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Engaging Non-traditional User Communities Through National Virtual Observatory Education and Public Outreach (NVO-EPO): A Needs Assessment Study of the Art Community

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"The central function of the artist should be a duality of discoverer and educator: discoverer of the varying possibilities for selecting from environmental stimuli specific percepts and organizing these into significant perceptions, and concurrently as an educator, training a public in the ability to perceive in newly discovered patterns."

Ben Patterson, Four Suits,
cited in Paul Hertz's interview,
August 2002

"At the core, both art and aerospace exploration search for a meaning to life."

James Dean,
Founding Director, NASA Art Program,
1962-1974

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Abstract

The SEGway Project at the Center for Science Education @ Space Sciences Laboratory, UC Berkeley, is engaged in conducting user requirements research on how large databases of space science imagery, spectra and data analysis tools—to be provided by the National Virtual Observatory project (NVO)—can be used for Education and Public Outreach purposes.

As part of the SEGway NVO E/PO project, a user requirements study was conducted from May-November 2002, which focused on the needs, interests and demands of the art community (including both traditional-media and electronic-media artists and students, and art-related professionals working in science museums). The rationale for surveying the art community as a potential user of the NVO E/PO program encompasses the opportunity to reach out to the non-traditional art community directly, as well as using their recommendations and creative thinking to identify the diverse interests of a segment of the public that would not otherwise be engaged in space science.

The results of this study highlight the art community's unique perceptions of space science and astronomy, and its specific needs and demands for tools and data. Our aim is to contribute to the design of more appropriate and efficient interfaces for the diverse NVO-E/PO users' groups, which, in turn, will lead to better acquisition, use and dissemination of knowledge about the Universe.

Structure of this Report:
The nature and scope, goals and methodological aspects of the study are presented in Chapter 1. A summary of the outcomes of the survey is presented in Chapter 2, and the recommendations for the NVO-E/PO project are discussed in Chapter 3. In Chapter 4, we describe potential future developments of this survey, and in Chapter 5 we present a cross-analysis of the interviewees' responses. In the Appendices we provide information on project participants (core research team, focus interest group members and consultants), as well as on interviewees, tables of questions posed to interviewees and their responses, as well as a roster of artists working with Art & Technology.

Executive Summary

Over the past two summers, the SEGway Project at the Center for Science Education @ Space Sciences Laboratory, UC Berkeley, has conducted needs assessment studies of how large databases of space science imagery, spectra and data analysis tools to be provided by the National Virtual Observatory project (NVO) can be used for Education and Public Outreach purposes. As part of this project, a study focusing on the needs, interests and demands of the art community (encompassing both traditional-media and electronic-media artists and students, and art-related professionals working in science museums) was conducted from May-November, 2002.

The principal goals of the study were to investigate how NASA space science data in the form of imagery, spectra, etc. as well as information and tools can best engage and invite non-traditional NASA communities, such as the art community, in the participation and acquisition of the vast NASA resources.

The core research team of this study was composed of an Electronic Artist (Dr. Rejane Spitz, Associate Professor at the Department of Art & Design at PUC-Rio University, Rio de Janeiro, Brazil, and a Visiting Scholar at the Space Sciences Laboratory), space scientists and astronomers (Dr. Nahide Craig, Director of the Science Education Gateway program - SEGway; Dr. Isabel Hawkins , Director of the Center for Science Education, Dr. Greg Schultz and Dr. Bryan Méndez, Scientist-Educators), and support staff from the Center for Science Education at the UC Berkeley Space Sciences Laboratory. Dr. Roger Malina, who is currently the Director of the Laboratoire d'Astronomie Spatiale, Marseille, France participated as an advisor.

With input from fourteen invited professionals from diverse art institutions and organizations and science museums in the San Francisco Bay, a list of thirty questions was devised by the core research team. The fourteen professionals served in the capacity of focus interest group and consultants, who gave on-going feedback during the project. These questions were grouped into six categories:

- Background information
- Philosophical/conceptual
- Web related
- Tools, functions and collaboration
- Art-Science interfaces
- References and recommendations

A national cadre of thirty artists was selected to be interviewed for this survey suggested by the members of our research team, focus interest group and/or by our consultants. Their selection was based principally on the nature and range of their diverse art, and digital-art background, professional practices, on their professional excellence and recognition in their fields.

A letter of invitation was sent to each potential interviewee, describing the nature of our study and some of its methodological aspects. The list of thirty questions was also sent to each potential interviewee as an attachment, so that they would have a better idea of the scope of the survey.

Twenty-five of the invited professionals were able to participate in this survey as interviewees, on a voluntary basis: seventeen artists (electronic artists, traditional artists, educators, curators, postgraduate art students) and eight art-related professionals working in science museums (exhibit designers, planetarium directors, exhibit specialists and web designers).

Semi-structured interviews were conducted in consonance with a qualitative methodological approach. Each interview lasted approximately one hour, and was audio taped. Each interviewee signed a consent form prepared in accordance with the recommendations of the committee of the Protection of Human Subjects of the University California at Berkeley.

Interviews conducted in person took place in different locations, such as the SIGGRAPH'2002 Conference San Antonio, Texas; the Chabot Space and Science Center, Oakland, California; San Jose State University, San Jose, California; and the Space Sciences Laboratory at the University of California at Berkeley. All the interviews took place between July 25th and September 20th, 2002.

Fifteen interviews were conducted in person, ten interviews were conducted by phone. Two of the subjects interviewed in person also sent their responses on a written form, and one interviewee gave his responses only in a written format. The written responses were also incorporated in the survey, since they covered different aspects and brought new insights. In all, we received twenty-eight complete responses from the twenty-five subjects interviewed in this survey.

The interviewees' responses reflected their communities' unique perceptions on space science and astronomy and specific needs and demands for tools and data.

A cross-analysis of the responses highlighted the following outcomes, which express the interviewees' major desires, requests and recommendations for the NVO project.

1. **Foster and enable diverse forms and methods of online and offline collaboration between different users and/or groups of users, including facilitating dialog between artists and scientists**

2. **Allow information to be adjusted to users' skills, level of knowledge, needs, and interests**

3. **Provide interactive, dynamic tools and activities, as a means of engaging the audience in constructing their own knowledge about space science and astronomy that goes beyond mere acquisition of facts and information**

4. **Provide information on a multi-sensorial way, including as many data dimensions as possible (3D, animations, sound, etc.), as a means of facilitating knowledge acquisition on space science and astronomy**

5. **Develop specific astronomy-related search engines**

6. **Provide a description of the data sources and of the process, methods and criteria for image creation and manipulation**

7. **Provide historical, cultural and artistic information on space science and astronomy**

8. **Provide both virtual (web based) and non-virtual (printed) NVO related materials and information**

9. **Include the participation of artists, science museum professionals and science educators in different stages of the NVO project**

10. **Enable the discussion of philosophical and conceptual issues in the domain of space science and astronomy**

11. **Use NVO to bring back the "moon landing era" excitement of space science and astronomy to the general public**

The final recommendations of this study - although primarily based on the interviews' outcomes - also took into consideration some other relevant factors, reflecting the research team's experience in space science and astronomy education and public outreach.

One important factor considered by the research team for addressing recommendations to NVO was our knowledge of space science and astronomy sites and software which are already available for the general public, as well as on potential web resources and technologies which are currently being developed and implemented by major space science and astronomy-related institutions. According to the survey's responses, we may conclude that the majority of the interviewees – not only artists but also some of the science museum's art-related professionals - are not aware of the variety of space science and astronomy web resources, tools and services currently available on the web.

Another relevant variable considered by the research team when outlining these recommendations was the degree of feasibility and appropriateness of some of the interviewees' suggestions as regards the scope and major goals of the NVO project. While some of the outcomes were coincident with NVO established goals, other requests and desires were far beyond the scope and objectives of the NVO project.

We also considered it important to address recommendations to both NVO and NVO-E/PO potential providers, since these two projects and groups greatly differ in terms of their role, scope and goals.

Recommendations from the interviewees	Recommendations from the research team to NVO	Recommendations from the research team to NVO-E/PO Potential Providers
1. Online and off-line collaboration between different users and/or groups of users including facilitating dialog between artists and scientists	- Provide the necessary infrastructure to allow online and off-line collaboration between different users and/or groups of users. - Encourage the dialog and promote collaboration between scientists and artists through grants, fellowships, internships, and commissions. - Include space science and astronomy related art works and information as part of NVO's repository.	- Enable and promote online and off-line collaboration between different users and/or groups of users. - Encourage the dialog and promote collaboration between scientists and artists through: • artist-in-residence programs and grants • art/science workshops commissioning artists to produce space science related work for NVO-E/PO - Development of new functions and tools to facilitate and enable collaboration - Facilitate communication considering language differences (different jargons, definitions and concepts employed by professionals from different areas – especially by scientists and artists)
2. Allow information to be adjusted to users' skills, level of knowledge, needs, and interests	Provide necessary metadata infrastructure to allow information to be adjusted to users' skills, level of knowledge, needs, and interests.	Scale the level of information and provide users with tools to select their entry level on different topics.
3. Provide interactive, dynamic tools and activities, as a means of engaging the audience in constructing their own knowledge about space science and astronomy that goes beyond mere acquisition of facts and information	Provide the necessary infrastructure to allow interactive, dynamic tools and activities to be devised and provided to the general audience.	Provide interactive, dynamic tools as a means of engaging the audience and facilitating knowledge acquisition on space science and astronomy

4. Provide information on a multi-sensorial way, including as many dimensions as possible to data	Provide metadata and file format infrastructure to allow information to be presented on a multi-sensorial way.	Present information on a multi-sensorial way, such as 2D and 3D static and animated representations, sound etc., and enable immersive environments for navigation whenever possible.
5. Develop specific astronomy-related search engines	Provide metadata infrastructure to allow the implementation of search engines for astronomy-related information that can access the federated NVO databases in a cohesive way.	Implementation of search interfaces for astronomy-related information, aiming at the artistic-minded audience
6. Provide a description of the data sources and of the process, methods and criteria for image creation and manipulation	Provide the metadata language appropriate to lay users and tag the history of processing and manipulation of the data (from raw to processed).	Description of the data sources and of the step-by-step data processing and manipulation techniques and criteria.
7. Provide both virtual (web based) and non-virtual (printed) NVO related materials and information in parallel	N/A	Cutting-edge technologies for presenting the information on the web should be provided along with traditional printed materials.
8. Include the participation of artists, science museum professionals and science educators in different stages of the NVO project	Encourage and sponsor artists' participation in different stages of the NVO project - from the early stages of brainstorming and structuring of preliminary ideas, to the advanced stages of implementing, using and testing resources.	Involve end-users in the development and testing of products and programs.

Table 1 – Recommendations for the NVO

In conclusion, the input and responses we received from the interviewees indicate that artists can play three different and important roles in the NVO project, as described below:

- **Artists as potential NVO collaborators:**

Artists have the knowledge and skills to help devise tools, metadata and interfaces in accordance to the needs and expectations of a broad range of audiences. The answers

we received from interviewees endorse and reinforce this view, and definitely indicate that these professionals should be involved in several different stages of the development of the NVO project: discussion of user needs, brainstorming new ideas, tools and forms of presentation of data, visualization and immersion issues, interface design, etc. Most of the interviewees have expressed their desire to participate in the process of creating compelling and innovative tools and interfaces. New approaches have been suggested by them regarding the presentation of information and tools, methods for navigating in a more intuitive or pragmatic way, and possible ways of establishing collaborations between users and scientists - all pointing to more effective and appropriate methods of knowledge acquisition. Interviewees have questioned how much of NVO's E/PO effort is about presenting information and how much of it is about engaging people in the process of science. Some artists currently working with scientific data say their job is translating data and information into another medium, both visually and cognitively. Artists also see users creating their own tools.

- **Artists as potential users of NVO**:

Artists have expressed their desire to take advantage of the E/PO offerings of the NVO project on a frequent basis, since they believe NVO has great potential in being able to present scientific data in a more interactive and multi-sensorial way, aiming at engaging non-traditional users of space science and astronomy web sites. They understand NVO-E/PO will provide access to a large scope of space science and astronomical related aspects and issues, providing the audience with a broader and more complete view about the Universe.

- **Artists as potential promoters of NVO**:

Another important role artists can play is as potential promoters of the NVO project. The art community's practice informs the general public on new discoveries, ideas and concepts, and has the potential of multiplying and extending the dissemination of knowledge on space science and astronomy. For example, art and science museum exhibitions and the film industry have been playing a crucial role in terms of disseminating information on space science and astronomy as well as fostering people's curiosity and interest on those issues. Other interesting combinations of art form and/or educational practices such as planetarium exhibitions, interactive or immersive installations, science events and festivals, are also potential conduits for the dissemination of information and curiosity, leading to a greater acquisition of knowledge on issues about our Universe by the general audience.

It is therefore crucial that these professionals participate in different stages of the NVO-E/PO project - from the early stages of brainstorming and structuring of preliminary ideas, to the advanced stages of implementing, using and testing resources - so that creative solutions may emerge and be adequately and efficiently developed for use by different segments of the general audience.

We hope this study will contribute to the design of more appropriate and efficient interfaces with regard to the diverse NVO-E/PO users' groups, which will in turn lead to better acquisition, use and dissemination of knowledge about the Universe.

1. Introduction

1.1. Nature and scope of the study

The National Virtual Observatory (NVO) [1]— a ten-year initiative sponsored by NSF and NASA — will bridge the vast yet separate collections of astronomical data from space and ground-based observatories, providing rapid and seamless access to our knowledge of the Universe. The NVO will enable new modes of scientific investigation and reveal phenomena that have not been detectable to date.

As far as the general public is concerned, The National Virtual Observatory (NVO) provides an opportunity to expand the existing NASA OSS Education and Public Outreach effort by identifying new user communities with a long-term interest in science and technology literacy.

Over the past two summers The SEGway Project of the Center for Science Education @ Space Sciences Laboratory, UC Berkeley, conducted a needs assessment study on how large databases of space science imagery, spectra and data analysis tools—to be provided by the National Virtual Observatory project (NVO)—can be used for Education and Public Outreach purposes.

In 2001, we selected the SETI@home user database, subscribed to by 7,000 school groups comprised of 100,000 students, to probe the goals of the educator user needs. The preliminary survey gathered information from one of our target groups, K-12 educators, on the use of on-line astronomy and space science resources [2].

In addition to the existing outreach efforts, NVO-E/PO has the potential to serve members of the art, entertainment, science museums, amateur astronomers and pre-service teacher communities.

Artists have been at the forefront of a number of innovative projects, utilizing emerging technologies. Over the last two decades, artists have not only used cutting-edge technologies as an intrinsic part of their artistic work, but also have devised and implemented technologies in diverse areas such as virtual reality, immersive environments, information systems, robotics, artificial life, microbiology, nanotechnology, sensorial extensions of the body, and space science [3]. The art community potentially constitutes a large percentage of future NVO-E/PO users.

Art-related science museum professionals – such as planetarium directors, exhibit designers, multimedia and web designers – also work at the crossroads of science, art, and education, and

[1] Documentation on the National Virtual Observatory project can be found at http://www.us-vo.org/

[2] Preliminary findings of this survey can be found at http://cse.ssl.berkeley.edu/nvo/seti.htm

[3] Wilson, Stephen. Information Arts: Intersections of Art, Science, and Technology. MIT Press, November 2001.

most likely will constitute a substantial percentage of future NVO-E/PO users. They also play a very important role as users and disseminators of space science and astronomical information.

In light of the above, a study on the art community's interest in space science objects, imagery, tools and data (as part of large distributed databases that will be integrated by the NVO) was conducted from May-November 2002 at the Space Sciences Lab, University of California, Berkeley.

The principal goals of the study were to investigate how NASA imagery, information, metadata and tools can best engage and invite the non-traditional NASA communities — such as the art community — in the participation in and acquisition of the vast NASA resources.

1.2. Methodological aspects:

1.2.1. The role of participant groups (research team, focus interest group and consultants)

The research team of this study was composed by the following professionals:

- **Dr. Rejane Spitz**, Associate Professor at the Department of Art & Design at PUC-Rio University, Rio de Janeiro, Brazil, and a Visiting Scholar at the Space Sciences Lab, UC Berkeley.
- **Dr. Nahide Craig** (Director of the Science Education Gateway program (SEGway), at the Space Sciences Lab, UC Berkeley) - who also coordinated this survey.
- **Dr. Isabel Hawkins** (Director of the Center for Science Education at the UC Berkeley Space Sciences Laboratory, UC Berkeley)
- **Dr. Greg Schultz** (Center for Science Education at the UC Berkeley Space Sciences Laboratory).
- **Dr. Bryan Méndez** (Center for Science Education at the UC Berkeley Space Sciences Laboratory).
- **Dr. Roger Malina** (Space Sciences Lab, UC Berkeley, currently serving as Director of the Laboratoire d'Astronomie Spatiale, Marseille, France.)

This interdisciplinary research team - encompassing one electronic artist and five astronomers - was aided by a group of nine invited professionals from the art and science museum communities, which formed the **focus interest group**, and by five **consultants**, all participated on a volunteer basis.

We formed these groups in order to help us define the categories for analysis and questions for the interviewees, suggest potential interviewees, provide innovative input and ideas, and give feedback on this report. We considered it important to receive input from well-known, respected, and active members of both the arts and science museum communities. They expanded our view on the nature and type of questions that should be posed to interviewees, reduced possible bias in the selection of interviewees, extended the scope of this survey, and endorsed some of the decisions we made along the way.

The following invited professionals, representing different academic and scientific institutions as well as independent professionals, participated in these groups, and helped us in different stages of the research.

Focus Interest Group:

- **Sharon Daniel**
  Assistant Professor of Film and Digital Media / University of California-Santa Cruz

- **Ken Goldberg**
  Associate Professor of Engineering / University of California-Berkeley

- **Jim Gasperini**
  Independent Artist

- **Brett Stalbaum**
  C5 and CADRE at San Jose State University

- **Beau Takahara**
  Director and CEO / ZeroOne – The Art and Technology Network

- **Stephen Wilson**
  Professor, Conceptual/Information Arts (CIA), Art Dept, San Francisco State University

- **Marco Molinaro**
  ScienceVIEW - Director of Multimedia Development
  Lawrence Hall of Science / University of California-Berkeley

- **Steven dos Remedios**
  IT Manager, Chabot Space & Science Center

- **Susan Schwartzenberg**
  Senior Artist, Exploratorium

Consultants Group:

- **Mark Beam**
  Writer, researcher, producer, Founder / Creative Disturbance

- **Greg Niemeyer**
  Dept of Art Practice, University of California-Berkeley

- **Joel Slayton**
  Coordinator, CADRE at San Jose State University

- **Alan Gould**
  Director, Planetarium / Lawrence Hall of Science

- **Beverly Reiser**
  Independent Artist, LEONARDO

More detailed information on project participants can be found in Appendix A.

1.2.2. Tools and methods used for gathering information

With the aid of the focus interest group and the consultants' group, a list of thirty questions was devised by the core research team. These questions were grouped into six categories.

- Background information
- Philosophical/conceptual
- Web related
- Tools, functions and collaboration
- Art-Science interfaces
- References and recommendations

The list of the thirty questions posed to the interviewees can be found in Appendix D.

1.2.3. Selecting interviewees: process and criteria

Because the NVO is a long-term, ten-year initiative demanding futuristic ideas and innovative tools, a major criterion for the selection of interviewees from both the art and science museums' communities was the professional expertise of the interviewees in areas such as interface design, scientific visualization, exhibit design, and web-related projects, who would potentially contribute to the project with their updated, broad and futuristic perception of the possibilities and challenges of NVO.

Specifically, the selection of the interviewees was based on the nature and diversity of their art and digital art background, their professional practices, and on the institutions and organizations they represented, as described below.

- **media:** traditional media (such as painting, drawing, sculpture and illustration) and electronic media (such as web design, multimedia, interactive installations, virtual immersive environments, digital art and computer graphics animation)

- **age level:** representatives of different age groups

- **professional activity:** artists, art educators, art critics and curators, as well as art students

Art-related science museum professionals – such as planetarium directors, exhibit designers, multimedia and web designers – were selected according to their professional role and museum affiliation in the San Francisco Bay Area, due to budget constraints.

In each of the selected institutions, one or more exhibit designers were interviewed, as were a number of exhibit coordinators or directors of more specialized units such as the planetarium and multimedia resources.

Considering the short duration of this project – four months in total – we estimated the number of interviews we would be able to conduct during the survey would not exceed thirty.

Thirty artists and art-related science museum professionals were selected to be interviewed for this survey, suggested by the members of our research team, focus interest group, and/or by our consultants.

The issue of geographical representation of the U.S. nationally was also a methodological concern. Hence, the selected group of interviewees included professionals from the states of Arizona, California, Illinois, New York, and Texas.

A letter of invitation was sent to each potential interviewee, describing the nature of our study and some of its methodological aspects. The list of thirty questions was included as an attachment to illustrate the scope of the survey.

Twenty-eight of the invited professionals agreed to participate in this survey as interviewees. The final number of professionals interviewed for this survey was twenty-five.

In all, seventeen artists (electronic artists, traditional artists, educators, curators, postgraduate art students) and eight art-related science museum professionals (exhibit designers, planetarium directors, exhibit specialists, multimedia and web designers) were interviewed. A list of the interviewees' names, their affiliation, and educational background can be seen at Appendix B.

1.2.4. Interviewing Methodology

Semi-structured interviews were conducted in consonance with a qualitative methodological approach. We allowed each subject to expand freely on different aspects of the problem. The interviews also aimed at collecting data on the subjects' previous knowledge of space science issues and imagery, and on their interest in space science.

Each interview lasted approximately one hour, and was audio taped. Each interviewee signed a consent form prepared in accordance with the recommendations of the committee of the Protection of Human Subjects of the University California at Berkeley.

Interviews conducted in person took place in different locations, such as the SIGGRAPH 2002 Conference San Antonio, Texas; at the Chabot Space and Science Center, Oakland, California; at San Jose State University, San Jose, California; and at the Space Sciences Laboratory at the University of California at Berkeley. All the interviews took place between July 25th and September 20th, 2002.

Fifteen interviews were conducted in person, ten interviews were phone interviews. All the recorded interviews were transcribed.

Two of the subjects interviewed in person also sent their responses in written form, and one interviewee gave his responses only in a written format. The written responses were also incorporated in the survey, since they covered different aspects and brought new insights. In all, we received 28 complete responses from the 25 subjects interviewed in this survey.

A complete list of interviewees' responses is presented on Appendix E.

2. Outcomes of the Survey

A cross-analysis of the responses of the twenty-five subjects interviewed during this survey highlighted the outcomes listed below, which express their major desires, requests and recommendations for the NVO project.

