountered.
- Please briefly specify what is good or bad about the site. (Example – "Amazon.com: good services, cluttered interface, easy to use")
- Please provide a few ideas that you would like to try out on the NVO, whether or not you can accomplish the same goal with another service.
- If NVO is to be used by proposers or proposal reviewers what functions would it provide?

A summary of answers to the survey questions is given in Appendix A.

Direct Observations

The interviews were conducted in individual volunteer's offices and at the AAS. The interviewer explained the purpose of the session and asked a few questions to establish what type of research the volunteer was interested in pursuing with the NVO and recorded any additional comments the volunteer might have. Then the interviewer, sometimes accompanied by either G. Greene or A. Conti for technical support, asked the volunteer to proceed to use NVO as they would if alone. The interviewers did ask the volunteers to verbalize their thinking and sometimes explain what they were doing so the sense of each volunteer's mode of research could be captured. Interviews were conducted by C. Christian, B. Whitmore and M. Sirianni and the nominal duration was 1 hour.

Several verbal interchanges with randomly selected astronomers also were videotaped during the AAS. These interviews proceeded as "Jay Leno" type questions and responses to probe the

general awareness of NVO that astronomers have and what their expectations are for using NVO. These interviews reinforced commentaries provided by the other interviewees.

Types of Research Problems (Use Cases)

The following are descriptions of a few types of research problems identified by volunteers either in response to the survey or during the *in situ* interviews.

1. Specific targets: Identify a specific type of object (e.g., galaxy, nebula, QSO) and measure fields surrounding to find physically associated objects and background samples. Could be used to study galaxy environments, searches for globular clusters and other objects, and similar studies. Requires combinations of catalogs and data sets.

2. Data and tools: Study the physics of a few specific objects and find observations, other types of data and simplified models to apply to observations.

3. Classes of objects: Research a type of object such as novae, nebulae, QSOs or other classes of object. Cross match favorite catalogs and new catalogs as well as observing lists. Follow up findings by retrieving specific data that may assist with research and point to new observations to propose.

Interview Results

Overall Usability

Users found that the NVO generally is useful for determining whether observations of an object exist, at least from large telescope facilities. Users found that the NVO does not yet allow efficient assembly of multi-wavelength observations. They expected that the NVO (now or eventually) would provide a simple way to collate and compare different cleaned, calibrated observations in order to be the preferred method of data access compared to retrieving data from individual archive facilities.

Users often found searches with their own lists of objects or lists retrieved through the NVO to be problematic or impossible. Users expected more crossover and coordination between various services, for example, it should be possible to retrieve or provide a list of Cataclysmic Variables and check the list against other resources, thereby locating, collating and retrieving observations and/or publications.

Simplicity: Many users felt that a simple, clean interface ("like Google") is preferable as the main page, with the possibility to go to advanced searches through other links.

Users found that some of the interfaces required a steep learning curve and are difficult to understand. Occasionally, SAR interviewers intervened to expedite the use of an interface so the interview could proceed in the allotted time (1 hour).

Recommendation: The SAR recommends that the NVO simplify the main interface and tune it to science users. Advanced search tools can be linked from a simplified mail search tool. Simplification should be accomplished with more complete user feedback and web interface design expertise.

Completeness: It is unclear how much data and how many catalogs are included in the NVO. Some estimation of the NVO volume and services *vs*. the total available would be useful (see figure 1). Users were uncertain on how much additional work they had to do to find the data and references they required for a particular line of research.

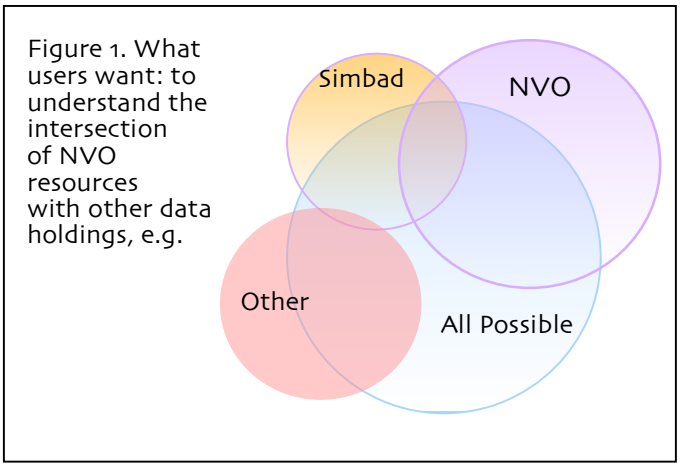


Figure 1. What users want: to understand the intersection of NVO resources with other data holdings, e.g.