1. **Foster and enable diverse forms and methods of online and offline collaboration between different users and/or groups of users, including facilitating dialog between artists and scientists**

2. **Allow information to be adjusted to users' skills, level of knowledge, needs, and interests**

3. **Provide interactive, dynamic tools and activities, as a means of engaging the audience in constructing their own knowledge about space science and astronomy that goes beyond mere acquisition of facts and information**

4. **Provide information on a multi-sensorial way, including as many data dimensions as possible (3D, animations, sound, etc.), as a means of facilitating knowledge acquisition on space science and astronomy**

5. **Develop specific astronomy-related search engines**

6. **Provide a description of the data sources and of the process, methods and criteria for image creation and manipulation**

7. **Provide historical, cultural and artistic information on space science and astronomy**

8. **Provide both virtual (web based) and non-virtual (printed) NVO related materials and information**

9. **Include the participation of artists, science museum professionals and science educators in different stages of the NVO project**

10. **Enable the discussion of philosophical and conceptual issues in the domain of space science and astronomy**

11. **Use NVO to bring back the "moon landing era" excitement of space science and astronomy to the general public.**

1. Foster and enable diverse forms and methods of online and offline collaboration between different users and/or groups of users

The importance of online collaboration was a consensus among interviewees. Collaboration between different users and/or groups of users – such as between artists and scientists, students and teachers, students and NASA, between artists, and between the general public and astronomers – was considered by most interviewees as a major capability NVO-E/PO should ideally provide for the general audience. Some interviewees suggested that collaborative communities could be created around space science and astronomy's common interests and topics, since "people might want to explore together."

Several subjects emphasized the need for devising and providing the audience with new tools to facilitate collaboration, and a few interviewees also mentioned the potential benefits of online collaboration for education.

Language was considered an obstacle for online collaboration, but interestingly enough, interviewees were more concerned about the different concepts and jargons employed by professionals from different areas – specially by scientists and artists - than about the different languages spoken by people from different cultures and countries.

Off-line forms of collaborations - such as workshops, grants, and artist-in-residence programs and activities - were also mentioned by some interviewees as a means to engage artists. Some interviewees suggested artists be able to submit their work and ideas to become part of NVO's repository.

2. Allow information to be adjusted to users' skills, level of knowledge, needs and interests

One of the most recurrent topics that emerged from the responses was the need for the scientific information offered by NVO to be broken down into very specific categories, so people from different age or educational levels can understand it. The great majority of interviewees agree that NVO should allow users to select the level of information to be presented to them, adjusted to different skills, knowledge, needs, and interest: *"I'm attracted to the idea of everything in one place, and of course scalable. It's a massive project to coordinate the information in such a way that you can take slices of it based on your particular perspective."*

Some subjects pointed out that information needs to be broad, but conversely, it also needs to be specific, and that the hierarchy of the information should be readily accessible, and easy to navigate.

3. Provide interactive, dynamic tools and activities, as a means of engaging the audience in constructing their own knowledge about space science and astronomy that goes beyond mere acquisition of facts and information

Interviewees have mentioned that NVO should not be only informing people of space science and astronomical issues, but *"giving people a space to their imaginations,"* and providing the audience with *"unexpected possibilities".*

By this they meant that not only should NVO-E/PO engage artists, but seek to inspire them as well*: "The issue in my estimation is that of engagement. How does this inspire me? How does the universe relate to me (the artist)? What does contemporary scientific information say to the artist, and what does it say about the situation humanity is in regards to itself and in contrast with the larger universe?"*

Some subjects have stressed that experiencing data, and taking part in the process, is an important means of engaging with the public: "*Actually having the experience, not simply reading about it is really, really important.*"

Art-related science museum professionals compared the high-end technology used by certain planetariums around the world to what NVO-E/PO could provide in terms of immersive experiences:

> *"I think with the technology that's coming to light now in the planetarium field, high definition all dome imagery […] can be used to present to [the] public in a more immersive environment... it's more realistic if the image is all around you vs. a 20" monitor. The Einstein Planetarium in Washington opened up the next level of all planetarium, detail and clarity of imagery. Germany is using lasers to the project imagery. When that becomes popular and more affordable then the sky's the limit."*

In the view of most interviewees, the NVO-E/PO project seems to be a potential opportunity to entice the public into learning more on space science and astronomy: *"NVO could be an a incredible tool for engagement with the public, I think this is a really unique opportunity for NASA to really get them excited again."*

Interviewees gave suggestions on how NVO-E/PO could engage the public— for instance, by commissioning artists to produce space science related work for the site.

> *"I think this notion of having some commissioned works in which artists specifically focus on conveying this sense of exploring this information space, also really completely broaden and deepen what you have. It will open the range of experiences that people can have, and people who will be drawing into that process - that could really help supply a fundamental elements of connecting space science with the public good actually."*

Most subjects would like NASA to "think as much outside the box, outside of Earth and into the Universe, as possible". They would like NVO to be an inspiration, a catalyst, and not just a repository of information:

> *"Think of it as something that goes out and creates new stars, instead of just coalescing all the stars into whatever. Make it an energetic, creative thing that goes out."*

4. Provide information on a multi-sensorial way, including as many data dimensions as possible (3D, animations, sound, etc.), as a means of facilitating knowledge acquisition on space science and astronomy

Interactivity, animation, immersive environments, online collaborations, all were possibilities cited by the interviewees as to what NVO-E/PO could provide for its artistic-minded audience. The common sense seems to be *"the more dynamic, the more engaging."*

In the view of most of the survey's subjects, the notion of Cosmos suggests and is related to dynamism, action, motion and change:

> *"I think in space everything is dynamic, because it's always moving, always changing."*

Several interviewees prefer that navigation be interactive and intuitive, and that users should have the sense they are actually navigating through three-dimensional space throughout the Universe:

> *"Space and time as an element, space travel and discovery should actually be the way the site be navigated. How can we change space, change time through the interface?"*

Some interviewees suggested that some interactive, dynamic, and successful experiences which can be performed and experienced in the concrete world should be translated into the virtual world:

> *"Going to an observatory and looking through those big telescopes can blow people away. If there's some way of getting that to them of what this is like, I think that would change a lot of people['s] perspectives…"*

The issue of representation was thoroughly discussed during the interviews, with emphasis on the differences between two- and three-dimensional representations. Most interviewees agree that information can be presented in different ways and dimensions, but there is a consensus that each added dimension or feature gives more information about the content:

> *"I don't think of myself as a 2D or a 3D artist; I think of myself as an artist. So as many dimensions to the tool that you could give, given the constraints of the technology, I think would be wonderful."*

> *"I'd love to have something more than 2D images. They convey the information, but I think it would be highly imaginative to have something different."*

The use of 3D representations was strongly recommended by most interviewees:

> *"I think 3D helps you to understand the images better. I mean, I started out as a 2D person, so I can read 2D images very well, but also if an image is beautiful I look at it as a beautiful image, 3D really allows you to understand it more completely."*

> *"2D is limited. […] The handling is important, 3D is important. When you look at pictures, when you can look at the axis around, that's really more effective. If you had images you could swing around and look at from different...it's a lot more engaging, interactive."*

"Definitely a difference. I can be very happy with 2D images as a painter…that doesn't bother me at all. When I'm thinking of molecular structures…that there's more operating that just the Moon goes in front of the Sun…I think 3D helps a lot… I like seeing different perspectives...we're always on the exact same perspective…"

" Absolutely 3D. I get so deeply into 3D right now. At physical objects, 3D is the best to go. Qualitative data, 3D may not be better than anything else. 3D affords you multiple perspectives, if you can rotate it, you have a better understanding, you can model things in your mind's eye. I know the potential for understanding was so much bigger."

"I think it would be interesting if we had a tool that we could take to look at a 3D space, maybe the Andromeda Galaxy and Milky Way Galaxy, to have a tool that would extrapolate where it is now. As we go out further, of course we have less and less data, but it would be interesting for people to see what we're seeing versus where they might be now"

It is interesting to note that when interviewees refer to 3D, they usually also refer to other dimensions of information or features such as animation, film and sound:

"It's possible to use sound and imagery and movement through 3D space, yet each one of those has implications of a kind of falsification. At the same time, they are really giving us information. Information that is given to us through instruments, that wouldn't even register on our senses."

The notion of realism is another concern expressed by the majority of our survey's subjects:

"Strongest recommendation is to make the environment in which the viewer will be looking at the images as realistic as possible, i think it'd make it more real for them. 2D or 3D, whatever, to make it as realistic as possible."

Some subjects believe NVO could incorporate multi-sensorial features which would enable users to experience the Universe and learn more about it through the use of their different senses:

"…We've been talking about this a great deal, an expansion of the sensory. Looking at it from the perspective of an intuitive form of ergonomics, an intuitive form of information architecture, […] multiple ways of visualization, multiple ways of using the senses to analyze data so we could ascertain these patterns."

It seems that the use of cutting-edge technologies in space science-related productions – such as video games and movies – has strongly influenced the perception of most interviewees regarding the potential of NVO. In spite of the constraints and limitations of the currently available web technologies, most interviewees have expressed their desire to navigate through the Universe in a virtual reality environment, and many of them have mentioned they would expect NASA to research and implement cutting-edge web-related technologies for enabling this to happen in the near future.

5. Develop specific astronomy-related search engines

Most of the interviewees use general search engine tools (such as Google) when looking for information on topics related to these areas. They reported several problems they have encountered when using these general search engines, and mentioned their desire of using specific astronomy-related search engines – which would be more appropriate for finding specific information about astronomy and space science. *"If somebody did a good search engine for space-related information, that would be a contribution."*

In fact, the interviewees' responses showed that artists are not frequent users of astronomy and space science sites. Most of the interviewees use only general search engine tools when looking for this kind of information, a few of the interviewees visit the NASA or the Hubble Space Telescope websites sporadically, but the majority of the interviewees simply do not search for information on space science and astronomy on a frequent basis. This is also true for some of the interviewed art related professionals working at science museums, in areas such as web design and exhibit design.

Some subjects explained what kind of difficulties they encountered when navigating or searching science-related sites, and suggested some ideas:

> *"If there was a way to organize their library of images, to be navigated a little more visually as well as systematically... [intuitively?] Yes."*
>
> *"Some practical things are to be able to, if they're presenting a collection of images, I think it's important that there be thumbnails to look at pretty quickly. Unfortunately with most of the NASA sites […] are usually so hard to penetrate for the average person. You have to do a lot of back and forth searching before you find what you're looking for. If initially there's a very small thumbnail that gives me a glimpse if it's close to what I'm looking for. I tend to be able to find factual information faster than I'm able to find a particular image. If you're talking about artists it's the same problem. An artist needs not only simple to find a certain content, but a certain expression of that content. It's often the situation that you don't know exactly what you're looking for until you find it. So it can be helpful to be able to gloss over a lot of images quickly to get a sense of what's out there, and then focus in from there."*

6. Provide a description of the data sources and of the process, methods and criteria for image creation and manipulation

Interviewees considered the authenticity and reliability of the information presented by NVO as a very important topic. They expect NVO-E/PO to provide users with a description of the data sources and of the process, methods and criteria employed for image creation and manipulation.

> *"What I need is a visual tool that will also be an educational tool that would really show how they're grabbing the images from the sky."*

"I think the public would at least like the option of clicking somewhere and getting more info...What's it made out of? Why does it have this really bright streamer?"

7. Provide historical, cultural and artistic information on space science and astronomy

Some interviewees highlighted the fact that people are quite intrigued by the history of scientific knowledge, and recommended NVO-E/PO should present information on astronomy-related historical data: *"To be able to walk through the history of astronomy is to walk through the understanding of how we know some of the stuff we know."*

They suggest there should be links to artistic and historical information, as well as to the way different cultures perceive and understand space science and astronomy:

"Having links back to the historical foundations of some of these telescopes and images we're seeing, why is a certain nebula named after this person and what's the historical relevance of that particular constellation in the sky—I mean, being able to take the information and have it so readily available to artists and humanities people that it almost becomes like a digital atlas or a digital book, a picture book, that I could go to and really find my place in the universe."

"I want to make a map of the sky where whenever you click on a....in all of the different known cultures, and maybe even tell the story of those constellations"...The Big Dipper is not always the Big Dipper. ...spend time doing, to gather up all of the information."

8. Provide both virtual (web based) and non-virtual (printed) NVO related materials and information

Some interviewees pointed out that cutting-edge technologies for presenting the information on the web should be provided along with traditional printed materials. They believe NASA should be equally concerned with the production and release of virtual and non-virtual materials:

"I think NASA should still continue to print their photographs in photograph books and books on the universe and space, and scientific magazines too. Still publishing books with really fine pictures in them is really very helpful." Don't go only virtual. So children that don't have access to computers or people can have access to these materials at the libraries. "

They are also concerned about forms of publicizing the website other than the computer. They think it would be important to download *"some of the fabulous pictures so you can use it, certainly for education. For other artists, fliers to university art departments. some fabulous catchy flier/poster. "Like this image? NASA's new website".*

9. Include the participation of artists, science museum professionals and science educators in different stages of the NVO project

Most of the interviewees highlighted the fact that artists, science museum professionals and science educators should definitely participate in the NVO project - from the early stages of

brainstorming and structuring of preliminary ideas, to the advanced stages of implementing, using and testing resources - so that creative solutions may emerge and be adequately and efficiently developed and used by different segments of the general audience.

Interviewees listed a series of professionals which should be involved in the design and development of the NVO project, such as designers, information architects, science museum professionals, science educators, artists and electronic artists.

10. Enable the discussion of philosophical and conceptual issues in the domain of space science and astronomy

The interviewees responses denote their strong interest in philosophical and conceptual issues concerning space and astronomical topics.

It is interesting to note that although our aim during the interviews was to obtain a balance between conceptual and pragmatic issues concerning the NVO, most of the interviewees expanded on the conceptual and cultural aspects of the problem, but did not show the same level of interest in terms of the more pragmatic questions.

> *"You want imagination to be on the same level as data and information. In this conceptual view of space, space should have imagination in a forefront position, that kind of reflective imagination needs to be a multi-vocal imagination, not just one message, but it needs to encompass more points of view. That's what would make it part of and accessible to human experience."*

11. Use NVO to bring back the "moon landing era" excitement of space science and astronomy to the general public

What would be the equivalent to the "moon landing era" excitement in today's world? According to the interviewees, exploration today is done through data, so the excitement they want to bring back has to do with participation, collaboration, the possibility of accessing the data in different ways, of adapting and adjusting the information to the user needs, of creating their own tools and devising their own codes and software.

3. Recommendations for the NVO project

The outcomes of the interviews discussed in the previous chapter reflect the major desires, requests and recommendations of representatives of the art community as regards the NVO project.

In this Chapter we present and discuss the final recommendations of this study's research team for NVO. These recommendations - although primarily based on the interviews' outcomes - also take into consideration some other relevant factors, reflecting the research team's experience in space science and astronomy education and public outreach.

One important factor considered by the research team for addressing recommendations to NVO was our knowledge of space science and astronomy sites and software which are already available for the general audience, as well as on potential web resources and technologies which are currently being developed and implemented by major space science and astronomy-related institutions. According to the survey's responses, we may conclude that the majority of the interviewees – not only artists but also some of the science museum's art-related professionals - do not know of several space science and astronomy web resources, tools and services currently available on the web.

Another relevant variable considered by the research team when outlining these recommendations was the degree of feasibility and appropriateness of some of the interviewees' suggestions as regards the scope and major goals of the NVO project. While some of the outcomes were coincident with NVO established goals, some other requests and desires were far beyond the scope and objectives of the NVO project.

We also considered it important to address recommendations to both NVO and NVO-E/PO potential providers, since these two projects and groups greatly differ in terms of their role, scope and goals.

Consequently, the following recommendations, as listed in Table 1 in the Executive Summary, represent a summary of the views, desires, and requests expressed by the art community in relation to the NVO, filtered through the research team's careful analysis of other aspects of the problem, which, in our perception, should also be considered.

1. Online and off-line collaboration between different users and/or groups of users including facilitating dialog between artists and scientists.

NVO should encourage communication between users and/or groups of users and allow interdisciplinary collaboration to take place. We recommend online and off-line forms of collaboration to be enabled and implemented by both NVO and NVO-E/PO potential providers.

Fostering off-line forms of collaborations - such as promoting and sponsoring art/science workshops, grants and activities – is also highly recommended to NVO-E/PO, as a means of encouraging and strengthening the dialog between scientists and artists. NVO should be concerned with the bridging of those areas, enabling professionals from different fields to work and collaborate, and to learn from each other's expertise. In their effort to bridge the science and art communities, several renowned scientific institutions around the world are sponsoring fellowship and artist-in-residence programs, which has proven to be a very successful method for cross-pollinating those communities' different views and perspectives, leading to interesting cross-disciplinary studies and projects. Commissioning artists to produce space science related work for NVO is also suggested as a way of engaging artistic-minded users and promoting the NVO initiative among the art community. Artists should also be able to send their work and ideas to be included as part of NVO's repository.

New tools and features must be developed to facilitate and enable collaboration between users from similar or different areas of knowledge, as well as different cultural contexts. Language differences (different jargons, definitions and concepts employed by professionals from different areas – specially by scientists and artists) should also be considered and – whenever possible – facilitated.

2. Allow information to be adjusted to users' skills, level of knowledge, needs and interests

NVO should provide necessary infrastructure to allow information to be adjusted to users' skills, level of knowledge, needs and interests. In turn, NVO-E/PO potential providers should be able to scale the level of information and provide users with tools to select their entry level on different topics.

3. Provide interactive, dynamic tools and activities, as a means of engaging the audience in constructing their own knowledge about space science and astronomy that goes beyond mere acquisition of facts and information

NVO has the potential to engage the public into learning more on space science and astronomy. As previously discussed, the interviewees' notion of Cosmos suggests and is related to dynamism, action, motion, and change.

We recommend NVO to provide the necessary infrastructure to allow interactive, dynamic tools and activities to be devised and provided to the general audience.

Interactive, dynamic and successful experiences which can be performed and experienced in the concrete world should also be translated into the virtual world. Artistic-minded users expect and desire to "have the experience, not simply reading about it". Therefore NVO-E/PO potential providers should devise interactive, dynamic tools as a means of engaging the audience and facilitating knowledge acquisition on space science and astronomy.

4. Provide information on a multi-sensorial way, including as many dimensions as possible to data

The use of cutting-edge technologies in space science related productions – such as video games and movies – has strongly influenced the perception of most interviewees as regards the potential of NVO. In spite of the constraints and limitations of the currently available web technologies, most interviewees have expressed their desire of navigating through the Universe in a virtual reality environment, and many of them have mentioned they would expect NASA to research and implement cutting-edge web-related technologies for enabling this to happen in the near future.

In fact, recently launched multimedia projects – such as the 3-D visualization program *Partiview*, developed by the Hayden Planetarium - are proving that the use of 3D immersive, interactive environments can be very effective and engaging as a learning tool for space science and astronomy.

Therefore, we recommend NVO to provide the necessary metadata and file format infrastructure to allow information to be presented on a multi-sensorial way.

In terms of NVO-E/PO potential providers, we recommend presenting information on a multi-sensorial way, such as 2D and 3D static and animated representations with sound effects and immersive environments for navigation whenever possible, which would enable users to experience the Universe and learn more about it through the use of their different senses.

5. Develop specific astronomy-related search engines

This survey's responses showed that artists are not frequent users of astronomy and space science sites. This is also true for some of the interviewed art-related professionals working at science museums. Therefore, based on the interviewees' requests and comments, and considering the potential role of NVO-E/PO for the general audience, we suggest NVO provide infrastructure to allow the implementation of search engines for astronomy-related information.

We also recommend NVO-E/PO potential providers to implement search engines for astronomy-related information - aiming primarily at the artistic-minded audience - as a means of engaging this community and facilitating their acquisition of knowledge on space science and astronomy.

6. Provide a description of the data sources and of the process, methods and criteria for image creation and manipulation

In the light of the survey's responses, and as discussed in the previous chapter, we recommend NVO provide the metadata language appropriate to lay users, and tag the history of processing and manipulation of the data (from raw to processed), so that NVO-E/PO potential providers can describe the sources and the step-by-step data processing and manipulation techniques and criteria.

7. Virtual (web based) and non-virtual (printed) NVO related materials and information should be provided in parallel

We recommend NVO-E/PO potential providers to present information on different formats and using different media, to meet both technological and cultural requirements, constraints and specificities of different segments of the artistic-minded audience.

We suggest cutting-edge technologies for presenting the information on the web to be provided along with traditional printed materials.

8. Request for the participation of artists, science museum professionals and science educators in different stages of the NVO project

Most of the interviewees highlighted the fact that artists, science museum professionals and science educators should definitely participate in the NVO project - from the early stages of brainstorming and structuring of preliminary ideas, to the advanced stages of implementing, using and testing resources - so that creative solutions may emerge and be adequately and efficiently developed and used by different segments of the general audience.

In our view, artists can play three different and important roles in the NVO project, as described below:

- **Artists as potential NVO collaborators:**

Artists have the knowledge and skills to help in devising tools, metadata, and interfaces in accordance with user needs and expectations. Interviewees' responses endorse and reinforce this view and definitely indicate that these professionals should be involved in the development of NVO in several different stages of the project (discussion of user needs, brainstorming new ideas, tools and forms of presentation of data, visualization and immersion issues, interface design, etc.). Most of the interviewees have expressed their desire to participate in the process of creating compelling and innovative tools and interfaces. New approaches have been suggested by them as regards the presentation of information and tools, methods for navigating in a more intuitive or pragmatic way, possible ways of establishing collaborations between users and scientists, all pointing to more effective and appropriate methods of knowledge acquisition. Interviewees have questioned how much of NVO is about presenting information and how much of it is about engaging people in processes. Some artists currently working with scientific data say their job is translating it into another medium, both visually and cognitively. Artists also see users creating their own tools.

- **Artists as potential users of NVO**:

Artists and science museum professionals have expressed their desire of visiting NVO on a frequent basis, since they believe scientific data will be presented in a more interactive and multi-sensorial way, aiming at engaging non-traditional users of space science and astronomy websites. They also understand NVO-E/PO will be presenting a considerably large scope of space science and astronomical related aspects and issues, providing the audience with a broader and more complete view about the Universe.

- **Artists as potential promoters of NVO**:

Another important role artists and science museum professionals have is as potential promoters of the NVO. Art and science museum communities' practice informs the general public on new discoveries, ideas and concepts, and has the potential of multiplying and extending the outreach of knowledge on space science and astronomy, in terms of the general public. Art and science museum exhibitions and the film industry - for instance - have been playing a crucial role in terms of disseminating information on space science and astronomy as well as fostering people's curiosity and interest on those issues. Other interesting combinations of art form and/or educational practice - such as planetarium exhibitions, interactive or immersive installations, science events and festivals - could also be mentioned as potential conduits for the dissemination of information and curiosity, leading to a greater acquisition of knowledge on issues about our Universe by the general audience.

It is therefore important that these professionals participate in different stages of the NVO project - from the early stages of brainstorming and structuring of preliminary ideas, to the advanced stages of implementing, using and testing resources - so that creative solutions may emerge and be adequately and efficiently developed and used by different segments of the general audience.

In conclusion, we hope this study will contribute to the design of more appropriate and efficient interfaces as regards the diverse NVO-E/PO users' groups, which will in turn lead to better acquisition, use and dissemination of knowledge about the Universe.

4. Potential Future Developments

We would like to continue this project by conducting an ***Interface Prototype Development.***

This effort would consist of research and development of interface elements to optimize the use of the tools, data and imagery to be provided by the NVO-E/PO project, targeted at the art community. This interface prototype aims to foster this community's interest in space science and astronomy, enabling them to use the on-line information as part of large distributed databases integrated by the NVO-E/PO project, and to acquire knowledge about those fields of study.

This ***Interface Prototype Development*** will encompass the following activities:

- Identification of how the website attributes and characteristics highlighted during the interviews could be implemented as part of NVO-E/PO demonstration websites for the art community, giving existing exemplary websites as guidelines.

- Development of a website as an entry point for artists and art-related science museum professionals to the NVO-E/PO project, aiming at optimizing the use of the tools, data and imagery to be provided online for these communities

- Evaluation of the website demo prototype, through the use of a variety of qualitative methods and evaluation procedures, which will include inviting artists who were interviewed during the first stage of the project, and an external group of artists (working with traditional media and/or electronic media) to use and comment on the demo prototype.

5. Cross-Analysis of Responses

For this survey, we conducted semi-structured interviews with twenty-five subjects, in consonance with a qualitative methodological approach. With the aid of the focus interest group and consultants, the core research team devised a list of thirty questions (*see Table below*). These questions were grouped into six categories:

- Philosophical/conceptual
- Background information
- Web related
- Tools, functions and collaboration
- Art-Science interfaces
- References and recommendations

• ***Philosophical/ conceptual***	
01.	How do you define "space"?
02.	If you had to locate your coordinates in space, what would they be?
03.	If you had to describe the environment / location in which you live, what would you say?
04.	If you could travel to any destination in the Universe, where would you go?
05.	What do you envision about your travel destination?
• ***Background information***	
06.	Do you use scientific data as part of your work as an artist? What for? When?
07.	Do you see any possible interaction between the kind of work you do, and scientific, astronomical data?
• ***Web related***	
08.	Have you ever visited web sites about space and astronomy? Which ones?
09.	List your favorite and least favorite science sites and why are they so?
10.	List your favorite websites in general, and why are they so?
11.	Do you find these sites useful? Do you consider you learn something when navigating these sites? Why?
12.	Are there any problems you encounter when navigating these sites?
13.	What kind of interaction would you like to have with web sites presenting scientific data?

• ***Tools, functions and collaboration***
14. What kind of information and data would you hope to find in a website about astronomy and space science? 15. What kind of tools do you expect to find on a site presenting information and data, such as imagery, on astronomy? 16. Should there be specific tools for artists to explore the Universe? What kind of tools? 17. What kind of on-line tools would facilitate use of astronomical or space science data in your creative work? 18. What kind of interactions/collaborative work could be fostered /provided by a site on astronomy and space science? 19. If you could choose a unit to describe the distance between the Earth and Mars, which unit would that be? Would that make it real to you? Why? 20. Do you find scientific measurement units meaningful or too out of context from daily experiences? How so? 21. How do you relate to light years, Angstroms, terabytes, joules, nanometers, etc? 22. For your kinds of projects, would a 2D or a 3D representation of space science and astronomy data be more important? 23. As regards space imagery, what in your view should be static and what should be dynamic? 24. How much supplementary information should accompany space science and astronomy images and models?
• ***Art/Science interfaces***
25. How could artists contribute to space science and astronomy? 26. What is the role of art in visualization or interpretation of outer space or the Universe? 27. What do you think the role of scientific data and astronomy could be in Art?
• ***References and recommendations***
28. Do you know of other artists working with scientific data and/or astronomy data? 29. Could you cite some relevant works in the Arts which involve scientific data and/or astronomy data? 30. Do you have any recommendations to NASA on how to make space science and astronomy data and imagery interesting/accessible/useful to artists?

Table 2 - Questions for Interviews

Fifteen interviews were conducted in person and tape recorded, ten interviews were audio taped phone interviews. All the recorded interviews were transcribed.

The interviewees' responses to each of the questions are presented in full in Appendix E.

The following is a cross-analysis of the interviewees' responses:

5.1. Philosophical/ conceptual questions

In order to know the needs, desires and requests of the art community regarding space science and astronomy issues related to NVO-EPO, five philosophical/conceptual questions were posed to subjects at the very beginning of their interviews.

We asked questions that were aimed at investigating the scope of the interviewees' perception and understanding of the Universe. They were composed in a manner that would encourage the subjects to think beyond the limitations and boundaries of their immediate surroundings, inspiring them to reflect on and explore the full extension and complexity of the Cosmos.

Their responses denote the strong interest artists have in philosophical and conceptual issues – in this case, related to space science and astronomy - as we will see in this section.

01. How do you define "space"?

It is interesting to note that most interviewees referred to the opposition of outer space and inner space:

> *"Well, in the context of the project, I first asked,* ***"Is it outer space? Inner space?"*** *To explain, I think it is what surrounds you. Your immediate - it could be the table, or outer space and the planets, it could be oceans or molecules going into that. So space is, for me, immediate space and what is around me when I look around and what I feel. It is what I am experiencing with the senses--the touch, the feel, the smell. The other space, I know it exists, but does it exist really? Or is just part of my imagination? Is it something I create as I move?" (CJ)*

> *"Space is very interesting because it doesn't necessarily mean* ***outer space*** *as you might think of the solar system and the universe. It can mean space around you, interior and private space, just the sense of wanting to be by yourself and away from a crowd, it could be* ***inner space****..." (PF)*

> *"Space for me is space in painting, architectural space, earth space, planet space,* ***outer space, there's inner space****, spiritual and emotional space and physical space. I think there's a lot of different spaces and auras as people, whether it's spiritual or physical or emotional." (DT)*

> *"I'm not sure. Mathematical descriptions. Geometric space****, living space****,* ***outer space****." (PH)*

"In my more contemplative moments I'd like to think that even when I step outside or just open my window that that same giant space of ***"outer space"*** *or the universe is really the same space that's coming in through my window, around the objects on my desk, around me. I end up going into the more cosmic definition of it." (CH)*

"In the context of this project when you talk about the virtual observatory, space to me suggests ***outer space****. But there are so many ways to define space. Space can be the area that contains whatever the structure is, or your location on a planet, I don't really have one definition." (GW)*

Another recurrent comment made by interviewees had to do with the notion of emptiness of space, as opposed to the perception of space as a filled entity:

"Space ***is something that is not filled****, and that means that space is an opportunity, a place where something can happen, there's a potential here."*

"Space is ***not an empty thing****, but something that is packed with promise – very much a generating force, and that which defines everything that's not space." (JACM)*

"I primarily think of volume, of the space between things, whether they're things of our immediate environment or between planets or whatever. When I really think of space I consider that ***there's much more of what we perceive of as empty space than there is of "stuff", even though I know empty space is not as empty as it seems to be****. I can sometimes remember being younger, looking at the stars and feeling a lot of awe about how much space there was, and how little we were." (CH)*

"I think of my warehouse as my space. ***I don't think of it as empty, but I think it can be empty.*** *I wonder about the expanding universe and what's at the end, or beginning… I think there's usually space and time together, I frequently think of space without time, what that would be like....someone filling up something, and that something would be space...****I'm aware that there's emptiness between these things. Filled with something can be emptiness****." (JG)*

Interviewees described several definitions of space, reflecting the general use of this concept in our everyday life, in different fields:

"This is difficult for me to define, because I feel that there are so many ambiguities to this term that coexist. This includes terms for ***discursive, existential, cognitive, virtual, architectonic, social spaces*** *to mention a few, but in the strictest astronomical sense, space exists for me as the continuum within which the objects and forces exist within what we describe as the known universe." (PL)*

*"I don't know if I have a hard mental picture. When I get into this type of …my mind tends to turn into the spiritual side of things…****spiritual space*** *as well, your internalization of the universe, …and your role in it…You are your own universe. Your ability to get outside of that...You're always ground zero, right?" (SL)*

Some interviewees also highlighted the multiple ideas about space which co-exist and influence each other:

*"I don't think there's any one reading of space. I feel I live with **multiple ideas about space that are simultaneously present in my thinking**. My interior space, my thoughts, my exterior space, my relationship to whatever physical space I am in, the space of memory, the space that you occupy when you're reading, the space you occupy when you're speaking to someone else or relating to someone else. There are many multiple spaces, and the mental map of those spaces allow them to coexist with each other and for us to make sense of them. I think **those are all physical as well as mental spaces, they very much each have a different character** […] they have a lot of emotional, intellectual, physical effect." (AW)*

*"There's physical, there's conceptual, there's…space to me, **you can look at it from a spiritual or physical scientist point of view**. Or philosophy in-between, and I try to stand in all those. It can even symbolize infinite possibilities, because of the unknown. A spiritualist might look at it as heaven, or infinite possibilities in a spiritual sense. or theoretical, it can be solid, composed of energies, we don't completely understand or acknowledge yet. For me, I tend to want to understand everyone's point of view in something, and **I adopt as many views as possible**...take everything into account. In one sense I'm a scientist with an artist heart. And in another sense I'm an artist with a scientist heart. I avoid quantifying qualitative information." (GM)*

02. <u>If you had to locate your coordinates in space, what would they be?</u>

The responses to this question showed that most interviewees locate themselves in the center of the Universe:

*" I guess I would be **the center of space, the "zero zero".** Which is egocentric if I think about it, but no, I couldn't locate it in a kind of universal longitude-latitude situation. I know where I am on a map, but I guess I would be the center of that too. Zero zero zero." (CJ)*

***"(0,0,0)** - all coordinate systems have an origin. I choose to not take an arbitrary center." (JM)*

*"I can think of it in two ways. Because I'm the only thing I know, for me **I'm the center of coordinates in space**, because I define the world according to my position in it. There's that sort of relative coordinate space. If I think about it in broader terms, the coordinates don't matter because it's continuous, it's everywhere. I am a part of it, but it's all alive and moving and pulsing and becoming, so coordinates don't make sense any more, there is no reason for that word." (JACM)*

*"If I am thinking self-centered**, I can think of myself as the coordinate zero zero zero with everything else going around me**. Or I can think of myself as a tiny infidecimal spot on the earth, coordinates might be zero zero zero, but it might be actually the center of the earth, the earth-center. Right now I'd say, everything would be from around me. I would be my coordinates as zero zero zero." (PF)*

*"**Zero zero zero**. Just like Edward Hume, I guess." (SL)*

Some subjects mentioned the planet Earth as their first reference point. From there they would go beyond, to include the Milky Way and other galaxies and clusters of galaxies:

*"**This planet**, this planet is going around this star,...one of billions in my home galaxy, the **Milky Way**, within trillions of galaxies...this side of the **Virgo super cluster**...from a technical astronomical viewpoint." (DC)*

*"Well, I guess it depends on what scale you talk about. The **planet Earth**, Oakland, CA, United States, planet earth, third planet from our Sun, 2/3rd way out […] **Virgo super cluster of galaxies**. As far as coordinates, unless you have a point of reference, don't really mean much in the universe. **My point of reference would have to be the Earth. This is where we are, we go out from here, out into the future.** That would be meaningless to an intelligent civilization elsewhere, our coordinate system would be useless. In science fiction everyone has hours, days, the earth hour is very different form the hour on mars... Martian hour? Whose hour are we talking bout? They just let it slide." (RD)*

*"I would do it in stages, by locating myself **on the face of the globe**, either by latitude/longitude, or by more naturalistic ways of locating myself on the face of the planet. "I'm on a hillside next to a bay on the planet Earth", and just stepping out from there, where the Earth is in relationship to the Sun and stepping out again, to how the sun is in relation to the **Milky Way**, and even though I know that there is structure beyond that, my knowledge of how the Milky Way is surrounded by the immediate environment of everything else is pretty fuzzy." (CH)*

Other interesting interviewees' comments suggest the influence of technology in physically defining and mentally shaping the notion of our location in space. They refer to their I.P. address on the Internet, to GIS (Geographic Informational System) and to GPS (Global Positioning System):

*"**130.65.200.17**. That is definitely a very important coordinate for me. That was my IP address for a long time, I'm current switching over to one in UC Santa Barbara and I don't know what that IP address is yet." (LJ).*

*"Right now **I'm at 598,493 Easting, 413 and 2967 Northing,** because we've been doing a project about locating sites in San Francisco and San Jose for publication called public lands. So I know the coordinates of where I am in terms of Northing and Easting values. I would consider myself at those specific geographic coordinates in terms of USGS Northing and Easting values." (GW)*

*"In a very traditional sense, one might say, **"I can be defined by my GPS coordinates,"** which would include whatever the satellite picked up of where I happen to be. Those would be more of the traditional coordinates. But I would like to think there are many more dimensions by which we can actually define where we are located, and definitely GPS is a very earth-centric type of measuring system." (NR)*

Another example of how technology affects our mode of thinking is illustrated in the response of this interviewee, who refers to the technique of triangulation as a means to locate her coordinates in the emotional space:

> *" I think it depends what space you're in, of course, what coordinates are within that space. In terms of* ***emotional space*** *it might be something today, something different tomorrow. It's difficult for me to say what my coordinates are.* ***You kind of triangulate yourself into your current location****, all kinds of ways." (LJ)*

03. If you had to describe the environment / location in which you live, what would you say?

Once again, artists had a chance to expand on philosophical and spiritual issues about their environment and their location in the Cosmos.

Interviewees described their environment with expressions such as a "warm, sexy, moist spot" (WC), or "rich in matter, energy and spirit" (JACM), and expressed their satisfaction with their environment and habitat:

> *"****I live in a beautiful area*** *that has wonderful mountains, you can go to the seashore, you can go to very gorgeous physical landscapes around where I live." (DT)*

One interviewee stressed that the cognitive and spiritual space is more important and in some ways dominates the physical space:

> *"When I think about it that way,* ***my universe is in my thoughts, it is not actually the physical body.****" (CJ)*

Another interesting comment has to do with the different concepts of scale and distance in the physical and virtual spaces:

> *"I would say that it* ***is both limited in physical space and much larger in virtual terms****. On a day to day basis, I travel very little outside a 4-mile radius, but through electronic means, I span thousands of miles every day." (PL)*

04. If you could travel to any destination in the Universe, where would you go?

Interviewees expressed their preferences, demonstrating their different levels of knowledge and understanding of space science and, astronomy, and their perception of the Universe:

> *"****The moon of Io****, that would be a first destination. Something like that, that is close and immediate, even though it would take 30 years to get there, something like that."(CJ)*

*"Maybe I'm being rather simplistic, but **I'd really like to visit another class M world that supports life**, something that would be hospitable to me, but something that would be so totally different, a different set of circumstances, it would be something compatible yet alien to me, on one hand I'd be able to survive, on the other hand it'd be something that's such a complete disconnect, it would be an entire world without me, that happened without me, and would go on, survive, without me, but something that I would have to completely reorient my entire paradigm to even deal with." (PL)*

*"**Saturn**. I'm very interested in, from the outside the rings look solid, but when you get up there, they're not solid, they're particles floating together in this gravitational field. I find that really interesting, how it breaks up in pieces. The closer you get to something and you suddenly see it break into pieces, like pixels, like points in a painting, and then you walk away and suddenly it's a solid thing. That would intrigue me to go to Saturn." (GS)*

*"**The Magellanic clouds**, which has a nice view of the Milky Way galaxy. If I can be well protected, the center of the galaxy, probably in a disembodied form. There's a massive black hole in the middle, generally not very good for you." (PH)*

Many interviewees agree on that instead of going to a distant planet, or flying to any other point in the Cosmos, they would rather stay here and explore the surroundings of our own planet:

*"I read that question earlier this morning, and I thought, "Wow, I'd love to go to a different planet that has different physics and stuff, I'd love to be so large I could fly anywhere, all over the universe and see things on different scales". But I've been given this very special chance to experience this little bubble of consciousness in this place, time–if those things are really valid-- and I don't need to go anywhere else because I'm in my most wonderful special place, which is all part of everything. **There's so much to explore here.** Everywhere you look there's magic in how this water is refracting light. Think of space as that pulsing, generating thing and light, or energy. And this is a special moment in that continuum where I get to look at how light, that energy, makes these beautiful things we see around us. This is a travel destination and a privilege, and every other one is." (JACM)*

It is crucial to note, however, that some interviewees stated very clearly that their desire to stay on this planet is due to their lack of information and knowledge about the rest of the Universe:

*"In a certain way **I feel pretty happy with where I am**. I think I can answer that more in terms of process than in a particular result. I can think of places that I want to go to that I've never been to, like the south island of New Zealand. But if I could really go anywhere in the Universe, I would need different kinds of data, different information about the places I might go so I could think about that, where I might want to go. I don't really feel that I have...**I have a certain amount of information about the Earth right now in particular, I'm not really looking to remove myself from that...**I would want to be able to move through a set of places and I don't know where they are, and when I saw move through them you would need to see about what would be in different places." (AK)*

*"I'm not tremendously adventuresome. I'm not sure that I would like to space travel because I'm not sure I want to go to the unknown. **I can think of places on this planet that I'd like to visit.** As far as the universe itself --if it were totally safe, and I would not have a fear for my own health and well being, I suppose I wouldn't mind spending time on the surface of Mars, just saturating myself with all that redness. It's something I'm a little more familiar with,*

seeing pictures of what the surface is like. ***Everything else is too much of a question mark for me to want to go to it.*** *" (PF)*

Another recurrent idea expressed by different interviewed artists has to do with the notion of the edges of the Universe. Several subjects would like to go to what they envision as being the boundaries of the Cosmos:

"I don't enough about astronomy to really talk about this, but it seems fascinating if you could go anywhere in the Universe--if there were several universes, if you could go somewhere in between universes, or if it's one universe ***to go to the edge of universe, that seems to be the most interesting place to go****. To be able to stand outside of the universe and see the whole universe, sort of. Or to stand outside and see several universes at the same time". (LJ)*

*"****I'm interested in the edges****, because that's an incomprehensible concept of does the universe end, does it not end. There's all this speculation about the Big Bang, the two theories of it, is it going to collapse, or keep expanding, they're contradictory in terms of one is edged and one is not. I want to know the answer to that. If there is an edge, I want to know." (GW)*

"Definitely ***to the boundaries of this universe****, not only that, but I think I'd like to travel into other universes, and then perhaps through black holes, etc. If there are other things that are parallel universes, I think that would be really fantastic experience." (NR)*

05. ***What do you envision about your travel destination?***

When asked what they envisioned about their travel destination, some interviewees replied in a very objective way, stating their knowledge about the place they wanted to visit:

"***It's a planet*** *[…] it's probably the most beautiful, mostly made of hydrogen. So it's the beauty of Saturn that's attracting you" (BS)*

*"****Volcanic activity****, glaciers, immense beauty." (JM)*

Other subjects, however – and especially those who wanted to go to "the edge of the Universe" - saw this question as an opportunity to expand further on this concept, in a more philosophical way:

"It's incomprehensible. It's one of those things that make your mind short-circuit, because it's not within our conceptual framework and, to me, I can't imagine things without edges because everything has edges that we experience in physical space here. But there's the possibility that there is no edge, but how could that be? And if there is an edge, what's outside that edge? It's just one of those things I consider an evolutionary cutoff that at this point we're not evolved enough to understand that." (GW)

"That's something I think about space, that's the most scary kind of thing. In a content sense, a most sublime place, it's so scary to think about a place where things end. You always want to know more, and I guess I want there to be more things coming, and I want to be out there to see this, both to thrill myself and get scared but also to find out that there are actually other things coming. ***I don't understand the concept, it's unfathomable to imagine an end to the universe.*** *The way I like to map, looking at whole system as an environment and trying to understand the environment as a whole as opposed looking at specific web pages. But looking at the whole structure of it, it seems like being able to do the same for this world... it's getting an overview, but it's almost like a vain thing, would it be possible? The same thing for the Internet, because you can't step above it.* ***Whatever investigations I do within that space I do inside it.*** *It causes a little bit of hideousness to attempt to do it, but that's what I'd want to do with space, or the universe." (LJ)*

Some interviewees also mentioned their desire to look at things from a different viewpoint and perspective:

"I personally find the idea of being able to shift my local, relative point of perspective and seeing something that puts ***me so outside the geocentric viewpoint****, as just incredibly exciting. If I want to abstract the question a little more, I'd want to go to someplace that puts me outside my geocentric viewpoint, and* ***shows me something that allows me to see a totally different viewpoint from an astronomical/universal scale than I'm used to****." (PL)*

5.2. Background information

06. Do you use scientific data as part of your work as an artist? What for? When?

It was quite surprising to see how many artists make use of scientific data in their artistic work. This can be partially explained by the fact that several of the artists we interviewed also had a scientific background:

*"Well, I am a scientist. Sure, I could be interested in representing data about what people do in different ways and about geological processes, for example. It's a good question, actually****. I'm very interested in the framing of science, because to me it's just another cultural practice, the same way that growing food or making baskets is****. I think that framing is crucial for our survival as a species for one thing, because the notion of participation, how people can be--****that's a form of scientific data I'm really interested in, what goes on inside of people-- about participation, and how to create structures where people are able to affect the outcomes of the important things that affect our lives****. I have a strong concern about the role of technology in those processes. My work is substantially about that." (AK)*

*"****A lot of my work is really based around a lot of the soft sciences and literature, and sometimes cognitive science****. I have a background in applied sciences, engineering and some physics. I'm very comfortable with that, but on an everyday basis,*

more or less I find I'm doing an installation that requires work with hardware. Sometimes if I'm doing electrical installations I have to do some engineering--you know with computer science, dealing with propagation delays and networks, and looking at the idea of what frequencies would be involved in analyzing what frequencies in space my installation is responding to." (PL)

"I would never think of it as that, but yeah, it's a relationship that underpins everything. I can't think of anything I do as anything separate from that. ***In my artwork, in practical terms, scientific data gives me a basis for very tangible things in my work. It provides sort of a bed, a grid, that gives some meaning to certain things.*** *So it gives you a framework, because otherwise things would be very nebulous. So what we know about the world, allows me to create stuff in Cartesian space or in spherical space or in n dimensions--and I think artwork has n dimensions, there's the dimensions you see and feel and experience, then there's the ones that we don't know about that affect us in resonance, in altering our consciousness in lots of different things. In very concrete terms, I look at what the discoveries are, I look at things like astronomical scales and microscopic scales and submicroscopic scales and all of that-in fact there's such a relationship in those two ends of the spectrum that make it a continuum for me--* ***that type of stuff informs my work and provides some grounding for it.****" (JACM)*

The intrinsic relationship between art and science was also underlined in many of the reponses, even by those artists who had no previous scientific education:

*"The artistry of something has everything to do with the content of it, with the educational opportunities****.....Science is just a way of looking at things, it's a language, it's a body of knowledge. You can't just have a pure aesthetic experience with no context, no content, no educational opportunities****... it's not strong enough, it has to be all of the above, the more of those walls you tear down the more you stop thinking in those categories. It's so much more rich when you think of it in terms of all of these things...Why would you cut one of those out? It makes the whole work so much stronger." (SL)*

*"****We're really focused on a lot of GPS and land-related art****. The project we were just recently working on was to compare- there was an article written about it - the cultural differences between San Jose and San Francisco. The author was interested in quantifying that. Her idea was very different from what ours was. She wanted an illustration of the difference. What we were working on was this database of USGS information that one of our members, Brett Stalbaum's been working on this software interface so you can put in different GPS coordinates and map out maps of certain areas and get all the elevations and standard deviations of the area. That was what we decided would be interested. […] We created images of the different landscapes in 3D modeling and then took pictures of the different locations and built these wire frames models." (GW)*

*"****The scientific data I use is not direct data, it's data as being interpreted by psychologists, neurolinguistics, by cognitive scientists****. So it's not the pure data itself; it's how do we understand the data, how do we give a structure to the data, how can we use it for art. So my field right now is studying what we call bio-semiotics, which is a language-base for nature. How do we look at nature as a series of signs, a system*

of signs that can be understand by us. We look at nature as a complete sign system that is intelligible." (GS)