For example, the ADS clearly includes *all* publications of some journals and little or none of others, so the user has a high confidence in the completeness of searches. This attribute is very important in a discipline where completeness and citations are greatly valued.

Recommendation: The SAR recommends that the NVO project find a mechanism for simply representing the data holdings available.

Throughput: Network throughput appears to hamper effective use of some tools. Adequate feedback in all tools that "something is happening" would be valued by users.

Recommendation: A simple display of network throughput is recommended for users to evaluate the performance of the system.

Help: Users expressed that contextual help would improve productivity. Users expressed that "if they were" to use the NVO, they would be required to read quite a lot of instructions to be productive. This was not a barrier for some, but led to frustration and abandonment on the part of others. In general, users gave an interface 5 – 10 minutes maximum before deciding to move on or ask for help. During the interviews, help was accessible, but for the average user, help will not be readily or quickly available when needed. For many users, a single "initial bad experience" will be enough to keep them from using a web resource for years to come.

Recommendation: More contextual help should be incorporated in applications.

Consistency: The impression from users was that NVO was expending a large effort in developing applications and less on usable simple user interface. Users felt smooth coordination and consistency of services is important and that some stronger governance on uniformity of data returned from queries. Users suggested that the NVO "do a few things very well" and perhaps hide other services or separate them in a "prototype" area.

All users felt that the search by name with SIMBAD coordinate resolution should be available through any tool. All search entry boxes should also be able to decipher various types of coordinate formats. This is another area where consistency throughout the NVO interfaces and services is very important and leaves a lasting impression.

Recommendation: The SAR felt more attention should be focused on some simple NVO usage scenarios with ample user input to develop a description of user needs, specifications, and requirements. This will begin to build a solid user base using the simplest tools available. The SAR recommends the NVO take the opportunity to concentrate on adequate user needs

assessment and subsequent user feedback mechanisms *in lieu* of starting development of new services.

Finding the NVO Interface

Most users easily find the NVO as the second item in a Google search. Some users that looked for "NVO STScI" or other combinations could not find it.

Some users familiar with MAST or the IVOA were confused by the NVO and wanted to understand the relationship between those entities (this is another manifestation of the feedback regarding completeness and consistency described above) for example, how does NVO compare with or intersect other services and organizations?

The Main US-VO Website Page

"Browsing" users roamed around the site first, usually selecting items on the left or right, before trying any services. Users who tend to read documentation first were glad to find it linked at the top page, yet did find the documentation wordy rather than being short, contextual and tiered in depth. Users who diligently read documentation would value such a tiered approach (contextual, short synopsis, detailed explanation with separate tutorials). Sometimes users wandered into the NVO EPO site and found the explanatory material on the education site quite useful, although, again, somewhat wordy.

Browsing users found that in the background area one of the first links is to a PDF file. In general people are adverse to such links and at a minimum would like to be warned that a PDF file is about to be downloaded.

Recommendation: Documentation linked from the top NVO page should be simplified, with a tiered structure, simple tutorials, and outfitted with contextual help throughout. PDF files for papers and other materials are acceptable, but for applications and services documentation other forms are recommended.

Simplify! Many users expected and expressed the desire to have a simple top website page with a search box with a link to an advanced search and possibly help ("like Google"). They expect most links displayed to be oriented to the science users. This feedback resonates strongly with the Science Steering Committee report. An advanced search option should be designed with care and ample user feedback – it could include searches with a variety of tools.

An existing search box located on the upper right side of the main NVO interface was often thought to be an object search as for MAST and other archives, therefore results, when obtained, were very confusing since they did not represent data. Other than for an object search, few users employed this box. If this search box persists, it should be clearly labeled as a website or documentation search. It would be better to have the website search at the bottom and the data search prominent.

The hints to the right of the existing search boxes in the middle of the page are very helpful. Many users did not understand that typing an entry in one of the boxes in the center (Registry, DataScope, Catalogs) required a <return> key to be hit to start the search. An optional search button (or "GO") should be added. In addition, if these boxes persist, the link underneath the box should say something like "Advanced Search: full DataScope interface" and the like, but a simpler Google search interface is preferred.

Recommendation: Along with the simplified, Google type search interface on the main page as recommended above, move the top search box lower, or event to the bottom of the page and identify its purpose more clearly. Create small links above the search box for more advanced searches "Google style".

Users who browsed the selections on the right or left of the main web page found the information not to be very useful for science research. Users commented that NVO advertises "the team" near the top of the page. Users wanted to know why that information is important to science users? It is not valuable to users unless those individuals offer help in specific areas.
Users expected to find a help desk link in the first page view (without scrolling).

Most science users did not think the NVO Summer School should be at the top right part of the main page.

Users who selected to the "proposal" link expected to see information about observatory proposals for observing time.

The "Publish" tab evokes a different context for science users than developers. This should be moved to a developers page off the top page during the main website redesign.

Recommendation: The top NVO page should be geared to science users with some linkage for the public and educators. Links to team/project information, links for stakeholders (funding agencies) and links to developer areas should be further down the page, in smaller fonts. A link that is labeled "Contact us" would be better than a link to "the team", preferentially at the bottom of the page. Create a small link at the bottom of the page to materials of specific interest to the NVO team activities and link all team information from there. Help facilities for scientists should be linked further up the page, probably over the "Google Search" type box.

Data Scope

Searching

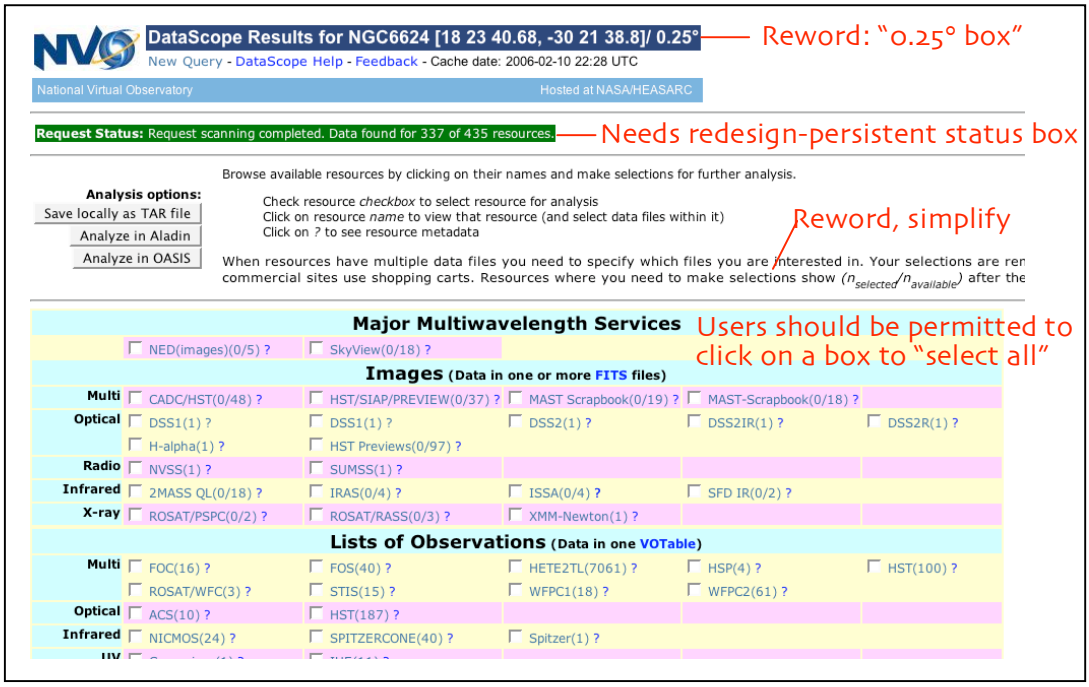
Most interviewees eventually found their way to DataScope. Few users accessed the advanced search ("full DataScope interface") until later in their session. Some users selected a specific type of data to search (optical, instrument, etc.) although most did not.