*"**Creative biofeedback displays. Extensive amounts of math and spatial comparison in music**." (WC)*

*"In some ways I do and in some ways I don't. A part of my artwork is very much related to the genome project, in fact I did several pieces that are related to the 3 sets of base pairs that code for the 20 basic amino acids. So that definitely, in that set, **that segment of my artwork, is very much related to the scientific aspect.**"* (NR)

However, some artists find it difficult to acess and use scientific data as part of their art work, and they have expressed this concern:

*"**I don't use any scientific data specifically to create what I'm doing**, but my students do consult the data. We do a lot of learning modules and so they would consult with observatories in Flagstaff to find where the planets are, and create modules to educate students on geographic locations of landmasses. So I would definitely consider using scientific data in that way. [It's more of a teaching approach rather than in your own work?] Yes. **I am not a math expert, I am not a computer scientist, I am not an Astronomer, and so I guess the access of getting that information would be the limit for me, not knowing where to go, or what to get, or how to find it. That could be the reason why I'm not using it**." (CJ)*

07. *Do you see any possible interaction between the kind of work you do, and scientific, astronomical data?*

Some of the artists interviewed in this survey have already made use of astronomical data as part of their work:

"Well, I use a lot of photographs in my artwork and in my teaching of outer space. Also new discoveries of outer space that I read about we talk about in the classes that I teach art in. I'm very interested in science and I've gone to many lectures and planetariums and looked through astronomical telescopes…I've been to Jet Propulsion Laboratory and AAAS meetings. I'm always interested in new developments in space." (DT)

"I've used imagery from both space and constellations or specific viewpoints into space we can't comprehend. They're the way we can comprehend space, because they give us sort of a field of view, a fulcrum, to give some definition and boundaries to things. But the imagery itself is beautiful. So I have things were I've used some actual images that were captured in space or through telescopes, microscopes, through everything from particle accelerators to Hubble Space images. It's interesting how similar they get at both ends

of the scale. And I've always been fascinated by stuff like that. You look at that and inherent in that dead little still picture is energy that created it." (JACM)

"I've used some in a performance piece about 15 years ago. I did projected images of the earth. At one point I was also working on a composition that used an arrangement of constellations in the sky. The distances between stars, trying to map out paths for a camera on the ground that would map out lines in the constellations, 25 years ago. I am fascinated by it. NASA images." (PH)

It is very interesting to note that even when using scientific data in their work, the approach used by artists is quite different from that of scientists. This artist explains how she works with the SETI data in a different way, with her students:

"Myself, I've been mostly concerned with Internet data, but some of my students have been getting all sorts of scientific data off the Internet, raw files and doing lots of new sensations with that, comparing data and playing with that. Using SETI data and making their own systems for interpreting that data, I make them do stuff that would prove that there is something out there in the universe. So instead of this depressing SETI@home thing where you never find anything, they would have to make something, using the same data, find some pattern in it so that, tweaking their systems, they did find things in it. So we did find life out there. The approach as an artist when you work with these things, artistic license is like you don't have to be true, or you can play, or it's more obvious that your methods aren't truthful, although I don't believe scientific methods are truthful in that sense either, but I think we can be explicit about that. There's two ways we can do that: one, we can pretend that the data doesn't have any significance whatsoever, even if I know it has all these layers, like you said it's scientific it's been through all these assumptions and systems and knowledge has been added to it to sort it, but to completely disregard that and say, well, these are just numbers. I do that with the Internet a lot, I just assign colors and I just use them in a kind of whimsical way, and I think you get something out of that. It's the naive approach, consciously naive approach to data, but the other approach is to say, this is meaningful, even when you know that it's not. You hope it's going to be meaningful. Like with the SETI program I forced my students to find meaning in it even though there's probably no meaning in it whatsoever. That's the approach I'm taking to this kind of data." (LJ)

Many interviewees do perceive potential interactions between their art and the use of astronomical data. They might be more or less interested on using this type of data as part of their work, but the great majority of subjects definitely consider it as a possibility:

"I listen fervently to stuff about Mars, recent discovery of water on Mars. But I don't have enough understanding in terms of astrophysics, the stuff that's going on right now. I would like to, eventually. It'd be nice to have a place where I can go look at this stuff. Right now my interest isn't focused primarily on that area." (GS)

"From an astronomical point of view, I just tend to be a little more terrestrial, not saying I'm not interested or not considering astronomical data as an option." (PL)

A few subjects, however, although dealing with scientific data, responded that they were not yet using astronomical data in their work:

"*I don't think I've thought very, very deeply, though, about space, although as I have a background, my undergrad was in chemistry, we definitely worked with those notions of both micro space and macro space and thermodynamics and quantum mechanics that in some ways deal with space. Currently, the closest I come in terms of using scientific data is working mostly with genomic data." (NR)*

5.3. Web related questions

08. Have you ever visited web sites about space and astronomy? Which ones?

Some of the artists we interviewed do visit web sites about space science and astronomy on a regular basis:

"I check out the HUBBLE telescope sites. I also check out frequently landmasses and different forms on the earth, particularly human habitation on the earth." (PH)

"Sure. A certain amount, that's what I would say. One of the preset collages that I created for Collage Machine has a bunch of space sites in it. I think the imagery, some of it is really beautiful, I have a certain curiosity about that." (AK)

"Yes. www.nasa.us.gov., mainly for its large body of images, information, and resources. Also SpaceNews when prompted by friends for specific articles." (PL)

"Most of the sites I visit are referenced by slashdot or memepool, but I do occasionally go to space.com on my own." (JM)

A group of artists included in this survey work in science museums, and some of them stated that they visit web sites on space and astronomy on a regular basis, as part of their job:

"One that I do go to frequently is any number of the USGS pages, as well as a lot of the NASA pages, which show aerial views of the planet, again, particularly I've been focusing on the Bay Area or California. I tend to be more interested when I'm doing searches like this, more interested in images than in text. Probably it's more just the content that I'm working with. […] Sometimes, even just out of personal curiosity, I'll explore SOHO satellite photos, movies of solar activities. Because part of my duty as an employee here [Lawrence Hall of Science] involves keeping up with the touring exhibits which come through frequently; we get things with astronomical content. We'll be looking at whether or not there are websites related to that. Some of the Hubble images we have up on our floor. We look through those." (CH)

"Most of the time when I'm looking at astronomy sites it's purely for research stuff…I usually end up with NASA sites and university sites, those are the ones I can trust. pseudo-science sites…glance at them, see what's going on in the latest hubbub in alien research." (WC)

Most of the interviewees, however, use general search engine tools (such as Google) as a starting point when looking for information on topics related to these areas:

> *"Right now I'm all over the place looking for earth-science curriculum. Nothing I go to over and over. Sure, but I usually start out with Google, get an inventory for what's out there. Sky and Telescope site for information about telescopes, that's a site I've visited more than once. NASA site? For NASA, if I'm going for activities I'll go on the Spacelink." (BS)*

> *"I start on Google, that takes me everywhere. SEDS.org, night planets. And then I ended up using Solar Views, Calvin Hamilton is the person, the problem is that it's commercially financed, so stuff pops up. But he's got good stuff. Archives of videos, Magellan mission, simulate the radar mapping. I show them the Magellan clip.... flyover of Venus. That's a website where I got all of my animations. I spend most of my day searching the web for stuff, picking out the best...I know the teachers don't have time for that. That's a limiting factor for things. How to use the stuff that's there." (CB)*

> *"I'll do a general Google search…what I'm looking for is specific researchers or people not into the business of making exhibits…the articles that are really kind of ignored, because they don't have context... those are the things I look for, those little gems…I built an exhibit that blows air rings, and so I searched up on Google and turns out that at Scientific American they did an article about the fact that dolphins make air rings and play with them….and I thought that's before it was an exhibit about blowing bubbles, now it's about dolphins, it's about play and you're blowing bubbles, and they are blowing bubbles... and it turns out they teach each other, these dolphins. They kind of show each other how to do it...and now you have an amazing angle...now the whole thing becomes beautiful...now all these things tie together into the final exhibit. I have a reason for looking, to go in search of info, this thing that I've already taken as ...the next step for me, is that I want to know more about it." (SL)*

Some interviewees reported problems they have encountered when using these general search engines, and mentioned their desire to use specific astronomy-related search engines – which would be more appropriate for finding specific information about astronomy and space science:

> *"I find most sites quite frustrating, it's very hard to FIND THINGS. it's usually difficult enough that I don't do it for fun anymore...then I end up at whatever site I end up at. Search in the site is harder than the search to the site. If somebody did a good search engine for space-related information, that would be a contribution " (MK)*

> *"Some practical things are to be able to, if they're presenting a collection of images, I think it's important that there be thumbnails to look at pretty quickly. Unfortunately with most of the NASA sites […] are usually so hard to penetrate for the average person. You have to do a lot of back and forth searching before you find what you're looking for. If initially there's a very small thumbnail that gives me a glimpse if it's close to what I'm looking for. I tend to be able to find factual information faster than I'm able to find a particular image. If you're talking about artists it's the same problem. An artist needs not only simple to find a certain content, but a certain expression of that content. It's often the situation that you don't know exactly what you're looking for until you find it. So it can*

be helpful to be able to gloss over a lot of images quickly to get a sense of what's out there, and then focus in from there." (CH)

In fact, the interviewees' responses showed that most artists are not frequent users of astronomy and space science sites. The majority of the interviewees simply do not search for information on space science and astronomy on a frequent basis:

"No. When I come across them I am intrigued by them. But I don't directly go to them, because of my work not geared that way right now." (GS)

"I really don't do that, no. Actually, I've used websites for medical information and looked through different sites for things like that. Haven't for astronomy." (DT)

"I haven't pursued anything really online. If there's an article in newspapers I'll check it out or if I happen to see something in the magazines I usually read it. I'm fascinated by anything I might see on television. My husband, a physicist, is very interested, so between the two of us, we follow findings, we read, and we talk to each other about what we might read in the news. I don't aggressively pursue." (PF)

"Primarily, when I go out to scientific sites, it's for research papers, because I read people's research papers when I'm doing research. I was doing a lot of research on auto-poesis, so I was reading a lot of Maturana and Varella." (GW)

"I almost never go to a… I'm not a regular visitor of any website... I have no websites I visit with any regularity, I wrote down the name of some website. I have a few files full of website addresses that I never follow up on. " (MK)

"I don't do regular, but the Internet to me is…information to me in this day and time is the way we travel to different information. Just like we're out there with telescopes and space shuttles and rockets trying to penetrate the vastness of space, there's an information space that the Internet is our rocket to. So I visit things, not always in a logical way--I love the fact you can make these leaps; it's time travel. It's hyper drive, you've got hyper drive on a website." (JACM)

09. ***List your favorite and least favorite science sites and why are they so?***

Science sites such as The National Geographic, the American Museum of Natural History, and the Exploratorium were mentioned by the subjects as being their favorite sites. Interviewees also cited space science and astronomy related sites, such as the Anglo-Australian Observatory, HUBBLE, JPL, Sloan and NASA.

When asked about their preferences, interviewees pointed out some pros and cons of those sites:

*"**Exploratorium.edu**, of which I'm very proud…worthwhile destination for almost anyone." (NW)*

*"**Hubble** web page**,** pretty nice, gives you a little info, I wish it gave more, I think the public would at least like the option of clicking somewhere and getting more info...what's it made out of? why does it have this really bright streamer?"*

*"I enjoy the **NASA** site for its breadth of information, despite its frequently unwieldy structure from facility to facility. Also **Space.com** for its timely coverage of space-related items."*

*"I've got **a gazillion bookmarks of scientific sites**. Rather than thinking of a favorite site, there are certain things that irritate me about sites. I like websites to be visually interesting. I like to feel comfortable using it. ...big block of text, it didn't engage me long enough to stick around." (MK)*

*"The ones I've been frustrated with is the **SLOAN** data… access some of the SLOAN pictures and they said they would be there and they weren't there and you couldn't' download them. There's a nice site, **American Museum of Natural History.**" (DC)*

*"There are some new **NASA** sites that have gone up that repeat a lot of what you can find on older sites, or sites from a different branch, **JPL vs. AMES**, or Goddard. I find it repetitive, especially if it's not complete. But not all the stuff and not what I'm looking for, I find it's just a waste of time for me." (RD)*

*"I think the things I know I appreciate in a site are very, very simple and limited selection initially. I'm thrown off by pages that throw too much at me too fast. I'd rather navigate in a more step-like fashion. To me, the **Google** opening page is great, because I'm undistracted, I know what I need to do and I do it. Occasionally, if I have to deal with some of the **NASA** space image libraries, it takes a little while to find what I'm looking for. Often times I'm 10 steps into the site before I'm even told that the images aren't even available to be looked at, they're only available to be ordered. That can be frustrating." (CH)*

*"**I rarely use science sites**, religiously. I love live stuff. Where the tides are. Live cams of the Bay Area from a top of channel 4…satellite images. Anything real I'll jump right at…at first it was really sexy…now I've fell back to my favorite books... Internet often is frustrating after about an hour...There's so much information, and so much of it is wr it-media. It's so two dimensional, you're sitting looking at a computer screen, trying to gather information. It's just not very dynamic." (SL)*

10. ***List your favorite websites in general, and why are they so?***

Interviewees' favorite sites covered a great diversity of topics and themes, including art-related sites such as the site of the Museum of Modern Art in New York and the site of the International Association of Astronomy Artists (IAAA), search engine' sites such as Collage Machine and Google, medical related sites such as the National Institute to Health, among others. They also expanded on the reasons for their choices:

*"The IAAA **International Association of Astronomy Artists** is one of my favorites. I can tap in visually to a lot of amazing things. Artists that have found a unique way of*

observing a galaxy, or extrapolated what a planet would look like around a certain type of star. I imagine those things myself. When you have a rudimentary understanding of astrophysics, the possibilities are infinite. I love to look at other artists work, it's inspiring and informational, it expands your database visually. Then of course any source of information, the ***NASA*** *site,* ***JPL****, those are favorite also, that's because I enjoy doing research. Then I enjoy any artists work, in these subjects, or just well-executed art." (GM)*

"Sites I commonly frequent are ***Google*** *for search engine, sites where I can do research…compare information…sites on topics that I'm interested in." (NW)*

"I love one for ***the Museum of Modern Art in New York****. It's a great website. You can actually check out their collection, name an artist and they'll zero in on the work they have. I do a lot of ordering online for materials, some are better, clear and easy to use, others are definitely inferior, enough so you get cranky when you're using it. There are definitely are some websites that are better designed than others. I like ones that are clear without complications that lead you around back to the beginning. Things like that make me cranky like an inefficient voicemail would." (PF)*

11. Do you find these sites useful? Do you consider you learn something when navigating these sites? Why?

12. Are there any problems you encounter when navigating these sites?

Most interviewed artists did not find scientific sites easy to access or use. Subjects' criticisms and comments covered a wide range of topics, including technical, artistic and design related issues. Most interviewees responded to question 12 as part of question 11:

"NASA site for earth sciences has a huge number of interesting images, [but] ***the database for it is kind of bad and buggy****." (PH)*

"I go to NASA's site, because I'm interested in seeing the space shuttle land in Florida. I would say in general ***they're pretty dry in terms of design, usually poor aesthetics.*** *NASA I think is a different case. But science sites that I usually look at are academic, those are usually really poorly designed." (GW)*

*"****Complex and inaccessible in some way****… I'm not sure how to incorporate the data that I would get into a Maya application, mostly because I haven't done it before. It could be intimidating in terms of amount and what is out there. Maybe a tutorial --as an educator I don't have a lot of time to spend a week just to figure out how to import the data-- if there was a tutorial that could show me how to do that in 10-15 minutes, or "these are ways we have used the data, and this is how we did that", I could figure things out. I could point my students in this direction as a resource." (CJ)*

"Yes ***they're problematic for artists in general****…There's a huge chasm between the kinds of tools scientists use and the ones artists use… because we're dealing with video*

and images and audio... I don't know if they see it as video streaming or audio as an important part to NVO...but important to artists who are working with NVO creatively...with NVO data." (DC)

*"**The sites are useful for raw information**, leads to possible areas of interest. I am also able to keep up on certain news items**, I do often learn from these sites, but often the information is trivial."** (JM)*

*"I like sites that have questions, that have information but don't know it all, that **ask questions that allow you to be part of the discovery process of the information**. We were talking before about "what if." I like sites that make you, or allow you, or send out energies to you--they may not ask you "what if" but they send out energies that inspires you to say "what if"--so that, to me, is the perfect site. "What if" sites." (JW)*

One interviewee suggested designers should be directly involved in the development of a website:

*"**Get a designer, to design the aesthetics, functionality, information design, the logic.**" (GW)*

13. ***What kind of interaction would you like to have with web sites presenting scientific data?***

The responses we obtained from the majority of interviewees point to more interactive and engaging forms of navigation:

*"Actually, **I imagine putting on a sort of virtual reality helmet and being able to fly.** Like, first be able to see the Earth, and the Sun, and the solar system, and then being able to click on Mars and go into Mars, and then some mediator or Avatar that would ask me what I was interested in, or these were some of the options, not all of them, and from that the Avatar would learn what I was interested in, but would also have other things that would pop up. Maybe talking about, "This is where they stepped on the moon", and why that was important." (CJ)*

*"One question I have about that is **how much is this about presenting information, how much of it is about engaging people in processes**. Is this function of this to report on work that's done and make data available? Is the function of it to teach people in a sort of deeper way about these ideas, about the universe and travel and what it means to be somewhere. **I would like to create engaging processes that cause people to reflect on some of these broader questions,** so that the experience of engaging in the interactivity makes them think in a certain way and affects their perspective, adds to it somehow, as well as giving information it should convey an experience and there should be a certain kind of basic human generosity as well as an imparting of knowledge…" (AK)*

*"**AV presentations. Interactives.** Like the old Mac program where you could make your own solar system based on real principles. It gave you a good idea how difficult it is. Pick a planet and go there. Simple programs that demonstrate properties. When I see sophisticated images with childlike interactions and prose, it is much more boring." (WC)*

*"You really want to go with the big concepts, which is scale, location, and change over time. I know I've seen Silicon Graphics put together…or Rose Planetarium in New York…**a 3D flyby of our universe**. That's something I've only seen in limited form, and not really with real data....both scale and location. It's really interesting and humbling to see that we're just the third planet from an average star. I think you'd want to open it up to people who are familiar with different audiences and have them try to design it." (GW)*

*"I understand that an informational site has to have more of an educational structure or easily accessible structure, but I'm not interested much in that. I would say the only way to use the structure of the web itself to do this, the whole open source method for it, **you basically provide a way for people to submit their tools, have people create their own tools and come up with some kind of smart system for that to work so it's easy to use, different levels created by the users themselves.** So I who really like creating tools for understanding data will use this more as a creator and go in there, use the data, create the tools that maybe I could upload there for other people to use, and maybe even have some kind of reward system. Not pay one person to do tools but have it so if you have people out there in the world developing things for this, it's open source but they can still be rewarded economically for participating and helping other people to understand it. […] With all this astronomical data it sounds like you have an excellent opportunity, if you have time and resources to set something up, to try to do it in a web open-source sort of fashion. **It's better than getting a designer to set up the site that's going to look a certain way, and have someone deciding what kind of tools we're going to use to harvest the data**." (LJ)*

5.4. Tools, functions and collaboration

14. What kind of information and data would you hope to find in a website about astronomy and space science?

Most interviewees expressed their desire for images and visual information:

*"I expect **pictures of the phenomena of the new happenings and discoveries**, besides written data. **I think the space pictures really capture people's imaginations**." (DT)*

*"I think **good visual imagery, pictures, good basic info** and the ability to look into that info and cue in certain aspects and go down for more depth. Also, see the visual picture and **let that picture lead you to other images**. For example, a nebulae, a way to go into part of it, see it in more detail." (PF)*

*"**Pictures, movies, animations**. Illustrations of theories." (JM)*

Some artists suggested ideas, information and tools which astronomy and space science sites could provide, in order to engage the artistic-minded audience:

*"I think I've looked at a few things, and there were a lot of photographs from satellites and images that had **different levels of detail, you could zoom in on**. I know that the information being collected is very rich and complex, but I think the problem is how it's being collected and categorized, and what the interface that the public sees, what the design is, how the design enables the viewer to access the information, rather than distancing it." (AW)*

*"What I like about many of the sites is I usually like obscure data, obscure things. **I look for obscure things. I usually look for things that unusual. I like seeing things that I haven't thought of before.** Lately there was an image that was put out on Space News of some of the new Hubble stuff, from an object they possibly considered as being 16 billion light years away. That is really inspiring. A lot of people say, "What does that do for me?" But it gives me a sense of perspective on my entire existence." (PL)*

Interviewees also highlighted their desire for conceptual, theoretical issues to be presented in a website about space science and astronomy:

*"What I'm interested in is the **high theoretical aspects about space and conceptual frameworks for thinking about the universe**. What would be useful is for highly technical information and a vocabulary that's used in the profession, that there's something that explains the vocabularies, a sort of **glossary**. I would be interested in discussions, **seeing discussions going on between the key people in the field that are talking about different theoretical frameworks**. I guess I'm not necessarily interested an expert describing to me those types of very factual things because I can find those things in my almanac. I'm interested in the professionals that are having a discourse that I don't have access to and I don't understand, because I don't have the vocabulary or education. Stuff that's on the theoretical frontiers. The theory, and why the theories are and what backs up the theories. I'd be interested in seeing the field from a whole what the theories are and which theories contradict and who is regarded and what is the state of the field now. What is considered the most authoritative, what's not considered very valid at all, where the consensus is if there is one, I'm assuming there isn't one, but I'd be interested what the perspectives are and how much is given to each of them. I'd be interested in how they disagree with each other and how they address each other." (GW)*

However, one of the most recurrent requests which emerged from the responses was that NVO break down scientific information into very specific categories, so that people from different age or educational levels can understand it. The great majority of interviewees agree that NVO should allow users to select what level of information is presented to them.

Scaling the information for users and providing tools for them to select their own entry level on different topics seem to be good ideas for NVO; this would allow information to be adjusted to different users' skills, knowledge, needs and interests: *"I'm attracted to the idea of everything in one place, and of course scalable. It's a massive project to coordinate the information in such a way that you can take slices of it based on your particular perspective."*

Some subjects pointed out that while information needs to be broad, it also needs to be specific (adaptable to the individual), and that the hierarchy of the information has to be readily accessible, and easy to navigate.

> *"First, they need to have **some stratification in their taxonomy**. Top level for people with no science, that is fairly simple information, but you have the ability to drill down into deeper aspects of the research."*
>
> *"So you can tailor that if the person who is viewing it informs you what they want, the level of information they want as well. Ideally, **the user makes decisions about what level of information they want**. Web interfaces, have a menu system of some sort, which sends queries to a hierarchical database, or relational database, designed by the experts, **to give varying levels of responses**. You want people to be able to use at least hearing and sight for the things they're seeing. Also being able to navigate through it. Bring the explanation up, have levels of complexity they can gradually dig down. It depends how much you're trying to explain at once. Rather large areas and large gaps in our knowledge." (PH)*
>
> *"You could also have **different quadrants for different resources**. You would turn that off, but you might want to know a certain amount of info, without the others, not necessarily what you're looking at."*
>
> *"You'd have to be able to **break it down into very specific categories so people understand it**. You have to think about who the audience is. You have to think about making it accessible to them. It needs to be broad, but it also needs to be specific."*
>
> *"What we're talking about is **allowing people to select what level of information is presented to them**. Someone using this knowledge base, a researcher might use the basic level to do some skimming, then find more detailed information they're looking for." (CH)*
>
> ***"Layers, going from general to more in depth would be the best approach**, so it's not overwhelming with complexity." (DT)*
>
> *"If someone asked me to design this site, with this idea of providing information for various different kinds of things at different levels, I think I would try to design the site from an information perspective so you get **different levels of detail of information depending on what your understanding is**, but it's all present all the time, so there's maybe a more superficial level of information for people that don't have a scientific background, then you could dive into water, go deeper on deeper depending on your interest and background. But keeping it somehow transparent and very fluid so it's all present all the time, and you have a choice to go. It might also be interested to see the same piece of information, a satellite photograph or graph or data, from that perspective. So what you see as an intelligent observer and what you see as a scientist." (AW)*
>
> *"**I don't think you can have one for all**. I think that a kid's informational tool is hugely different from a 40 year old's informational tool. **I would think it would be impossible to reach all those audiences with just one**. I guess I don't think that you're not just creating a site that would have all those things, that you would create multiple sites. […] If you want anything of value to any of those groups, you have to go so much deeper for*

*each of them and have such a difference language, and such a different understanding**. I would think at the very least people can decipher where they think they can fit in, but you have to have languages, children versus adult, laymen versus professional.** Those are different categories that you should specify out so if somebody isn't sure if they're laymen or professional that's when they go in and explore. I think you have to at least define those categories and recognize them." (GW)*

15. ***What kind of tools do you expect to find on a site presenting information and data, such as imagery, on astronomy?***

Artists expanded on a great variety of tools they expected to find on space science and astronomy sites. Suggestions mentioned by the interviewees included educational tools, tools for accessing cultural and historical information, the possibility of letting people create their own configuration and annotations, a synopsis of the most recent theoretical positions on space theory, and the creation of a 3D space representation of the Universe:

*"**Tutorials**. Even educational classes where I could go in and learn about astronomy. I've been at Lowell Observatory and have really appreciated the information they have there. But to gather more and grasp that…" (CJ)*

*"I think there's a qualitative perspective that accompanies astronomy, that's extremely important. Say, **historical contexts that have affected things** like the cultural significance of the return of Halley's comet. People are going through the site, and also dynamically creating associations. Creating paths. We could learn as researchers from what people are seeing as important. But I think it all needs to be included [historical, x-ray information]. And possibly **we could have a slider at the bottom that could go from the hard sciences to the soft sciences to the humanities**, so that people could then, say, twist the prism through the part of the spectrum that they want to see. I'm even looking at it from a disciplinary point of view." (PL)*

*"What I would be most interested in is **a synopsis of the most recent theoretical positions on space theory and the universe**. Something that was easy to access in terms of it's all collected somewhere, and you can easily have an overview of the latest and greatest." (GW)*

*"One thing that comes to mind spontaneously about that is you could create a space--if there's a lot of information and data-- that **allows people to create their own configuration and own annotations**. You could let them share those with each other. You could let them share those on different levels, you could let them make these spaces and navigation spaces through your stuff and let them exchange those, and create a way to organize those as well, a kind of index system, knowledge classification system. **You could let people engage in that authoring process together that would be on an even more participatory level**." (AK)*

*"For me, it would not be on a screen…all day, that's one of the biggest limitations of the multimedia world is dealing with one screen. Something more holographically real. **I***

would be immersed in a 3D space environment where I really could fly around these planets or in space to get the different perspectives. *In an interactive website, I don't have any problem with touching something and getting something...it's something more visceral, more intuitive rather than more didactic." (JG)*

16. ***Should there be specific tools for artists to explore the Universe? What kind of tools?***

17. ***What kind of on-line tools would facilitate use of astronomical or space science data in your creative work?***

Most of the interviewees responded to these two questions in a combined and/or related way. They listed several different specific tools for artists to explore the Universe, which they also considered would facilitate the use of astronomical and space science data in their creative work:

*"**The capability to zoom in and out for detail**. A wide variety of images, zoom in a section of the sky, I have to be confronted by decisions....An ideal tool will allow me to do a great deal of zooming in and out...choose from a wide range of sources, because there isn't one image of the sky we rely on. Rapidly move up and down scale and move around. That's something I wanted to do with satellite images of the earth." (PH)*

*"I don't know, what came to my mind was **give me stars to paint with.** You'd need a big palette for that." (JacM)*

*"**The artists' brain is the only requirement**, beyond that anything is a tool for exploring the universe." (JM)*

*"Artists are going to come up with whatever tools they need, that's just the nature of art. **Being able to really show the history of where the sampling has come from, and what the original stuff is, is important, because it allows you to better understand**. Part of the purpose of doing educational exhibitions is to inspire people. What's really inspiring is very beautiful compelling imagery, but what makes something beautiful and compelling can be the conceptual part of where that image is. Another thing I have a great concern for is misinformation...that's a beautiful mistake that they probably have wonderful memories of in their adulthood, but I don't want adults to misconstrue...more and more information, that it's really important that scientists and artists have some way of documenting the changes they do." (WC)*

The most recurrent issue cited by the subjects was the desire for a 3D virtual reality immersive environment, that would allow the user to navigate through space in a very interactive way:

*"**Flight simulator around the universe**. A voyeur system, like NASA select where you can watch the earth rotate or download the current data and astrophysicist is working on. Make your own solar system like Sim City." (WC)*

*"To be able to have **a navigational approach that feels less like flipping from a page to a page, and more like moving through space and flying from one spot to another**." (CH)*

*"**It would be a web page that again was completely 3D virtual reality** and would use some type of 3D viewing whether the flipping LCD headset that transmits the signal 60 hertz, 30 hertz, kind of like the new space station. **Something like that that allowed you to go anywhere, start on planet earth, view from orbit, zoom in, fly over the surfaces of the planets.** We've totally mapped Mars and Venus, those flyovers are possible. Always have the option to click somewhere and have the original data, the original 2D picture taken by the Hubble telescope, you can see what the VR world is based on and compare it." (RD)*

18. ***What kind of interactions/collaborative work could be fostered /provided by a site on astronomy and space science?***

The importance of online collaboration was a consensus among interviewees. All the subjects mentioned the need for NVO to foster communication between users and/or groups of users, by providing online means for collaboration.

*"It seems **like it's a very rich opportunity to collaborate**, especially with the web, it allows you to bring together a lot of information from disparate sources and make connections between things."*

*"I really believe **the collaborative component is essential**…for people that are not just scientists. The tools need to be set up in ways that are more friendly than the scientific websites and how they operate."*

*"I definitely see this exploration of space as a collaborative work. **In fact our relationship to space is in a way collaborative**."*

*"It might be **interesting to create collaborative communities of people who might want to explore together**, who have an interest."*

*"My tendency is that **when I'm excited about something I want to share it**. That site might be a useful way of exploring, or developing an idea into something that can be shared with other people."*

The collaboration between different groups – artists and scientists, artists and artists, students and teachers, students and NASA, and between the general public and astronomers – was also underlined by some interviewees.

The potential benefits that online collaborations could have for educational purposes were also emphasized by interviewees:

*"The site could offer **community areas for groups to discuss such topics**, and even host discussions with well-known artists who might have interest in these issues"*

*"**I can see students collaborating with NASA**, space sciences, series of artworks, posters, murals, anything based on the theme"*

*"I think **it would be great from an educational perspective** to be able to go on a trip with a crew and people have different ideas of where they want to go and what they want to explore. I think multiple navigation would be great, but I also think it would take a tremendous amount of skill to do that effectively."*

The need for devising and providing the audience with new tools to facilitate collaboration was also stressed by several interviewees:

*"Definitely **tools where you could collaborate**."*

*"I'd like a draw window, a shared whiteboard that I know is out there, why aren't we using it? I love seeing the other people, I love hearing the other people, but I can't share with them like we can share a napkin on a table right now. **I want the Internet napkin on the table.** I would like a shared drawing image space."*

*"Different points of view on the same information. Someone could pick on one computer, some kind of drop down frame, and they choose that and it changes the information. Now, both viewers are looking and talking about the same object, but one picks that frame, and the other one picks a different frame. You've got two frames interpreting the same information, it would change the information, and possibly the way it looks. That'd be interesting. **Like different cameras set-up on the same information, where each camera represents a different frame, or point of view, or context.**"*

One of the interviewees sees language as an obstacle to collaboration, both in terms of the different languages spoken by different cultures, as well as in terms of the diverse concepts and jargons used by professionals from different areas:

*"That has to be really worked on. It is one of the big problems in collaborative groups getting together, there is **literally language barriers between individual groups."***

Offline forms of collaborations were also strongly suggested, such as workshops, grants, and artist-in-residence programs and activities. Some responses stressed the potential for artists to send their works and ideas to be included as part of NVO's data repository.

*"NVO should **provide grants or workshops, discussion boards, and a registry of artists that would be interested in using the data or working with other artists** on that."*

*"I do like the idea of opening, of perhaps creating some kind of **artists residency program to design skins**....media artists and designers, to experiment around and have fun with it, and see what takes off."*

*"They **could sponsor exhibitions, competitions**. Have it online. Really link art to what's going on in astronomy. It's a turn on. Any time chance to exhibit inspires people to think. NASA can have a "call to artists," collecting artwork."*

19. ***If you could choose a unit to describe the distance between the Earth and Mars, which unit would that be? Would that make it real to you? Why?***

Several subjects stated that they preferred to deal with units they were more familiar with, in everyday situations. These units tend to refer to the human scale, or are units that have being already assimilated by them, in cultural terms:

*"For me**, the pool is always a good kind of unit**, just because it's 25 yards, or 50 meters, and to calculate, how many laps would you need to swim to get to Mars, that would be an amazing unit. I could calculate day-in day-out, well okay, I swim 3000 meters in a day, and in so much time, you could say, it would take you this many days of swimming or hours." (CJ)*

*"When I was doing the water project, the research for that, a lot of the information that really made sense was information that was rephrased in terms of commonly understood elements. If all of the water of the earth were in a jug, the fresh water would be a teaspoon. Anything metaphorically expressed so you can envision them, otherwise it's very hard to imagine how far the Sun is away from us, or the diameter of the earth. **Ways of expressing vast numbers or quantities or relationships that take them back to our physical space, because it all comes back to the body, we refer everything back to the body in terms of locating things in space**." (AW)*

*"I know how long my studio is, my warehouse is 40x30 feet. A lot of times I think of things in studio-units**. I've been there a long, long time, and I know exactly what it means**." (JG)*

*"**Kilometers, because it's standard, it's something that's very easy to relate to other numbers.** Miles would be okay, it's just less common in the scientific community. I don't have anything that's new and different, the general scale analogy and the speed of light type stuff, but I don't think I have a very good feeling for it, so I don't think I have a good way to give other people a feeling for it." (BS)*

*"Meters? **I think all types of measuring systems that are consistent are fine to use**. Again I don't like…I think light years is a difficult concept. It's strange. Meters for me would be the unit for everything." (LJ)*

20. ***Do you find scientific measurement units meaningful or too out of context from daily experiences? How so?***

21. ***How do you relate to light years, Angstroms, terabytes, joules, nanometers, etc?***

Most of the interviewees responded to questions 20 and 21 in a combined and/or related way.

Some of the subjects do not think scientific measurement units are very meaningful in most cases, and they find it difficult to relate to them in their daily experiences:

> *"Yeah, but if there's a unit I don't know, I try to translate it to a unit I do know. Very, very large numbers, you can go with astronomical units, it's really hard to visualize units in space.* ***I can't tell you I have any sort of idea about the space between Earth and Mars, in relation to anything I have experience with****." (BS)*

Some interviewees suggested that they try to understand and relate to those units, since they are gradually becoming part of their "daily readings":

> *"Being outside my experience it takes quite a bit of manipulation to discuss angstroms or parsecs, but enough angstroms or a small enough fraction of a parsec are within my experience. Scientific notation is good for this.* ***My daily reading touches on these, the newly discovered planets are parsecs away, the new microchips are pushing atomic scales, and DNA, is a billion combinations****." (JM)*

However, interviewees with a scientific background seem to relate to scientific measurement units in a more comfortable way:

> *"Astronomical Unit, the distance from the earth to the sun. Light years or kilo-light years.* ***I might have an intellectual understanding of them. I'm comfortable with the notion of the light year, again, you have to be able to explain that****. There's a number of complexities hidden in that as well... relativity, ability to measure distance and times. effects of relativity on measurements. The effects that show up if you could drive up, the universe is changing perceptually because of your motion. There are non-trivial aspects to it." (PH)*

> *"Being the fact that I've dealt a great deal with light and sound, doing a lot of things with dynamic analysis of sound in some of my current installations, doing real-time spectral analysis to create various triggers--I am very comfortable with kilocycles, not hertz that's more arbitrary than I like, megacycles or kilocycles I'm fine with that. Of course, Angstroms... I tend to use nanometers rather than Angstroms****. I may be at a bit of a disadvantage because I may have too much of a familiarity with the sciences****. If I could shut off the applied scientist in me, it's hard...I think one unit that's very good is the astronomical unit, because that's something that's very tangible, a terrestrial unit the distance from earth to the moon, or a Martian unit the distance from earth to Mars, possibly use those basic astronomical units as a very basic, visceral sort of thing. A light year is good****. I was looking at things like the astronomical unit as a relatively friendly thing.*** *This is something that has a very visceral sort of referent. If we ever had the technology possible, I would say that it would be mandatory for every person to leave earth at least once to get a viewpoint of the relative nature of human existence." (PL)*

As stated by this subject, people with no scientific background would probably find it very difficult to relate to most of those scientific units:

*"Being that I have a background in applied science, I relate to them quite well. However, **I wonder how the average person, or even the artist without a background in the sciences might relate to them**." (PL)*

22. For your kinds of projects, would a 2D or a 3D representation of space science and astronomy data be more important?

The issue of representation was thoroughly discussed during the interviews, with emphasis on the differences between two- and three-dimensional representations. Most interviewees agreed that information can be presented in different ways and dimensions, but there is a consensus that each added dimension or feature should give additional information about the content:

*"**I don't think of myself as a 2D or a 3D artist; I think of myself as an artist**. So as many dimensions to the tool that you could give, given the constraints of the technology, I think would be wonderful." (JacM)*

*"**I'd love to have something more than 2D images**. They convey the information, but I think it would be highly imaginative to have something different."*

The use of 3D representations was strongly recommended by most interviewees:

*"**I think 3D helps you to understand the images better**. I mean, I started out as a 2D person, so I can read 2D images very well, but also if an image is beautiful I look at it as a beautiful image, 3D really allows you to understand it more completely."*

*"2D is limited. […] **The handling is important, 3D is important.** When you look at pictures, when you can look at the axis around, that's really more effective. If you had images you could swing around and look at from different...it's a lot more engaging, interactive."*

*"**Definitely a difference.** I can be very happy with 2D images as a painter…that doesn't bother me at all. When I'm thinking of molecular structures…that there's more operating that just the moon goes in front of the sun…I think 3D helps a lot… I like seeing different perspectives...we're always on the exact same perspective…"*

*"**Absolutely 3D**. I get so deeply into 3D right now. As physical objects, 3D is the best to go. Qualitative data, 3D may not be better than anything else. 3D affords you multiple perspectives, if you can rotate it, you have a better understanding, you can model things in your mind's eye. I know the potential for understanding were so much bigger."*

"I think it would be interesting if we had a tool that we could take to look at a 3D space, maybe the Andromeda Galaxy and Milky Way Galaxy, to have a tool that would extrapolate where it is now. As we go out further, of course we have less and less data,

but it would be interesting for people to see what we're seeing versus where they might be now"

It is interesting to note that when interviewees refer to 3D, they usually also refer to other dimensions of information or features such as animation, film and sound:

*"It's possible to use **sound and imagery and movement through 3D space**, yet each one of those has implications of a kind of falsification. At the same time, they are really giving us information. Information that is given to us through instruments, that wouldn't even register on our senses."*

*"I think the only other thing is the incorporating of **3D, film, or film-like**, of more experiential ways of looking at this information."*

The notion of realism is another concern expressed by the majority of our survey's subjects:

*"Strongest recommendation is to make the environment in which the viewer will be looking at the images **as realistic as possible**, I think it'd make it more real for them. 2D or 3D, whatever, to make it as realistic as possible."*

Some subjects believe NVO could incorporate multi-sensorial features which would enable users to experience the Universe and learn more about it through the use of their different senses:

*"We've been talking about this a great deal, **an expansion of the sensory**. Looking at it from the perspective of an intuitive form of ergonomics, an intuitive form of information architecture, […] multiple ways of visualization, multiple ways of using the senses to analyze data so we could ascertain these patterns."*

It seems that the use of cutting-edge technologies in space science-related productions – such as video games and movies – has strongly influenced the perception of most interviewees regarding the potential of NVO. In spite of the constraints and limitations of the currently available web technologies, most interviewees have expressed their desire to navigate through the Universe in a virtual reality environment, and many of them have mentioned they would anticipate NASA researching and implementing these technologies in the near future.

23. As regards space imagery, what in your view should be static and what should be dynamic?

In the view of most of the survey's subjects, the notion of Cosmos suggests dynamism, action, motion and change:

*"**I think in space everything is dynamic, because it's always moving, always changing**." (DT)*

Interactivity, animation, immersive environments, frequencies we can't see translated into sound, online collaborations, all were possibilities cited by the interviewees as what NVO-EPO

could provide for its artistic-minded audience. The commonsense seems to be *"the more dynamic, the more engaging."*

> *"**You could have an interface where everything is dynamic**. A whole range of sounds, or frequencies we don't see, that can be translated into sound, or image processing to shift wavelengths we're using to view something. It changes the perception. To understand the universe is not just silent--not really audible frequencies--but there's a vast range, we don't need to understand it purely in physical light or what we hear. More than a static image. What does a variable star look like. It'd be interesting to hear. The sounds coming from the electro-video sources." (PH)*

Several interviewees prefer that navigation be interactive and intuitive, and that users should have the sense they are actually navigating through three-dimensional space throughout the Universe:

> *"Space and time as an element, space travel and discovery should actually be the way the site be navigated. **How can we change space, change time through the interface**?"*

Some interviewees suggested that some interactive, dynamic and successful experiences which can be performed and experienced in the concrete world should be translated into the virtual world:

> *"**Going to an observatory and looking through those big telescopes can blow people away**. If there's some way of getting that to them of what this is like, I think that would change a lot of people's perspectives…"*

This interviewee, however, thinks it is better to avoid interactivity, since it might reduce the complexity of the Cosmos into the human time and scale:

> *"If you have interactivity, it puts the focus on the persons themselves. Space is a completely different scale, both in terms of time and in terms of size. Interactivity always puts time into human time, real time--a second is what we think about as a second. In terms of size, things that relate to our body. And I don't think you can understand this type of data thinking about the size of our bodies, and I don't think you can understand the processes that create the universe if you're locked into processes that acts in a human timescale**. Interactivity is better to avoid in all times when you need to describe systems that aren't acting on a human scale. I would say avoid interactivity, avoid three dimensionality**." (LJ)*

24. How much supplementary information should accompany space science and astronomy images and models?

Interviewees described their preferences in terms of the relationship between text and images, and expanded on how and when supplementary textual information should accompany space science and astronomy images and models.

Some subjects said they prefer looking at the images first, before reading about them:

*"I think **I'd rather look at the picture first, then I read about it, and then I look at it again**. I like a lot of information. If it's too complicated, then I just skip some of it. I understand a bit of science because I've been to so many science meetings and lectures. I know a lot of the language." (DT)*

*"**I would definitely see the image first and get excited by that**. Oftentimes, I know that there are images that I have looked at that, initially, have not been in/of themselves exciting to me until I read their description. One example was on the Hubble website, of one of the very deep space photos, that showed a gravitational lens distorting the images that were behind a certain body. I had heard about that, but to see this physical phenomena you can witness optically, that was pretty astounding to me. If I hadn't read it on the site, the image itself wouldn't have been of interest to me. It was well-presented in that case. That site is pretty well done, I think. Because initially you get descriptions of what it is you're looking at, and then there are opportunities to go deeper." (CH)*

*"I personally am usually a text-first person, but **I know from my experience of watching visitors that they're usually image-first.** It's an age range thing as well. They like to look first, then see if it's compelling enough to read more." (WC)*

Other subjects consider that captions perform an important role as supplementary information for images, since – at least in the domains of space science and astronomy - the image does not necessarily convey all the information:

*"I look at the captions as information that's available if people want to find out more. **Ooh beautiful image, but maybe don't understand what's going on in that particular image**. Some will be interested and some don't. Hubble images right now just displayed as a beautiful image, **caption writing is attempt to add more content, another layer for people that want to go into more depth.."** (BB)*

Some interviewees pointed out that since different user groups have different preferences, *"**all possible information should be accessible from any image**. The user should be able to drill down as far as they please." (JM)*

5.5. Art/Science interfaces

25. How could artists contribute to space science and astronomy?

Different perspectives about the possible contribution of artists to the fields of space science and astronomy have emerged from the responses of the interviewees.