All users found the DataScope interface to be daunting. Very often, interviewers had to intervene with coaching or suggestions.

Most users except those who were very diligent in reading documentation did not understand why the design of the refresh works as it does rather than updating a small portion of the web page. All users disliked the refresh of the whole page. Most users wanted an estimate of the time it would take to complete the searching. Many users do not understand the ($n_{selected}/n_{available}$) nomenclature even after reading the tag line at the top of the search results.

Recommendation: Create some other simplified method for indicating progress on searches, and eliminate the full page refresh. Reword the description of this nomenclature for clarity, for example "Click on a link to select individual files. $n_{selected}/n_{available}$ shows the number you selected over the total number available."

There is much confusion between “Images” and “Observations”. Some brief explanation regarding why an observatory does or does not return images for data should be included. The section “Lists of Observations (Data in one VOTable)” is generally not understood. The user expects to probe into the Lists and select actual data in one click. This situation is particularly frustrating for situations such as HST where few preview images might be available, but hundreds of observations exist. It is not clear to the user why there is not a one-to-one correspondence between images and imaging observations. Most users have no idea what a VOTable is, so the description is not helpful.



If a user clicks on a box in the returned results area in DataScope that indicates there are multiple entries in the found resources, a popup box appears warning the user that the resource they just selected has returned more than one result. It says “This resource contains multiple entries. Do you wish to look at these?” Currently users can either continue and select individual files, or the selection is canceled.

Recommendation: Reconfigure the popup box to allow “yes”, “cancel”, or “select all”.

Most users expect (or hope) that NVO will return cleaned, combined observations that can be inter-compared at a common, preferably user selected (with coaching) resolution.

Users were amused by, but did not find very valuable the list of sources that returned results at the bottom of the page. Names of the resources searched are not always immediately obvious except for aficionados and should be tuned to reflect common nomenclature. **Recommendation**: The lists of resources searched should be restructured, or perhaps offloaded to another cached area where the user can link to see what sources of data have been searched. Sources should have a contextual (mouse over) short name as well as a linked longer explanation. The terminology “No Response from XXX sources” is confusing and should be relabeled with something more informative such as “No response received yet”.

Contextual help is generally informative for DataScope. In some areas this could be improved: for example, in the *Images* area, when the user clicks on a specific resource and finds a table of entries – science users will know what FITS is, but not all users, few users understood "?", and many users were baffled by "QL".

How are "Catalogs of Data" different than the holdings in "Catalog Coverage Map and Source Inventories"? Users were confused by this. **Recommendation**: Clarify this difference.

Retrieving Data

In viewing an individual item under "Lists of Observations" users were annoyed to find that clicking on "Data" did not always select the individual observation described. For HST, FUSE and a few other missions, preview data was available. However, clicking on "Data" results in widely disparate results. For example, clicking on "Data" launched the user into a confusing area with verbiage and no data and/or a link to a generic observation list page. Users expected to have check boxes as are provided under resources in the "Images" section. **Recommendation:** As mentioned above, consistence, governance, and standardization of returned results are important for the long term future and usability of the NVO. These issues must be addressed to insure that the NVO Facility becomes an effective and preferred astronomical research environment.

When catalogs were retrieved through DataScope, users expected to get some ascii representation rather than html. No export feature appeared for simple ascii. **Recommendation:** Add an ascii export (or change "cvs" to say "ascii").

Analyzing data

Aladin and OASIS in general were often very slow and provided little feedback if the network connection was slow. Users were puzzled by the slowness because web connections to the same external facilities seemed quick (tested through a ping or www…). When network connections were fast (seconds to 10s of seconds response) feedback was adequate. Often users click on a utility multiple times resulting in further slowdown, because multiple clicking spawns multiple versions of the program. Sometimes Aladin failed to load and a whole session had to be restarted, including backing out of DataScope and starting over. Some users familiar with Aladin realized they should download data to disk and use their own local copy of the program.