Most of the answers highlighted the fact that artists have a different perception, interpretation and understanding of science, and can devise new forms of presentation of scientific information to the general audience:

*"I would say that most artists think a lot or deal a lot with perceptions, the nuances of how people know things and experience things, as well as how people are moved by what they see and experience and what resonance in a person from the world around us. I think astronomy, almost more than any other science is one that taps pretty quickly into experiences of awe and wonder, and gratitude for being able to see these kinds of things**. I think artists can help present, organize or synthesize things that scientists are learning to not necessarily to improve people's life practically, but to enrich the quality of their life by helping the general public get a more visceral sense, or a more tactile sense, of what's being learned and the excitement of what's out there**. Artist are a good resource for that." (CH)*

*"What I think artists do so well is **open up other directions of seeing**, just like 2D is a way of looking at something that might give you more than the original, give you information you might not have gotten flying through the space, you can see patterns and things because you're coming at it from a different direction or a different dimension. **The artists are those kind of bellwethers, they can keep you from being too grounded in a linear, rational way of thinking, because we never would have broken the bonds of earth if we hadn't had some of those non-rational leaps.** There's so much more to discover out there, we haven't even tapped into it. Now we're out in space and there's so much out there." (JacM)*

*"To visualize, to take information, and not scientific visualization, but **to interpret the information visually, to connect it to the way we think about space**. If you think about the images of William Blake, his images connected space with spirituality and a way of looking at the universe that was reflective of his time, and I think we can do the same thing. Put it in context either by metaphor or the way we image it to show how we feel about it, the effect it has on us, to interpret it." (AW)*

*"**Art has always humanized things that are hard to understand, visual arts or music or drama.** Always dealt with issues, natural world or social issues, that are hard to understand. Another role would be artists interpretation is good PR for space program, NASA. publicize a series of, posters to postage stamps NASA website, people's interpretation, children's, professional artists, sculpture/prints, themes and bits of music, inspired, young/old composers, electronic music..." (PF)*

26. What is the role of art in visualization or interpretation of outer space or the Universe?

Responses to this question covered a wide variety of topics, ranging from illustration and animation, to strategies for pattern association and the design of tools:

*"I think the tools are not there. **That artists can help to design the tools so many people can use them.** Without the role of the artist, I believe the data will always remain an esoteric archive only scientists will be able to understand and access… artists should have input, because they speak for a large portion of the population...lay people, but have some very innovative use for the data. Artists can bring to the table a way of accessing and formatting the data so people may have a better handle on it." (DC)*

*"Fundamental, color choices are made on the interpretation of radio telescope images**. Artists are not necessarily more visual than anyone else but there is a certain amount of study involved**. If the goal is the transmission of knowledge then art can reach a brain in ways logic, reasoning, and facts cannot." (JM)*

*"**Visualization and various strategies for pattern association** might allow the user to have a better grasp of relations between objects, their location, relative position to earth." (PL)*

*"**Animations and images…**There's a few things: We have some astronomy artwork, there's been a few artists, a well-know astronomer has a mural out here by our stairway, I forget. He's an astronomer but he's talented as an artist. He has artwork that is very true to science...they're showing you something you can never see a photograph of. In that sense, the **art can represent something that you can never see directly**. It's art, it's beautiful. Art and engaging. We have art upstairs that shows where meteorites come from." (CB)*

27. ***What do you think the role of scientific data and astronomy could be in Art ?***

Most interviewees agree that scientific data and astronomy play an extremely important role in Art, both as an inspiration and as a means of perceiving the world in a different way:

*"**I see it as very inspirational for Art**, that everything in the world is inspirational to an artist depending on what really inspires them and turns them on. Space is one of the last frontiers we have in the world, we can explore a little more in Antarctica and North Pole, South Pole. I think when Kennedy started the space program it caught everyone's imagination. Today people are still very interested in space. I know when I teach my classes to children, they're just very interested in space, some of the kids know more about space than I do." (DT)*

*"**Simply as inspiration**. Fantastical color and form, simply the awe, knowledge of huge distance and size. Who knows what it might trigger? Social interaction or vastness of desert/ocean, night sky and heavenly bodies. **Role of astronomy for art is simply inspiration**."(PF)*

*"**I think the scientific approach is a wonderful exercise**. I think there's lots of those. There is great validity in scientific approach for everybody. Everybody's an artist.[Do you see a site like we're talking about influencing, changing, manipulating people's perception of the universe?] I hope so. I think one of our most unique things as humans is that we have this incredibly malleable brain that we only use a portion of. **I'm an artist, and a scientist, and I choose when I want to think about things rationally, and that informs what I think as an artist, and the art stuff informs what I think as a rational scientist.** I don't see the two as dissimilar. I think everybody's capable of this. If you can come up with a website that helps set off these sparks in people's brains, you've created new constellations, you've created new universes." (JacM)*

"I think we get to play with their models. ***They're providing the models of reality that we're currently saying what we're based in, what our reality is, what our lives are based on.*** *And then we get to play with that." (LJ)*

*"This is almost like asking, "What is creativity****?" I believe that Astronomy and scientific data could have immense application in Art****, but the hurdles that need to be overcome are largely associated with making the discursive links between the disciplines, meaning that there are many areas in which the two relate to one another, it's merely making both more aware of the other, and being diligent about determining what those links are." (PL)*

5.6. References and recommendations

28. Do you know of other artists working with scientific data and/or astronomy data?

29. Could you cite some relevant works in the Arts which involve scientific data and/or astronomy data?

Most interviewees were able to cite a few artists working with scientific data and/or astronomy data, as well as their relevant works Interviewees responded to questions 28 and 29 in a combined way.

It is interesting to note that some artists or groups (such as Donna Cox, Eduardo Kac, Natalie Jeremijenko, Ken Goldberg and C5) were cited by several of the interviewees:

"Off the top of my head, definitely ***Eduardo Kac*** *and* ***James Turrell*** *actually deals with it quite a bit. I think* ***Steve Schkolne*** *would really benefit from working with that. I know there's a lot of graphic artists that would be able to get in and use the data for information graphics, and I can't think of any specific names right now." (CJ)*

"There's a lot of artists right now working with--people right now can access all sorts of data with the internet--people working on the internet tend to work on this kind of data. ***C5*** *for example, also artists that were in the Whitney Biannual for the art this year.* ***John Klima*** *was using this sort of satellite geographical data. In whole the internet art community that works a lot both with visualization and large data sets. I think this guy I'm going to teach with at UC Santa Barbara,* ***Marco Pelan****, I've been looking at his web stuff, I think he does a lot of data, things about space I think.* ***Sonya Rappoport*** *up in Berkeley, she was talking to me about some project doing with some relation to space communication data. He does 3-dimensional visualization stuff, John Klima, and* ***Ben Fry****. We're going to have a conference at the University of Colorado, Boulder, in a few weeks with me, John Klima,* ***Mary Flannigan****, artists working with visualization strategies. I think there's a lot of that going on." (LJ)*

*“A number of artists working with biotechnology. **Natalie Jeremijenko**. The ubiquitous **Eduardo Kac**.” (PH)*

*“I saw this interesting piece by **Ken Goldberg** called "Mori", and he took data from the Hayward earthquake fault, we are all living on this fault. "Mori" of course means death, or presence of death in Japanese, and it was a hectic sound, visual and interactive installation.” (GS)*

*“There's a variety of artists who are using data as part of their works: **Eduardo Kac** is definitely one of them. **Lisa Jevbratt**, her whole work is based on data and the interpretation of that data, and sort of relationships between that data and some way of pictorializing, of manifesting that data in an interesting way. The whole **C5 collaboration**, they're using data all the time. There's a group that's a combination of people from MIT and Tokyo where you can enter, say genomic data, and they'll create some sort of organism for you based on the information you give them and the algorithms that they use. There are people in Israel, I forget who specifically, but they're working with bacterial data and creating images from the understanding of that bacterial information. The guy at Berkeley, **Ken Goldberg**, he uses data from the Internet to work on specific art pieces. Those are just a few. There's been a mushrooming of people that are using a vast amount of data to do this. Say from Australia, **Natalie Jeremijenko** also works with a lot of data and uses it to make art.” (NR)*

***“Donna Cox** comes to mind. **Joseph Cornell** comes to mind, because he built universes and transcended universes. If he'd come up with some of those measurements we were talking about, I think that would've been interesting. I keep a file of people who connect art and science. **Ken Knowlton** and this woman's in Maryland, There's the people making nano-sized sculptures using non-lasers, or whatever. I feel people use what we consider pure science as part of their art making.” (JacM)*

*“Someone more like **Stelarc** might even be...because he's taking a lot of this information and turning back into a visceral component of the body. **Eduardo Kac**...both of these artists are problematic for me in terms of visualization. I think that **Donna Cox** is doing amazing, amazing things in the Big Bang project. That's fairly traditionalist representation of data, but in doing simulations like that, giving the look and feel of something is extremely important.” (PL)*

*“Well, there **Natalie Jeremijenko's** "Ride the Loma Prieta Pony", that's a nice piece with the bucking bronco ride, the more seismic activity there is the more it tries to throw the rider. **Jennifer Healy** has this piece that has to do with startled response that's kind of interesting. About measuring when people are startled and using that to trigger video.” (AK)*

*“**Steve Wilson** runs a course on artists and emerging technologies at SFSU.” (JM)*

*“We collaborate with the Hayden planetarium in NYC, former students…one of the top artists there is **Carter Emmert**… I would consider him to be an extremely good artist…traditional background.. used to work for NASA…..several other artists working there on projects for the planetarium dome...treating it very artistically and sending it out to the public… The other artists coming back from the biannual electronic arts show*

that's in Perth, Australia--there were several other artists there. I don't know their names, I just met them. That are working with large data and bringing it into a gallery setting...explorations of that data." (DC)

It is also important to note that a few interviewees were not able to cite any artist working with space science or scientific data in general:

"I'm sure there a lot of people working on the web with databases. ***I'm just drawing a blank now****." (AW)*

*"****No, not of any right now****." (PF)*

*"****I can't think of anyone right now****." (NW)*

*"****I can, but not right now****. I have most of my information is at my desk at work. Just offhand…not that many" (WC)*

*"****I can't give you any names****, but not long ago, this year, I saw a painting of space at SF MOMA, which was an exhibition of different artists' work. So every so often I see other people doing space paintings." (DT)*

A more comprehensive roster of artists working with Art & Technology is presented on Appendix F.

30. Do you have any recommendations to NASA on how to make space science and astronomy data and imagery interesting/accessible/useful to artists?

In the view of most interviewees, the NVO project seems to be a potential opportunity to entice the public into learning more on space science and astronomy:

*"****NVO could be an a incredible tool for engagement with the public****, I think this is a really unique opportunity for NASA to really get them excited again."*

They think that, ideally, NVO should not only engage artists, but also inspire them*:*

"The issue in my estimation is that of engagement. ***How does this inspire me? How does the universe relate to me (the artist)?*** *What does contemporary scientific information say to the artist, and what does it say about the situation humanity is in regards to itself and in contrast with the larger universe?"*

Interviewees expressed the opinion that NVO should not be informing people of space science and astronomical issues, but *"giving people a space to their imaginations"*, and providing the audience with ***"unexpected possibilities."***

In fact, most subjects responded that they would like NASA to *"**think as much outside the box, outside of earth and into the universe, as possible**":*

> *"**I would like NASA to think of the website as an inspiration, a catalyst, and not just a repository of information.** Think of it as something that goes out and creates new stars, instead of just coalescing all the stars into whatever. Make it an energetic, creative thing that goes out."*
>
> *"I think on one hand, we've been talking about this a great deal, **an expansion of the sensorium.** Looking at it from the perspective of an intuitive form of ergonomics, an intuitive form of information architecture. We've seen it here at SIGGRAPH, we have so many people working with multiple ways of visualization, **multiple ways of using sensoria to analyze data so we could ascertain these patterns**."*

Some interviewees have stressed that experiencing data, and taking part in the process, is an important means of engaging the public:

> *"**Actually having the experience, not simply reading about it** is really, really important."*

Interviews listed a series of professionals who should be involved in the design and development of the NVO project, such as designers, information architects, science museum professionals, science educators, artists and electronic artists.

> *"**Somebody who is a really, really talented, designer, information architect**, these are people that are extremely skilled at creating really graphically understandable sites."*
>
> *"**You need those rare people that are within their field that are natural teachers**, that know how to communicate the esoteric aspects of their field. Those would be really, really important people to have."*
>
> *"But I would **like people from different parts of the world to really be involved**. Diversity of perspectives not only from geographical areas, but in terms of disciplines, and in terms of beliefs too."*
>
> *"**I'd like to see NASA work with the science centers around the country**, they've been appealing to the target audience for decades."*
>
> *"**Science museums are in touch with the general public**. It may be too that just putting out a query on the website...open for discussion, here are 5 different possibilities of where we might do the next project."*
>
> *"To be able to do some kind of an evaluation of what to focus ...what layer to do next. **Really nice if it came from the audience, artists do that kind of stuff already.** There's no point in making something that no one else is interested in getting the answer to as well."*

Finally, most of the interviewees stressed that artists should definitely participate in the NVO project - from the early stages of brainstorming and structuring of preliminary ideas, to the

advanced stages of implementing, using and testing resources - so that creative solutions may emerge and be adequately and efficiently developed for use by different segments of the general audience.

> *"**I think artists are good at provocation**, so that's the other end. If you're just looking for utility, you want to go out and find what people need. **Artists come from the end, I think, they come to shake people's world up a little bit, not thinking about their day to day needs. Offering an extraordinary look**."*

> *"**Art is the mechanism with which I can bring both types of information and hybrid them into a more complete character of true information**."*

Several interviewees have expressed their desire to engage in the process of creating compelling and innovative tools and interfaces. They have suggested new approaches for presentation of information and tools, methods for navigating in a more intuitive or pragmatic way, possible ways of establishing collaborations between users and scientists—all pointing to more effective and appropriate methods of knowledge acquisition.

> *"**One thing I would like to do is be a part of the tool-building process**...Let's say we had links that would bring a history of art's interest in science, the obvious ...LEONARDO...astrophysical, astronomical...Wonderful thing to have that as a resource that would either complement or augment NVO. **I think their awareness as art in contribution in this area is very important. That an interactive artistic work that would engage and bring together** ...with the new tools, would be very interesting..." (DC)*

Some interviewees suggested ways NVO could engage artists, by providing them with grants and organizing workshops, or by commissioning artists to produce space science related work for the site:

> *"I think this notion of having some **commissioned works** in which artists specifically focus on conveying this sense of exploring this information space, also really completely broaden and deepen what you have. It will open the range of experiences that people can have, and people who will be drawing into that process - that could really help supply a fundamental elements of connecting space science with the public good actually."*

> *"I think that accessibility and being able to communicate and collaborate is the best use of that for artists. I think having those opportunities and maybe even **grants or workshops**, or within the website, **discussion boards**, and a registry of artists that would be interested in using the data or working with other artists on that. " (CJ)*

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This project has been reviewed by the UC Berkeley's Committee for the Protection of Human Subjects, CPHS, and is fully approved.

Presentations:
AAS Meeting at Albuquerque, NM June 2002 - Poster
1st NASA E/PO Conference Chicago, Ill June 2002 - Poster
NVO Outreach Workshop at Baltimore MD July 2002 – Presentation
NASA AISRP conference Mt. View CA- Presentation
AAS Meting Seattle WA- Jan 6 2003- Poster (accepted)
AAAS Meeting Denver CO 2003

Section 1.01 Appendices

Appendix A: List of project participants (research team, focus interest group and consultants)
Appendix B: List of interviewees' names, educational background & current affiliation
Appendix C: Table of interviews' modes, locations and dates
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Appendix F: Roster of Artists working with Art & Technology

Appendix A. List of project participants (research team, focus interest group and consultants): affiliation and short bios

	Participating Members	Affiliation
	Research Team	
1	**Rejane Spitz**	Space Sciences Lab, University of California at Berkeley
2	**Nahide Craig**	Space Sciences Lab, University of California at Berkeley
3	**Isabel Hawkins**	Space Sciences Lab, University of California at Berkeley
4	**Roger Malina**	Laboratoire d'Astronomie Spatiale, Marseille, France
5	**Greg Schultz**	Space Sciences Lab, University of California at Berkeley
6	**Bryan Méndez**	Space Sciences Lab, University of California at Berkeley
	Focus Interest Group	
1	**Sharon Daniel**	Assistant Professor of Film and Digital Media / University of California-Santa Cruz
2	**Ken Goldberg**	Associate Professor of Engineering / University of California-Berkeley
3	**Jim Gasperini**	Independent Artist
4	**Brett Stalbaum**	C5 and CADRE at San Jose State University
5	**Beau Takahara**	Director and CEO / ZeroOne – The Art and Technology Network
6	**Stephen Wilson**	Professor, Conceptual/Information Arts (CIA), Art Dept, San Francisco State University
7	**Marco Molinaro**	ScienceVIEW - Director of Multimedia Development, Lawrence Hall of Science / University of California-Berkeley
8	**Steven dos Remedios**	IT Manager, Chabot Space & Science Center
9	**Susan Schwartzenberg**	Senior Artist, Exploratorium
	Consultants	
1	**Mark Beam**	Writer, researcher, producer , Founder / Creative Disturbance
2	**Greg Niemeyer**	Dept of Art Practice and Film Studies, University of California-Berkeley
3	**Joel Slayton**	Coordinator , CADRE at San Jose State University
4	**Alan Gould**	Director, Planetarium / Lawrence Hall of Science
5	**Beverly Reiser**	Independent Artist, LEONARDO

Research Team:

Dr. Rejane Spitz is an Associate Professor at the Department of Art & Design at Rio de Janeiro Catholic University, in Brazil, where she teaches courses on "Electronic Art", "Computer Graphics" and "Interactivity", at both graduate and undergraduate levels. She also coordinates the Electronic Arts Unit, an experimental research laboratory working with art and technology, at PUC-Rio (since 1992). Dr. Spitz - who is currently a Visiting Scholar at the Space Sciences Lab, University of California at Berkeley - has a Ph.D. in Education from PUC-RIO University (1993), a M. Arts in Graphic Design (1983) from the Central School of Art & Design (London, UK), a Certificate in Advanced Typographic Design (1982) from the London College of Printing (London, UK), a B.Arts in Industrial Design (1979) and a B.Arts in Visual Communication (1979) from PUC-RIO.She has been working with computers in the Arts since 1983. She was a Computer Graphics animator at Pullman Video & Graphics (1983-84, UK) and at TV Globo (1984-85, Brazil). In 1985 she was invited to organize and teach Computer Graphics as part of the Art & Design curricula at PUC-Rio. She has been awarded the Golden and Platinum Records from WEA Music for the creation of the interactive track of the CD "ÁLBUM" (for the "Barão Vermelho" rock band), and among her main works are: the Ecumenical Digital Bible CD-ROM for Loyola Publishers; the "Brazilian Beats: Expressive Culture and Arts in Contemporary Brazil" CD-ROM, in collaboration with the University of Florida; and the website "Private Domain: please, keep off!", which was presented as part of "The Homestead" web exhibition, curated by Paul Hertz (Chicago, USA). Her project "Netizens, net-fringers and outsiders" – which has been awarded Rio de Janeiro's "*Cientistas do Nosso Estado*" (Scientists of our State) grant - shows how people living in dramatically different social-economic circumstances perceive and understand the Internet, how it affects their lives, and its implications for their future. This work has been exhibited at major exhibitions, conferences and art galleries around the world, such as the Race in Digital Space (Los Angeles, 2002), FILE 2002 (Sao Paulo, Brazil), SIGRADI 2001 (Concepcion, Chile), SIGGRAPH'2001 (Los Angeles, USA), Kingston University (UK, 2001), Colville Place Gallery (London, UK, 2000), and ISEA 2000 (Paris, France). Rejane has been also working as a curator of several exhibitions on Electronic Art, and has written extensively on social and cultural issues related to the use of computers in developing nations. She is on the Editorial Board of the journal LEONARDO (MIT Press), on the International Advisory Committee of ISEA (Inter-Society for the Electronic Arts), on the Advisory Board of The Digital Art Museum (DAM), and the South American Representative of SIGGRAPH Education Committee (SIGGRAPH).

Dr. Nahide Craig is the Director of the Science Education Gateway program (SEGway), funded by NASA's SR&T and the UC Berkeley Interactive University Project. A research astronomer with 10 years' involvement in the EUVE mission and the SSL Experimental Astrophysics Group, Dr. Craig has provided science support for both the EUVE and the ORFEUS missions, obtaining ground-based observations of interstellar Na I, Ca II, and Ti II. Dr. Craig's expertise includes dissemination of Education and Outreach programs, resources, and methods to scientists and educators through their professional societies (NSTA, AGU, AAS). She has participated in training workshops for AAAS Benchmarks and National Standards and has been involved in the design, articulation, and management of K-12 initiatives through the Non-Profit Education Program. SEGway program serves as an infrastructure for education and outreach materials for NASA's HESSI, FAST, CHIPS and STEREO/IMPACT space science satellite missions.

Dr. **Isabel Hawkins** is a Senior Fellow in Science Education. She conducts research in astronomy/space science education, and is Director of the Center for Science Education at the UC Berkeley Space Sciences Laboratory (SSL). SSL is an organized research unit that builds and operates NASA space science satellite missions. Dr. Hawkins' primary area of astrophysics expertise is in chemical abundances of the interstellar medium. As Director of SSL's Center for Science Education, Dr. Hawkins is principal investigator of several national education initiatives, including NASA Office of Space Science's Sun-Earth Connection Education Forum (in collaboration with Goddard Space Flight Center), and Project FIRST (Fostering Reading Through Science and Technology) funded through the University of California School-University Partnerships program. She is also a member of the NASA NVO Science Definition Team. Dr. Hawkins has more than 60 astrophysics and science education research publications. As part of SSL's teacher professional development program, Dr. Hawkins developed a Satellite Mission Operations Course for science teachers. Dr. Hawkins received her B.S. in physics with High Honors from the University of California, Riverside, where she also became a member of Phi Beta Kappa. She received her Ph.D. in astronomy from the University of California, Los Angeles in 1986. She is a member of NASA's Office of Space Science Education Council and a former member of NASA's90 Space Science Advisory Committee.

Dr. **Roger F Malina** is an astronomer and space scientist. His degrees are in Physics (MIT 1972) and Astronomy (Berkeley, 1979). He currently serves as Director of the Laboratoire d'Astronomie Spatiale, Marseille, France. He is a member of the NASA NVO Science Definition Team and of the International Academy of Astronautics, and co-chairman of their Committee on Space Activities and Society. Dr Malina is also an editor and is Chairman of the Board of the non-profit professional organization Leonardo/The International Society for the Arts, Sciences and Technology. He serves as the Executive Editor of Publications including the scholarly Journal Leonardo and Leonardo Book Series published by MIT Press. He has served on a number of art juries and conference organizing committees including the International Symposium for the Electronic Arts, the jury for the Louis Vuitton Science For Art Prize and the Ars Electronica art juries. For a number of years he has organized workshops on space and the arts in Paris which bring together artists, writers and space scientists and engineers.

Dr. **Greg Schultz** a NSF Postdoctoral Fellow in science education, working at UC Berkeley's Center for Science Education at the Space Sciences Laboratory (CSE@SSL; http://cse.ssl.berkeley.edu/), with fellowship funding from the National Science Foundation (NSF) and its PFSMETE program (http://www.ehr.nsf.gov/dge/programs/pfsmete/). As such, I'm working full-time in education & public outreach (EPO), and I broadly consider my work to be "science education R&D (research & development)". The primary focus of my R&D efforts is on teacher education and professional development, and part of my work is to effectively integrate astronomy & space science in these domains. Before coming to UC Berkeley, I received a PhD in Astronomy from UC Los Angeles (as well as an M.S. in Physics from Purdue Univ.). As an astronomer and science educator, I have a keen interest in the National Virtual Observatory, and see promising opportunities for it in EPO.

Dr. **Bryan Méndez** is an Education and Public Outreach Scientist working in the SEGway (Science Education Gateway) program at the Center for Science Education at UC Berkeley's Space Sciences Laboratory. He received a Ph.D. in Astrophysics from UC Berkeley. As a member of the SEGway team, he develops products and programs for K-12 classrooms and general public audiences. He also participates in professional development programs for teachers.

Section 1.02

Focus Interest Group:

Sharon Daniel is an Assistant Professor of Film and Digital Media at UCSC where she teaches classes in digital media theory and practice. Her research involves collaborations with local and on-line communities which exploit information and communications technologies as new sites for "public art." Her net-based Collaborative System, NARRATIVE CONTINGENCIES, is an interactive, non-linear narrative, which allows participants to contribute texts and images to a continuously evolving story. An installation or "community site" for Narrative Contingencies was open to the public as part of the CORCORAN 46th BIENNIAL - Media and Metaphor, at the Corcoran Gallery of Art in Washington, DC. Dec. 2000-March 2001. Narrative Contingencies website is currently on exhibition via the Mediateca of the Fundació "la Caixa", Barcelona and was presented in the Korean Biennial exhibition "2000 Kwangju Biennial Media Art Project." The Portugese version, has been exhibited in in the South American Biennial 1999 - Bienal de Artes Visuais do Mercosul, in Porto Alegre, Brazil. Daniel's current project, "Subtract the Sky," (a collaboration with Mark Bartlett) is conceived as public art that engages technology and scientific research projects through interactive interfaces on the internet. These interfaces give the public access to The Keck Observatory, the Landsat satellite system, and the Human Genome Project and their databases. "Subtract the Sky" extends the context of public art by allowing individuals and communities to evolve an aesthetically, intellectually, and politically expressive, collaborative environment on-line. Daniel's current research also includes, "Need_X_Change," a project designed to help the staff and clients of Casa Segura, an HIV prevention and needle exchange clinic in Oakland, California attain social and political "voice", through communication with their local community and participation in the global information culture. This project is a collaboration with the staff and clients of Casa Segura supported by the Creative Work Fund. Through these works Daniel provides opportunities for self-representation, communication, and education that effect direct and substantive change in the attitudes and circumstances of individuals and communities.