Some users were not clear why they should use the NVO and then Aladin rather than just using Aladin.

OASIS seemed more mysterious to use and in many situations, OASIS does not remember the search coordinates if the users selects one of the icons at the top of the OASIS interface (such as "access remote image archives") although OASIS is selected directly from results returned from a search. The coordinates should be persistent. OASIS also apparently uses a lot of memory and exceeds the limit quickly. Those users unfamiliar with the specific utilities often became frustrated or resorted to using their own more familiar utilities to analyze the data. However often this operation occurred just to preview images, so the slowness and necessity to download files for local use created a large time lag before the user obtained something they actually could exploit.

Recommendation: Testing of connectivity and speed of use for Aladin should be done to inform the NVO Facility on how heavily it should rely on Aladin for a visualization tool. Users should be encouraged to download their own copies of Aladin everywhere a button to Aladin occurs.

Users should be instructed to save data to disk to use Aladin, unless throughput problems can be mitigated. If OASIS is to be used, it should have a smarter interface to user data retrieved.

Overall Recommendation: The DataScope interface is very difficult and confusing to use and needs considerable thought and user feedback for redesign.

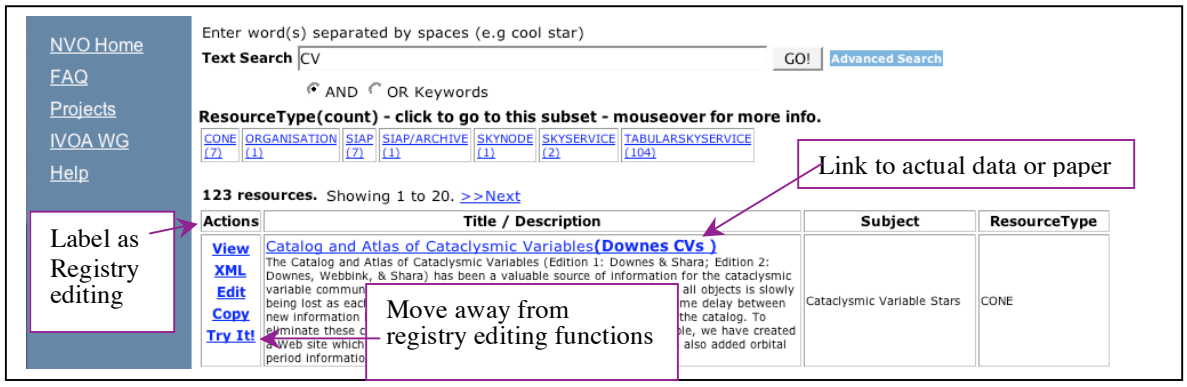
Registry

Recommendation: The Registry link/search should not be the first search in the middle of the main NVO page, but the last or deferred to an Advanced Search page and to the developer's area.

Annotated tutorials, when accessed, were useful.

The utility of the Registry is not clear to users. Some users eventually deciphered that the Registry is oriented toward Registry entry maintenance. Some users thought they had to register to use the NVO through the Registry. The first impression from most users exploring the Registry was "this is not what I expected or need". **Recommendation**: For the Registry to be useful to users, the hypertext linked item in the Registry search results should be a link to the catalog found. An additional URL to the associated paper should be in close proximity to the URL directly linked to the catalog if the Registry entry found is a catalog (see figure). The items at the left (XML, Edit, etc.) should be clearly labeled as being Registry entry maintenance functions.

Most users of the unfamiliar NVO interfaces try something they know before embarking on something more ambitious. In the case of the Registry, most users were looking for specific references and papers. If expected references were not found (such as a well-known catalog of a specific type of object), confidence in the Registry was diminished. Registry use reinforced ambiguity about the "completeness" of the NVO.



With coaching, the "Try it" feature was somewhat useful, but did not actually produce the results desired. Users were not pleased to have only XML, HTML and VOTable as formats. Most users want ascii unless there is a compelling reason to use some other format but this was not obvious to most users. When results were obtained, the VO Plot coordinate system is in decimal degrees which is viewed as not very helpful, especially for Right Ascension. Also, the display and XY coordinates displayed were not of immediately obvious use and required more time than user patience tolerated to understand.