Ken Goldberg, is an artist and Associate Professor of Engineering at UC Berkeley. Goldberg's art installations have appeared in the Interactive Media Festival, Ars Electronica, the Walker Art Center, ICC Biennale in Tokyo, Berkeley Art Museum, and the Whitney Biennial 2000. Goldberg received his PhD in 1990 from the School of Computer Science at Carnegie Mellon University. He is editor of _The Robot in the Garden: Telerobotics and Telepistemology in the Age of the Internet_ (MIT Press, 2000) and co-editor of _Beyond Webcams: An Introduction to Online Robots_ (MIT Press, 2002). For more information:http://www.ken.goldberg.net/

Jim Gasperini is an independent artist. More information on his works and biography can be found at http://www.well.com/user/jimg

Marco Molinaro, PhD in Bio-Physical Chemistry, is the Director of the ScienceVIEW educational multimedia design, research, and development group specializing in creating multimedia materials aimed at teaching and learning science in formal and informal settings. He

has over seven years experience in the field, and has developed more than 15 major CD-ROM and Internet-based products for teachers, students and informal science center visitors. He is currently leading various research efforts related to educational technology effectiveness including: learning-optimized use of simulations in the classroom, understanding the potential of computer-based data collection for formative assessment in formal and informal learning environments, and understanding the impact of technology on social learning behaviors of groups. Since 1992, he has been a prime example of a researcher that has combined research interests with educational technology and practical tools.

Steven dos Remedios is IT Manager at the Chabot Space & Science Center
More information can be found at http://www.ChabotSpace.org

Susan Schwartzenberg is a Senior Artist at the Exploratorium, San Francisco. My professional life has had two parallel paths, a staff member of the Exploratorium and as an independent artist. At the Exploratorium I have worked as a photographer, graphic designer, and exhibition curator. In 1992 I became Director of Media, a newly formed department combining photography, video, and interactive media. Our task was to experiment with and find creative educational uses for new telecommunications technologies. In 1998-99 I took a leave of absence from the Exploratorium and spent a year in a fellowship program at the School of Design at Harvard University. I studied the urban design process and the potential of narrative approaches to design in multiple public contexts. I returned to the Exploratorium in a new position as Senior Artist. My professional artwork has been realized in many forms from books and installations to curated exhibitions and larger scale public works. My themes include biography, memory, urban life and history. My most recent projects include the co-design of the Rosie the Riveter Memorial in Richmond California, and Hollow City: The Siege of San Francisco and the Crisis of American Urbanism, a book published by Verso 2001, with author Rebecca Solnit. I have taught at the California College of Arts and Crafts, the San Francisco Art Institute and the Academy of Arts College.

Brett Stalbaum is a C5 research theorist specializing in theory, database, and software development. He was also a co-founder of the Electronic Disturbance Theater in 1998, for which he co-developed software called FloodNet, which has been used on behalf of the Zapatista movement against the websites of the Presidents of Mexico and the United States, as well as the Pentagon. As Forbes Magazine put it "Perhaps the first electronic attack against a target on American soil was the result of an art project." For EDT, this was all learned behavior taught by the example the Zapatistas. In 2001, Stalbaum was a guest in Lisa Jevbratt's Mapping the Web Infome project, and in 1997, he participated in "Landscape Painting as Counter-Surveillance of Area 51", a site-specific performance at the border of the well known secret air base. As part of that performance, he instigated an investigation of his activities by the department of defense and the FBI after he spammed a large number of unpublished email addresses at Nellis Air Force Base. In the interstice, he has done many other individual and collaborative projects, written on net art and its context/aesthetics, and is a past editor of Switch. (switch.sjsu.edu) His contribution to the legacy of C5 projects include16 Sessions (Walker Art Center), RCSP (Siggraph), YDSTYDS (ASU), and others. Current projects include GIS software development focused on the creation of a database, related libraries, and utilities for use with GPS, digital elevation modeling, and other applications. The platform is designed for use by artists and endurance athletes, as well as consumer applications for hikers, campers, naturalists, OHV enthusiasts, survivalists, hunters and fishers. Stalbaum holds an MFA in fine art from CADRE at San Jose State University, and a BA in Film Studies from San Francisco State University. Currently, he teaches programming at Evergreen Valley College in San Jose.

Beau Takahara is the Director and CEO of the non-profit organization ZeroOne – The Art and Technology Network located in Palo Alto, California. She comes to the Network after five years at The Tech Museum of Innovation in San Jose where she worked as a fundraiser on the Capital Campaign and the Annual Fund. While at The Tech, Beau curated an art and technology lecture series and arranged for two art and technology exhibits, one from Interval Research and one from Xerox PARC, to each be installed for a six month period in the new Tech. Prior to her time at The Tech, Beau worked with a number of not-for-profit art organizations including Yerba Buena Center for the Arts, San Francisco; and George Coates Performance Works, San Francisco, where she was executive director for three years and involved in large-scale, leading-edge productions of new music theater utilizing state-of-the-art technologies. While at The San Francisco Museum of Modern Art for nine years, she curated video and media exhibits, produced a large computer graphics festival in conjunction with SIGGRAPH, and organized the first museum screening of HDTV, as part of a large seven week festival: Tokyo Form and Spirit which she conceived of and produced. Beau is past Board Chair of The Lab, an alternative arts organization in San Francisco that presents experimental work by visual and performance artists. She received a BFA in art and art history from The University of Utah and did graduate studies in art history at the University of Iowa.

Stephen Wilson is a San Francisco author, artist and professor who explores the cultural implications of new technologies. His interactive installations & performances have been shown internationally in galleries and SIGGRAPH, CHI, NCGA, Ars Electronica, and V2 art shows. His computer mediated art works probe issues such as World Wide Web & telecommunications; artificial intelligence and robotics; hypermedia and the structure of information; GPS and the sense of place; synthetic voice; and biological & environmental sensing. He won the Prize of Distinction in Ars Electronica's international competitions for interactive art and several honorary mentions. He is Head of the Conceptual/Information Arts program at San Francisco State University. He was selected as artist in residence at Xerox PARC and NTT Research labs. He has been a developer for Apple, Articulate Systems and other companies and principal investigator in National Science Foundation research projects to investigate the relationship of new technologies to education. He has published extensively including articles such as "Dark & Light Visions", Artist as Researcher", "The Aesthetics and Practice of Designing Interactive Events", "Interactive Art and Cultural Change", and "Noise on the Line: Emerging Issues in Telecommunications Art". He has published three books, Using Computers to Create Art (Prentice Hall, 1986), Multimedia Design with HyperCard (Prentice Hall, 1991), and World Wide Design Guide (Hayden, 1995), which promotes an experimental, culturally aware approach to Web design. His new book called "Information Arts: Intersections of Art, Science and Technology" published by MIT Press in November, 2001 surveys artists, theorists, and researchers working in advanced inquiries in fields such as biology, medicine, physics, artificial life, telepresence, body sensors, vr, artificial intelligence, and information systems.

Consultants:

Mark Beam is Co-Founder and CEO of Creative Disturbance (1999), a global R&D network dedicated to advances in human-computer interface. He is also a Co-Founder of Glass House Studio (2001), an immersive visualization and simulation services company. Prior to that he

directed beaming, llc. (1995), a new media venture consulting firm in San Francisco, advising public and private organizations, universities and corporations. beaming also produced "New Minds," a widely acclaimed lecture and performance series in San Francisco that focused on the cultural impact of new media. From 1983 to 1994, Mark was a financial securities executive, investment banker and portfolio manager for three of the largest banks in the world in Chicago, Los Angeles and New York. Mark's experience centers around identifying, articulating and managing opportunity in the financial marketplace and in the emerging art & technology space. He serves as a Member of the Board of Directors of Leonardo and as an Advisor to the Department of Media Arts at SF MOMA and to WITI (Women in Technology International). He received a Bachelors Degree in Business, a JD and MBA from Creighton University in Omaha, Nebraska.

Alan Gould is the Director of Holt Planetarium at the Lawrence Hall of Science, UC Berkeley, Director of Planetarium Activities for Students Success (PASS) - alias Participatory Oriented Planetariums for Schools (POPS) Author in the Great Explorations in Math and Science (GEMS) project as well as coordinator of the GEMS Commercial Kit effort which is making all materials for teaching GEMS activities available in kits through Sargent Welch. Co-director of Hands-on Universe (HOU) project that enables teachers and students to request their own images of celestial objects via the Internet. Images are available from our online library and from the international network of HOU telescopes. Students analyze the images with HOU image processing software. Students at all ability levels investigate the universe as they learn concepts from science, mathematics, and technology. Director of Global Systems Science (GSS) -- high school curriculum, which has volumes (student books and teacher guides) downloadable from the GSS website. In this project, we're trying out a new concept called JOHDI--Joint Online and Hardcopy Design Interface--which will make documents that are BOTH easy to read online AND in paper print. Alan Gould has worked at LHS since 1974, starting out as a part-time planetarium show presenter at the Holt Planetarium, which is known for its innovative audience-participation planetarium shows. Since then, his responsibilities have increased to include teaching school workshops and courses teacher education workshops curriculum development. He has authored and co-authored a number of works including Planetarium Activities for Students Success (PASS) , and GEMS (Great Explorations in Math and Science) teacher classroom activity guides.

Greg Niemeyer studied Classics and Photography in Switzerland before he came to the US in 1992. Through photography, Greg experienced the contest between reality and ideal in his perception of the world, especially in documenting the 1991-1992 collapse of the GDR and in photographing a story about the perception of time among Catholic monks. Based on these experiences, he understands media art as a “reality engine”, as a possible source of increased experience of our reality. Because of the ability of computers to document and display a wider array of information than traditional photography, Greg engaged information technology as a key component of his creative practice. He enrolled in Stanford's MFA program in New Genres in 1996 with the intention to explore science and information technology as a context for art. In 1997, he founded SUDAC, the Stanford University Digital Art Center, in anticipation of the need for an academic space dedicated to the practical and theoretical exploration of information technology and art. Under Greg's direction, SUDAC has become a productive center with 6 courses per year. All SUDAC courses were developed with an emphasis on project-based learning, which culminated in annual presentations of digital art in public spaces and of CG short feature animations. In 2000, SUDAC opened its first exhibit, Refresh: The Art of the

Screensaver, at the Cantor Art Center and at www.artmuseum.net, and conducted its first conference Attraction/Distraction: The Perceptual Conditions of Digital Media. For his digital media installations, Greg received a substantial Intel Corporation Creative Research Grant. This grant allowed him to produce and present some of his hybrid virtual and physical installations. For SFMOMA's 010101 show, Greg produced a hybrid network sculpture named PING, in collaboration with composer Chris Chafe. The next major installation project with Chris Chafe is another hybrid installation named Oxygen Flute. These projects demonstrate the possibility of inhabitable structures, which combine a static, passive, physical structure with a dynamic, active, electronic structure. Seeking a stronger community of digital media artists, Greg Niemeyer moved to UC Berkeley in 2001 to join Shawn Brixey's and Linda Williams growing program in Digital Media at the Departments of Art Practice and Film Studies. His courses focus on computer graphics animation. Here, Greg also found the academic context to study the cultural implications of digital media, in particular of CG simulations. These studies will lead to a book publication with co-author Celia Pierce currently titled "Transfusion: Transgressions in Physical and Virtual Architecture". In the interest of forming a more communicative digital art community, Greg Niemeyer serves on the boards of CCAC (Digital Media), SMAC (San Francisco Museum of Modern Art Media Arts Council), GenArt and GroundZero.

Beverly Reiser has been the president of Ylem/Artists Using Science and Technology since 1985. She serves on the Advisory Board of the International Society for the Arts, Science, and Technology, and on the External Advisory Panel to the Xerox PARC Artist-in - Residence Program and was recently described by MicroTimes as a multimedia pioneer and one of the 100 most influential people in the computer industry. She creates pictures, animations, and designs visual interfaces.

Joel Slayton is a recognized artist, writer and new media theoretician. He is Professor of Digital Media Art at San Jose State University. Joel Slayton has bee Director of the CADRE Laboratory for New Media since 1991. Professor Slayton is the Executive Editor of SWITCH, CADRE's on-line journal of critical and theoretical discourse involving new media. Joel Slayton is President of C5 Corporation, a business as art venture specializing in theoretical models, analysis and tactical implementations of information technology. Joel Slayton serves on the Boards of Directors of Leonardo/ISAST, where he is Chairperson of the Leonardo/MIT Press Book Series, and on GroundZero- a Silicon Valley non-profit organization dedicated art and technology project incubation. Regarded as a pioneer in digital media, Joel Slayton was an original member of the Visible Language Workshop at MIT. His artwork has been featured in over one hundred international exhibitions and published in more than fifty publications and books. Professor Slayton has been an invited speaker at international symposia such as Transmediale, Siggraph, Ars Electronica, Visual 2000 and ISEA. He has produced large scale site specific installation performance works for the cities of Palo Alto and San Jose and many insertion site works such as "Landscape Painting as Counter Surveillance of Area 51" and "Panamint Launch at Lucky Jim Wash". His installation exploring the nature of virtual space, was commissioned for "Alternating Currents: American Art in the Age of Technology" at the San Jose Museum of Art, co-curated with the Whitney Museum. Joel Slayton's projects involving telepresence, robotics and social networks are widely renown. He is currently exploring social networks using wireless technology. C5 Corporation artworks have been featured at the Brooklyn Anchorage, ASU Center for Creative Inquiry, Walker Art Center, San Jose Museum of Art, Ars Electronica, Stanford University, Transmediale, Siggraph and the New Museum. Publications include Wired Magazine, After Image, the New York Times, ArtByte and Flash Art. C5 is both a business and artwork simultaneously. Professor Slayton's theoretical writing explores the social nature of

information systems, structures and networks. Recent papers include: Re=Purpose of Information: Networks as Art; Ontology of Organization as System and Social Software. Joel Slayton was selected for participation in the PAIR program at the Xerox Parc Research Center in Palo Alto.

Appendix B. List of interviewees' names, educational background & current affiliation

	Name	Educational Background	Current affiliation
1	**Christopher Johnson (CJ)**	**Master of Fine Arts, Art and Technology**, The School of the Art Institute of Chicago, IL ,1995-96.	**Assistant Professor** at Northern Arizona University, School of Communication, Flagstaff, Arizona, since 1996.
2	**Donna Cox (DC)**	**BA and a MFA in Computer Graphics Arts** at the University of Wisconsin at Madison.	**Associate Professor** in the School of Art and Design and Assistant Director, Virtual Director Group, National Center for Supercomputing Applications (NCSA) at the University of Illinois at Urbana-Champaign
3	**Jacki Morie (JacM)**	**MS Computer Science** University of Florida in 1988, and **Master of Fine Arts**, University of Florida in 1984.	**Manager of Creative Development**, USC Institute for Creative Technologies and Project Lead, Sensory Environments Evaluation Project, 2000- present.
4	**Patrick Lichty (PL)**	**Art and Social Theory**	**Experimental media arts researcher**, independent curator, writer, designer, musician, social activist, and editor.
5	**Annette Weintraub (AW)**	**Painting**	**Associate Professor**, Department of Art and Design, The City College, New York
6	**Andruid Kerne (AK)**	**BA Applied Mathematics / Electronic Media**, Harvard. **MA Music / Composition**, Wesleyan. **Ph.D. Computer Science**, New York University.	**Assistant Professor**, Department of Computer Science, Texas A&M University
7	**Dorothy Timourian (DT)**	**BA in Art Education, Masters in Painting from San Jose State University.**	**Independent**
8	**Peggy Frank (PF)**	**BA in Fine Arts (painting and art education)**, from University of Denver.	**Artist, Art Instructor**
9	**Glen Sparer (GS)**	**Film making**, NYU.	**Postgraduate Art Student** at CADRE, San Jose State University, California.
10	**Paul Hertz (PH)**	**Art**	**Adjunct Professor**, Interactive Multimedia, Department of Radio, Television and Film, and Medill School of Journalism, Northwestern University, Evanston, Illinois, 1995 to present.
11	**Craig Hansen (CH)**	**BA in Fine Arts**	**Exhibit developer and designer**, Lawrence Hall of Science Museum, University of California at Berkeley.

12	**Lisa Jevbratt (LJ)**	**BA** in **Fine Art**s, **M.F.A in the Computer in Fine Arts** from the CADRE Institute of the School of Art and Design, at San Jose State University.	**Professor** at the Art Department of UC Santa Cruz
13	**Geri Wittig (GW)**	**MFA in Computers in Fine Art** from the CADRE Institute of the School of Art and Design, at San Jose State University.	**Research Fellow** at the CADRE Institute of the School of Art and Design at San Jose State University, Research-theorist at C5, San Jose, California
14	**Nora Raggio (NR)**	N/A	**Postgraduate Art Student** at CADRE, San Jose State University, California
15	**Bonnie Shulkin (BS)**	**BA in Astrophysics and Computer Science** from Williams College.	**Enrichment Coordinator**, Chabot Space and Science Center, Oakland, California.
16	**Ben Burress (BB)**	**BS in Physics, minor in Astronomy**	**Exhibit Designer** , Chabot Space and Science Center, Oakland, California.
17	**Ryan Diduck (RD)**	**BS in Physics, major in Astronomy**	**Director of Astronomy**, Chabot Space and Science Center, Oakland, California.
18	**Celeste Burrows (CB)**	**BS in Mathematics**.	**Astronomy Instructor**, Chabot Space and Science Center, Oakland, California.
19	**Wendy Coones (WC)**	**BA in Fine Arts**	**Exhibit Coordinator**, Chabot Space and Science Center, Oakland, California.
20	**Jody Gillerman (JG)**	**BA in Fine Arts**	**Multimedia Artist, Director**, VIPER
21	**Shawn Lani (SL)**	**BA in Art History, a BA in English (creative writing) and a MA in Museum Studies**.	**Senior Exhibit Developer** at the Exploratorium
22	**Noah Wittman (NW)**	**BS in Physics and Master in Education**.	**Multimedia Director**, Exploratorium
23	**James Morgan (JM)**	N/A	**Postgraduate Art Student** at CADRE, San Jose State University (SJSU)
24	**Myron Krueger (MK)**	**BA in Liberal Arts** from Dartmout College**, M.Sc. in Computer Science** from University of Wisconsin, **Ph.D. in Computer Science** from University of Wisconsin.	**Independent**
2	**Garret Moore**	**BA in Fine Arts and Design**	**Creative Director** at ManyOne Networks

5	**(GM)**		

Appendix C. Table of interviews' modes, locations and dates

	Name	Interview's mode	Interview conducted at	Interview conducted on
1	Christopher Johnson	in person	SIGGRAPH Conference, San Antonio, TX	25 July, 2002
2	Donna Cox	in person	SIGGRAPH Conference, San Antonio, TX	25 July, 2002
3	Jacki Morie	in person	SIGGRAPH Conference, San Antonio, TX	26 July, 2002
4	Patrick Lichty	In person	SIGGRAPH Conference, San Antonio, TX	26 July, 2002
5	Annette Weintraub	in person	SIGGRAPH Conference, San Antonio, TX	26 July, 2002
6	Andruid Kerne	in person	SIGGRAPH Conference, San Antonio, TX	27 July, 2002
7	Dorothy Timourian	phone	-	14 August, 2002
8	Peggy Frank	phone	-	19 August, 2002
9	Glen Sparer	in person	San Jose State University, San Jose, CA	15 August, 2002
10	Paul Hertz	phone	-	21 August, 2002
11	Craig Hansen	phone	-	16 August, 2002
12	Lisa Jevbratt	in person	San Jose State University, San Jose, CA	15 August, 2002
13	Geri Wittig	in person	San Jose State University, San Jose, CA	15 August, 2002
14	Nora Raggio	phone	-	16 August, 2002
15	Bonnie Shulkin	in person	Chabot Space and Science Center, Oakland, CA	26 August, 2002
16	Ben Burress	in person	Chabot Space and Science Center, Oakland, CA	26 August, 2002
17	Ryan Diduck	in person	Chabot Space and Science Center, Oakland, CA	26 August, 2002
18	Celeste Burrows	in person	Chabot Space and Science Center, Oakland, CA	26 August, 2002
19	Wendy Coones	in person	Chabot Space and Science Center, Oakland, CA	26 August, 2002
20	Jody Gillerman	in person	Space Sciences Lab, UC Berkeley, CA	27 August, 2002
21	Donna Cox	phone	-	28 August, 2002
22	Shawn Lani	phone	-	28 August, 2002
23	Noah Wittman	phone	-	29 August, 2002
24	Wendy Coones	written	-	30 August, 2002

25	James Morgan	written	-	30 August, 2002
26	Patrick Lichty	written	-	30 August, 2002
27	Myron Krueger	phone	-	3 September, 2002
28	Garret Moore	phone	-	20 September, 2002

Appendix D. Questions for Interviews

Philosophical/ conceptual
31. How do you define “space”? 32. If you had to locate your coordinates in space, what would they be? 33. If you had to describe the environment / location in which you live, what would you say? 34. If you could travel to any destination in the Universe, where would you go? 35. What do you envision about your travel destination?
Background information
36. Do you use scientific data as part of your work as an artist? What for? When? 37. Do you see any possible interaction between the kind of work you do, and scientific, astronomical data?
Web related
38. Have you ever visited web sites about space and astronomy? Which ones? 39. List your favorite and least favorite science sites and why are they so? 40. List your favorite websites in general, and why are they so? 41. Do you find these sites useful? Do you consider you learn something when navigating these sites? Why? 42. Are there any problems you encounter when navigating these sites? 43. What kind of interaction would you like to have with web sites presenting scientific data?
Tools, functions and collaboration
44. What kind of information and data would you hope to find in a website about astronomy and space science? 45. What kind of tools do you expect to find on a site presenting information and data, such as imagery, on astronomy? 46. Should there be specific tools for artists to explore the Universe? What kind of tools? 47. What kind of on-line tools would facilitate use of astronomical or space science data in your

creative work?

48. What kind of interactions/collaborative work could be fostered /provided by a site on astronomy and space science?

49. If you could choose a unit to describe the distance between the Earth and Mars, which unit would that be? Would that make it real to you? Why?