Most users who persisted in utilizing several services found the Catalog Coverage Map and Source Inventories (below) service more useful for finding catalogs but were disappointed that nomenclature searches could not be accomplished, as they are with the Registry. These users also

wanted an option to find catalogs and source inventories of classes of objects, not one object at a time.

The advanced search should be much more user friendly. Most of the language on the advanced page is obscure to the novice.

Recommendation: Allow searches on words as well as targets in the catalog searches and improve the user friendliness of the advanced page.

Catalog Coverage Map and Source Inventories

Recommendation: The checkbox should not be at the extreme right, but on the left.

The utility of the full coverage maps were illusive for many users. Most users thought they were "neat" but since they only appear after a search has been done on one object, it was not clear why they were useful in this service. These coverage maps would be much better utilized if one was able to search the sky, say *via* some visual utility and see the footprints of catalogs and observing lists before searching.

It is not immediately obvious to users that clicking on the link to the immediate right of the number of sources gives the source list. It would be better to have the source number be the hypertext link.

Why doesn't OASIS remember central coordinates when the user clicks on OASIS next to a catalog? Why is OASIS on the extreme right if it is not linked the individual catalog selected? The OASIS launcher sometimes did not work from this area even though it worked from the DataScope interface during the same session. In fact, even if an OASIS session was opened with the same coordinates as in DataScope, the OASIS invoked from the catalog service could not find the application.

Recommendation: The coverage maps and presentation of results should be redesigned. If OASIS is to be used and persistent throughout this service, it must be closely linked to the catalog or inventories selected by the user.

OpenSkyQuery

Users found queries on a large number of sources (say 1000) to be problematic. This type of research capability would be invaluable for survey work however.

Users who tried using their own list had trouble using OpenSkyQuery to make a table they could name and use. Users expected to be able to load several catalogs from previous searches and use them. If this is possible, it is not obvious.

Building queries is very technical. Users found finding information about source lists to be tedious to understand and often required more patience than time allowed. Users believed this service to have potential but too difficult to formulate queries at this time. The simple query seemed useful but it was not obvious how to include ones own lists in this tool.

Recommendation: Improve the service to accommodate large lists and insure that user supplied lists can always be accommodated. Multiple user lists and results from catalog searches should be accessible for this tool. Method of building queries should be made much more intuitive and

simple. Users should be able to do simple queries on their own lists cross matched with other catalogs.

Services that Users thought "Have Potential"

1) WESIX: Users familiar with WESIX find it very useful. Users who have not spent some time with WESIX found it baffling and response slow, especially when the user does not know what to expect.

Recommendation: The ability to use user supplied lists would be valuable.

2) The Mosaic tool and WCS FIXER were looked at by a few users, but not investigated.

Additional Services Desired

Users expressed interest in additional services such as

- Searching and access to software packages based on functionality
- Filter functions to compare to spectroscopic observations
- Access to synthetic spectra libraries
- Models
- A "how to" feature, for example how to do certain searches. Perhaps short tutorials would assist in this.

Recommendation; The NVO project should consider the above list and conduct thorough user surveys to determine the most appropriate tools for new development after the interface issues are addressed.

Appendix A: Details on Answers to Survey Questions

The survey questions were designed to probe what types of resources scientists use for both research and other purposes as well as impressions of good websites and poorly executed websites to serve as models.

In addition, the SAR wished to probe expectations on the part of users regarding the purpose and functioning of the NVO.

There was an idea generated from discussions with the NVO Science Steering Committee that simple links from proposal tools or proposals provided to reviewers to the NVO would be useful for the proposal process and further demonstrate the utility of the NVO to scientists. The survey question prodded responders to describe what the specific functions and information would be if such linkages were established.

What web-based tools do you use for your research, in order of most frequent use?

- Google
- NASA ADS abstract server -- http://adsabs.harvard.edu/abstract_service.html
- astro-ph -- http://xxx.lanl.gov/archive/astro-ph
- NED -- http://nedwww.ipac.caltech.edu/
- SIMBAD astronomical database -- http://simbad.u-strasbg.fr/Simbad
- MAST -- http://archive.stsci.edu/
- SkyView -- http://skyview.gsfc.nasa.gov/
- Many others (including LEDA, Starview, CDS)

Have you used the NVO for research? If so, please briefly describe what services you have used.

Generally no.

Describe your idea of the purpose of the NVO, that is what is goal of NVO?

NVO is intended to be a means of making the wealth of astronomic data acquired in electronic form available in a rapid and seamless manner. In so doing the nature of doing astronomical research may undergo a fundamental change, analogous to how the existence of the internet has changed things in a general sense.

The VO should enable easy use of multiple data sets. Really straightforward tasks using purely cataloged data ought to be simple to accomplish. Cross-query catalog data.

The NVO should provide a clear-cut way to test things on a small scale, and then use the same methods to do the project on a massive scale.

The NVO should give access to all available online data products (catalogs, images, general information on targets) and covering all wavelength ranges. It should be the central source for accessing information and data on all detected astronomical targets, all in one place without the need to invoke other web-tools.

NVO should be a discovery tool to find new data and resources that the scientist did not expect to find.

Websites are generally used in two basic modes: 1) general surfing, 2) looking for specific information or services. We are interested in testing both modes. Which mode is applicable for your research and generally, what you might be interested in looking for on the site?

Generally both.

NVO should allow the user to quickly find services and available data, then when it is time to use the data, "hooks" for scripting languages (e.g. python or IDL) should be available so that the data can be imported for analysis.

Obtain information on specific lists of objects.

Any site requiring too many clicks to links to desired information, data or synopsis (including thumbnails of retrievable information) is not a good site.

Please give some examples of good and bad websites you have encountered. Please briefly specify what is good or bad about the site. (Example – "Amazon.com: good services, cluttered interface, easy to use")

Good

- Google - Amazingly good at what it does. Simple interface and presentation. Sparse, powerful, fast and clean.
- ADS – a standard, astro-ph - Good, simple presentation
- NED –however popping up of multiple windows often disorienting
- http://docs.python.org/ - content is superb, presentation very good given that the documentation is generated generally automatically, but you may have to be familiar with what you are looking for
- Amazon.com – good services, cluttered interface, easy to use
- Travelocity -- easy to figure out how to specify a simple search.

Annotated sets of links:

- http://www.philb.com/iwantto.htm -- VO needs something like this for VO related things.
- http://www.mat.univie.ac.at/~neum/glopt/software_g.html - Another attempt to provide an annotated set of useful links.

Generally Bad:

- sourceforge -- tedious to find documentation through this resource.
- http://www.scipy.org/ -- hard to find what you need
- http://cas.sdss.org/dr4/en/ -- Not easy to extract data
- MAST -- difficult to navigate to desired search, fine once bookmarked. Difficult to determine what arcane entries are needed for simple things like 'filter'
- Deltek -- our time card system. A real disaster, very hard to use, irritating (not the concept, the execution).
- SPITZER website – not easy to find what you need and is not clear what is available

Please provide a few ideas that you would like to try out on the NVO, whether or not you can accomplish the same goal with another service.

Checking catalogs, cross checking lists with catalogs and other lists, searching for observations related to a given target or a class of target.

If NVO is to be used by proposers or proposal reviewers what functions would it need to provide?

- Have the proposed results been *published* already? ADS, astro-ph and Google get you most of the way there for this, also Simbad.
- Have the proposed data been taken already? VO can help but it's holdings need to be complete. What other observations are available?
- It is very hard to query for generic "deep fields", where the actual pointing direction matters less than whether the parameter space in depth, area, bandpass, observing technique has been covered already.
- A map of the objects such as an overlay of map symbols on an actual sky map (footprints) so that likely correlations can be established between sources at different wavelengths.
- Visibility functions for telescopes – what can be observed when?
- Provide one-stop shop of sufficient information on sources to plan new observations.
- Automatic links to some of the above from proposals (for reviewers)
- Links to important proposal dates, documentation and tutorials