50. Do you find scientific measurement units meaningful or too out of context from daily experiences? How so?

51. How do you relate to light years, Angstroms, terabytes, joules, nanometers, etc?

52. For your kinds of projects, would a 2D or a 3D representation of space science and astronomy data be more important?

53. As regards space imagery, what in your view should be static and what should be dynamic?

54. How much supplementary information should accompany space science and astronomy images and models?

Art/Science interfaces

55. How could artists contribute to space science and astronomy?

56. What is the role of art in visualization or interpretation of outer space or the Universe?

57. What do you think the role of scientific data and astronomy could be in Art?

References and recommendations

58. Do you know of other artists working with scientific data and/or astronomy data?

59. Could you cite some relevant works in the Arts which involve scientific data and/or astronomy data?

60. Do you have any recommendations to NASA on how to make space science and astronomy data and imagery interesting/accessible/useful to artists?

Appendix E. Tables of interviewees' responses

Interviewee's Name	Question 1. How do you define "space"?
Christopher Johnson	Well, in the context of the project, I first asked, "Is it outer space? Inner space?" To explain, I think it is what surrounds you. Your immediate --it could be the table, or outer space and the planets, it could be oceans or molecules going into that. So space is, for me, immediate space and what is around me when I look around and what I feel. It is what I am experiencing with the senses--the touch, the feel, the smell. The other space, I know it exists, but does it exist really? Or is just part of my imagination? Is it something I create as I move?
Donna Cox (in person)	
Jackie Morie	I think of space as a sort of womb out of which everything comes to being. I think of it not as an empty thing but something that's packed with promise--very much a generating force, and that which defines everything that's not space. I mean, you need space to define all the stuff that's not space. I think it's a very pulsing, live, living thing.
Patrick Lichty (in person)	I think that that's a very multivalent question--on one hand, we could go to a straight formalist perspective and say that's the definition of one's occupation and physical space, there's a certain time within the continuum that we would call Einsteinian time-space. That's only one particular idea. Of course, the one thing I say is there is many spaces that we can inhabit on a daily basis. Myself, I tend to span the globe in a virtual perspective. So I work in many different types of virtual space. Also, I work in metaphorical spaces and alliterative spaces. And then there's the concept of astronomical space. In context of this project, I think the idea of space is very important. And that all of these spaces could be of advantage to the explication of such a project. Such is the idea of using a metaphorical space effectively within a virtual space, to expand upon astronomical space, and bring all these things together that make a very intuitive and visceral experience for the researcher and the layman. In my opinion, in order to get the public as well as astronomers and artists involved in astronomically based discussion, there really has to be both a rigorous and intuitive sort of interface and approach to accessing this information, because of the fact that I think there is a lot of disappointment in the idea of space. 2001 didn't happen, Star Trek didn't happen, and there are a lot of people realizing that there's not going to be...actually, a lot of people say it's just happening 18 years late. But that's more political than we need to be. I think that something like this could be, if done in a way that's intuitive and visually engaging and rich in a media perspective, it could possibly be one tool in an arsenal for NASA to help reenergize a kind of excitement in the idea of space more in the astronomical sense.
Annette Weintraub	I don't think there's any one reading of space. I feel I live with multiple ideas about space that are simultaneously present in my thinking. My interior space,

	my thoughts, my exterior space, my relationship to whatever physical space I am in, the space of memory, the space that you occupy when you're reading, the space you occupy when you're speaking to someone else or relating to someone else. There are many multiple spaces, and the mental map of those spaces allow them to coexist with each other and for us to make sense of them. The space of us dreaming at night or lying on the grass looking up at the sky, I think those are all physical as well as mental spaces, they very much each have a different character. The sense of space in a church, or in the Alamo or building that carries a lot of history, they have a lot of emotional, intellectual, physical effect.
Andurid Kerne	The first thing I think about space is openness. Space is something that's not filled, and that means that space is an opportunity, a place where something can happen, there's a potential there. One thing that makes me think about is this presentation on Zen gardens I saw the other day, and how it makes you think about space as an architectural element and openness, and also the notion of a conceptual space is the space of ideas, when you can share a conceptual space with someone, that means there's a place there to make something, a potential for emergence, there's the possibility for new ideas. You could look at space as unfilled ness, as something missing, which I would see as missing a big opportunity. I don't know. I think that the idea of space as potential is probably a substantially, makes me think of Daoism, to see space as a potential and Western culture tends to be more focused on things, substantiations, than on unsubstantiated ness as something backward. Outer space as a metaphor in this culture is very much linked to potential for better or worse. One place you go with the idea of space is the Star Trek cliché, that's a strong current in popular culture, which I think there are a lot more interesting metaphors...but if you want me to project into popular ideas of space, that would be a strong association people would have.
Dorothy Timourian	Space for me is space in painting, architectural space, earth space, planet space, outer space, there's inner space, spiritual and emotional space and physical space. I think there's a lot of different spaces and auras as people, whether it's spiritual or physical or emotional.
Peggy Frank	Space is very interesting because it doesn't necessarily mean outer space as you might think of the solar system and the universe. It can mean space around you, interior and private space, just the sense of wanting to be by yourself and away from a crowd, it could be inner space, if you think dropping down to microscopic level, the space you might see in a cell of human body. It sort of depends on the scale that you're talking about. The general word space can mean a lot.
Glen Sparer	It's hard because from what I've learned from books in school, space is a void, there's no gravity there. Things like this. I can understand the words, but I haven't had the experience yet, so it's still kind of nebulous. That's not the space I know. The space I know is different.
Paul Hertz	I'm not sure. Mathematical descriptions. Geometric space, living space, outer space.

Craig Hansen	I primarily think of volume, of the space between things, whether they're things of our immediate environment or between planets or whatever. When I really think of space I consider that there's much more of what we perceive of as empty space than there is of "stuff", even though I know empty space is not as empty as it seems to be. I can sometimes remember being younger, looking at the stars and feeling a lot of awe about how much space there was, and how little we were. In my more contemplative moments I'd like to think that even when I step outside or just open my window that that same giant space of "outer space" or the universe is really the same space that's coming in through my window, around the objects on my desk, around me. I end up going into the more cosmic definition of it.
Lisa Jevbratt	Since I've been working on the Internet a lot, space to me is basically the IP address system. Then I have to think about why I define that is space. It seems to be a set of categorically equivalent parameters or points, as long as these points are in the same category like IP addresses, they create a space. They can also be emotional points as long as they're on the same categorical level that forms sometimes space so you can position yourself. You have to be able to potentially position yourself within those coordinates to be able to talk about what a space is.
Geri Wittig	In the context of this project when you talk about the virtual observatory, space to me suggests outer space. But there are so many ways to define space. Space can be the area that contains whatever the structure is, or your location on a planet, I don't really have one definition.
Nora Raggio	There's I think been a shift in the way we look at space given the whole aspect of general relativity that Einstein brought about, and I think we often see the classical way of seeing space, as in 3D, but I think that the connection to time is so important that at least there is a fourth dimension. I think that with this new theory of string theory that has come up in physics, there are hidden dimensions of space that we do not seem to be aware of. That in some way vibrate in ways that could give us information that would relate to space, but that have not been totally uncovered. The beauty of string theory as it is today, I think, it has been uncontested, but it seems to bring in the microspace, which is the quantum theory space, with that of the cosmic space, the larger space that Einstein's general relativity. So if I were to define space, I think it's a set of parameters or dimensions that are very much linked to time and also to other parameters that, at this point, we are yet to discover.
Bonnie Shulkin	I think I have a very broad view, anything beyond the atmosphere of the earth. It just depends on the context.
Ben Burresss	I guess it's something that's evolved in my imagination since I was a kid. I had a wall picture, painting of the solar system, the sun, orbits and planets, decorating it with stickers and things, Santa Claus around Pluto. Outside of earth and more playful. Now, it's the universe. I try to hold in my mind the scales and magnitudes we're trying to give people here...our place in the universe. perspective on the scale, our planet's place in it, and our place on it. Scale is very important. It's something that always seems to excite children,

	you go through the demonstrations the relative sizes of the planets, etc...often you get lost because it's such an incomprehensible scale, you still get a lot of oohs and aahs, you're sparking interest whether they really understand what you're saying...
Ryan Diduck	
Celeste Burrows	
Wendy Coones (in person)	
Joan Gillerman	I think of my warehouse as my space. I don't think of it as empty, but I think it can be empty. I wonder about the expanding universe and what's at the end, or beginning…in terms of space and time travel, and I don't' know what the connections are with time travel, I'm very interested in that just as a concept. I think there's usually space and time together, i frequently think of space without time, what that would be like....someone filling up something, and that something would be space...I'm aware that there's emptiness between these things. Filled with something can be emptiness.
Donna Cox (phone)	
Shawn Lani	I don't know if I have a hard mental picture. When I get into this type of …my mind tends to turn into the spiritual side of things…spiritual space as well, your internalization of the universe, …and your role in it…You are your own universe. Your ability to get outside of that...You're always ground zero, right?
Noah Wittman	
Wendy Coones (written)	It's a descriptor rather than a thing. Little bits of particles and atoms that fly off in all directions. It is simply terminology to define something infinite it does really contain or quantify it.
James Morgan	The third dimension. All that we physically experience is in "space."
Patrick Lichty (written)	This is difficult for me to define, because I feel that there are so many ambiguities to this term that coexist. This includes terms for discursive, existential, cognitive, virtual, architectonic, social spaces to mention a few, but in the strictest astronomical sense, space exists for me as the continuum within which the objects and forces exist within what we describe as the known universe.
Myron Krueger	It's actually broader than…I think of the body in space I think of the body as a space…both in the space but also as potentially divorced, as it's own space. The body can become a set of dimensions, which then turn it into an instrument, which you can play visually or in sound …the whole idea that the body becomes a set of parameters to act in other kinds of spaces. I was aware of an incredible plasticity of the body in space ...and of the ability to interact through the body in different kinds of spaces...Very important, like the critical thing...the Head Mounted Display, I always argued that was a useless unit to walk around, and you could walk around wirelessly. Because that is the natural interface between body and space. At the same time, the body can be any set of transformations...in the space and about the space and even to

	create space. I do create 3D shapes with your body...your body now is just an instrument for creating three dimensional space.
Garret Moore	There's physical, there's conceptual, there's…space to me, you can look at it from a spiritual or physical scientist point of view. Or philosophy in-between, and I try to stand in all those. It can even symbolize infinite possibilities, because of the unknown. A spiritualist might look at it as heaven, or infinite possibilities in a spiritual sense. or theoretical, it can be solid, composed of energies, we don't completely understand or acknowledge yet. For me, I tend to want to understand everyone's point of view in something, and I adopt as many views as possible...take everything into account. In one sense I'm a scientist with an artist heart. And in another sense I'm an artist with a scientist heart. I avoid quantifying qualitative information.

Interviewee's Name	Question 2. If you had to locate your coordinates in space, what would they be?
Christopher Johnson	Well, based on that explanation, I guess I would be the center of space, the "zero zero". Which is egocentric if I think about it, but no, I couldn't locate it in a kind of universal longitude-latitude situation. I know where I am on a map, but I guess I would be the center of that too. "Zero zero zero". [What kind of dimension do you imagine for that?] In the physical world it's definitely "zero zero", but when I'm teaching a class or talking to friends, those dimensions expand into emotional and connections with all kinds of different meanings attached to it. So more dimensions than just a flat surface or a three dimensional surface.
Donna Cox (in person)	
Jackie Morie	I can think of it in two ways. Because I'm the only thing I know, for me I'm the center of coordinates in space, because I define the world according to my position in it. There's that sort of relative coordinate space. If I think about it in

	broader terms, the coordinates don't matter because it's continuous, it's everywhere. I am a part of it, but it's all alive and moving and pulsing and becoming, so coordinates don't make sense any more, there is no reason for that word. [So you would be "zero, zero, zero"?] If we had to think in those types of Cartesian terms, I guess so, but I don't think of it in Cartesian terms. [How many dimensions do you envision?] I don't think there's a limit to the dimensions that are out there. I think we do that to make sense of the world. We have to limit the way the world and the universe is, to be able to abstract some sort of logical sense out of it, because of part of the way we're wired. But I don't think we have to do that. Cartesian coordinates of "zero, zero, zero", is a very limited, abstract concept where I might say, "My coordinates are zero, zero, zero, zero, zero, zero to the nth" because the dimensions are that great.
Patrick Lichty (in person)	In the most foremost sense. Say, for example, we're very tied to our own physicality. No matter what flights of fancy, basically, in a couple of hours I'm going to get hungry. If I fall down the escalator over there, I'm going to hurt. No matter how much we abstract ourselves there's still that point in time and space that we really, in the most basic sense, tend to locate our consciousness from a subjective standpoint. And that's almost a, should we call, a root note of consciousness from which we expand everything else--it's a subjective root note. So, although I'd like to look at things from a relativist standpoint, I still do believe there's a given experiential point through senses and through physical experience from which we tend to shape things. This is a very anthropic standpoint from which I, many times, differ. We also have to understand our existential nature a little bit as beings of sense, beings of flesh, beings of desire and all of that. I think sometimes in this technological stage we ignore the animal, you know. We think that we're totally abstracted. We're still extremely far from fulfilling the Moravic Linere dream of externalizing ourselves into the virtual. The other thing is we've come about from billions and billions of years of development in which we're so wired into physical space, in that, all of a sudden, dematerializing ourselves into another form, I even wonder the psychological implications of such a thing would be. Whether that would be better or not. I don't even think it was painful, it was more of a momentary shock, something beyond the sensorium.
Annette Weintraub	I think the cognitive space. I live in my head. A number of people have always said to me that I only see what I want to see. I can be walking down a busy street with a million things happening around me with my focus totally on something that I'm thinking about, I have to wear glasses for driving or movies, but I never wear them on the street because I want it to be a sort of imaginary space. I see well enough to read signs and walk down. I like the softening of the physical space so you can really inhabit the mental space while you're walking and not be distracted by the physical space. I think memory is really important. I think I'm a very visual person. I remember visual

	memories very strong. I can go back to a place I haven't seen in 10, 20, 50 years and have a mental image of it in my mind and recognize streets and remember where to go, as if I was just there the previous week. All of that is something you carry in your head, a mental image of a physical location.
Andurid Kerne	I could talk about where I am, this chair, in the Drury hotel in San Antonio in Texas in the United States in North America, and you could draw that out into the whole powers of ten way of looking at the multi-scale paradigm, that would be one way. I guess I would think about it chronologically, place it in the context of my lifetime, like my recent move to Texas from New York, or I could put it out on a scale in terms of my family's coming to North America from Europe, or I could do it in terms of the chronological things in terms of larger senses of history, like post-September 11th, early 21st century, information age, or the world in terms of the history of civilizations, or the species of Homo Sapiens and evolution. There's a wide space of different kind of interpretations I could use for space and placing myself in coordinates and some of that would be personal and some would be cultural, historically, geologically, economically, there's all these different systems of representations. One could invoke to do placements to create spatial and temporal coordinates in a way.
Dorothy Timourian	Actually I'm in all those spaces. I think we live in the universe, and universes which are made out of space that we don't even know how far it exists, besides our earth space which we reside in, and emotional space and spiritual space, whether we believe in a supreme being or not, how we fit in with other people in a spirit.
Peggy Frank	If I am thinking self-centered, I can think of myself as the coordinate zero zero zero with everything else going around me. Or I can think of myself as a tiny infidecimal spot on the earth, coordinates might be zero zero zero, but it might be actually the center of the earth, the earth-center. Right now I'd say, everything would be from around me. I would be my coordinates as zero zero zero.
Glen Sparer	
Paul Hertz	The coordinates that allow me to move around primarily involve paths and path-finding rather than Cartesian grid. It's called way-finding, I know the ways places are connected up.
Craig Hansen	I would do it in stages, by locating myself on the face of the globe, either by latitude/longitude, or by more naturalistic ways of locating myself on the face of the planet. "I'm on a hillside next to a bay on the planet earth", and just stepping out from there, where the earth is in relationship to the sun and stepping out again, to how the sun is in relation to the Milky Way, and even though I know that there is structure beyond that, my knowledge of how the Milky Way is surrounded by the immediate environment of everything else is pretty fuzzy. That's where my ability to locate myself in the universe would break down a little. I can only vaguely picture myself in relation to space by the Milky Way because descriptions and images that I've seen and read,

	whether in Carl Sagan's "Cosmos", that gives me a knowledge that we're on the outer edge. Then I can build a picture in my head that feels right.
Lisa Jevbratt	130.65.200.17. That is definitely a very important coordinate for me. That was my IP address for a long time, I'm current switching over to one in UC Santa Barbara and I don't know what that IP address is yet. I think it depends what space you're in, of course, what coordinates are within that space. In terms of emotional space it might be something today, something different tomorrow. It's difficult for me to say what my coordinates are. You kind of triangulate yourself into your current location, all kinds of ways.
Geri Wittig	Right now I'm at 598,493 Easting, 413 and 2967 Northing, because we've been doing a project about locating sites in San Francisco and San Jose for publication called public lands. So I know the coordinates of where I am in terms of Northing and Easting values. I would consider myself at those specific geographic coordinates in terms of USGS Northing and Easting values. [Is it possible to have a UPS, universal positioning system?] Possibly some day yes, when we have the vantage point...we don't know where the universe ends, you would have to be in a position where you're observing the universe from a vantage point that's unknown at this point. It doesn't seem like we have the capability.
Nora Raggio	That's an interesting perspective because it's so relative to where one is perceiving those coordinates. There can be a psychological space, this is beyond the space I was talking about, there can be cosmic spaces but then where do those coordinates begin. In a very traditional sense, one might say, "I can be defined by my GPS coordinates," which would include whatever the satellite picked up of where I happen to be. Those would be more of the traditional coordinates. But I would like to think there are many more dimensions by which we can actually define where we are located, and definitely GPS is a very earth-centric type of measuring system. [UPS?] I think that's the kind of studies that the organization with which you're working with is trying to find those kinds of standards. Perhaps theoretically if one took into account the whole theory of relativity, one could perhaps find a way of defining space using that relativity filter, so that in a way, I don't believe there is an absolute universal positioning system, but there might be ways of having that absolute UPS being defined relatively.
Bonnie Shulkin	I don't really know of a coordinate system that encompasses all of space. I can give increasing specificity of where I am. Earth, solar system. I can't give you number coordinates because I don't know of any system. Chabot Space & Science Center. The end is the universe. That's as big as it gets. The Virgo super cluster of galaxies. In terms of my knowledge.
Ben Burresss	
Ryan Diduck	Well, I guess it depends on what scale you talk about. The planet Earth, Oakland, CA, United States, Planet earth, third planet from our sun, 2/3rd way out…Virgo super cluster of galaxies. As far as coordinates, unless you have a point of reference, don't really mean much in the universe. My point of reference would have to be the Earth. This is where we are, we go out from

	here, out into the future. That would be meaningless to an intelligent civilization elsewhere, our coordinate system would be useless. In science fiction everyone has hours, days, the earth hour is very different form the hour on mars...Martian hour? Whose hour are we talking bout? They just let it slide.
Celeste Burrows	
Wendy Coones (in person)	
Joan Gillerman	There was an interesting lecture at SIGGRAPH…problems with Cartesian…x, y, and z. Another one where you work in a sphere, you locate your place in a sphere. I think more like that. …I'm here, in my studio, which I'm not now. ..in this universe, surrounded by this enormous universe. i do think a lot outside the earth into the universe.
Donna Cox (phone)	This planet, this planet is going around this star,...one of billions in my home galaxy, the Milky Way, within trillions of galaxies...this side of the Virgo super cluster...from a technical astronomical viewpoint. "Space" is a very interesting topic in and of itself...theoretical literature...bring space into the context of the individual, we only know space from what we have experienced with our bodies...time we have grown up since little children....George Lachoff, I think at Berkeley, cognitive linguistic department, written a lot on the idea of embodiment...how we understand space. Space is a concept that we learn from a child as a result of our bodies moving in this space...concepts of in and out, to and from,...built up from primary metaphors into very, very complex metaphors...linked together to the point where we even deal with ideas metaphorically with the mapping of where we re in the universe...metaphorical mapping of what space is according to...alto of what we're looking at...is computer-mediated, it is highly mediated mathematically, we are building our view of the universe with enormous assumptions. i think it's important to realize that many of these...today, may be obsolete 200-300 years in the future...we'd never really be able to know this space that we're going to describe with these advanced technologies. ...really experience unless we really go out int. o it...we can't get that far into the universe. We can only map accurately a very tiny portion of our galaxy...we are extremely...the early mapmakers, describe the continents...the maps were all wrong. We were looking at a point of view from the....either with our bodies or probes, we really have a very limited view. We're putting together a very enormous map....arts and humanities must be a part of this mapmaking...how space is described, and many contexts in which space is a reality which we experience...VR, indigenal imaging...different technologies that allow us to experience the 3 dimensionality of the data we are bringing back to us....experience with our bodies...we can experience space virtually and the space that goes well beyond what we can...Yes, I think that NAS A has invested a lot in terms of their outreach program...so the funding and people will be willing to pay the tax dollar...more probes, more rockets that are going to take people out as far as physically possible.. simple physical ...freeze the

	body and send somebody out and take them out as far as the speed of light can take them...I think that we better accept the fact know that we will explore most of this universe virtually...with the bets tools that we have, and bring that info back to us...there's nothing like, I have been blessed to be one of the first artists ever to be in a VR cave in 3D with a scientists Brent Tully...as far as possible, accurate mappings that are in the local cluster...probably there is ka lot of error in this mapping,...because of the red shift and the calculations and the data he has done...inside the cave virtual environment and 3D stereo, you get an embodied experience of flying...you visit and revisit the same place you learn to navigate, you get familiar with the territory...the morphology of the local positions of galaxies near to us. It is an embodied experience through VR, with the eyes and the body, the 3D and placement of these galaxies in space. There is absolutely nothing like it....choreograph paths...IMAX movies...and then can take and bring to 3 million people a tour of that data...long slow data...visualization and onto a TV program to even provide a tour ...it's not the same, not nearly as good as standing in a stereo environment and walking around the gala...it's a much more educational and awesome....environments that provide Virtual experience to more people. The first prototype we did was a demo fro 1992 SIGGRAPH in Chicago. Then in 1994...the whole point behind virtual director ...control, record, and fly through voice commands. that was it. Gesture the flight path with a wand and play it back in real time....more features, when we started to use VD for Cosmic Voyage...to a real tool. Then we really used it and added hundreds of commands that take us to diff locations, that record, turn up or down the luminosity of the stars, that playback...collaborate over remote distances...Stephen Hawking lab in Cambridge, ...with UCSD with Mike Norman a scientists there...Amsterdam, and international collaboration using VD tying these people together, interacting over their data, actually over networks that aren't super fast, we are not maximizing the bandwidth for our application...work in ways that the bandwidth has been low...it used to be only a cave application tool that was voice command and controlled with gesture and voice...rewritten by another person in our team so it operates on all kinds of platforms, with or without the cave, or cave library...avatars that are streaming video avatars, not just design 3D avatars...low-cost systems like Linux boxes, inexpensive....rewrite the code into a library that other people can use and bring into their own software.
Shawn Lani	Zero zero zero. Just like Edward Hume, I guess.
Noah Wittman	We're in a planet around an average-sized star in the Milky Way.
Wendy Coones (written)	A drop of warm sexy water in a cold boring space. An aphid on a plant.
James Morgan	(0,0,0) - all coordinate systems have an origin. I choose to not take an arbitrary center.

Patrick Lichty (written)	In the strictest sense, that would probably be the relative position that my body has within the general time/space continuum that we know as the physical universe. If we wanted to abstract this, I could go on to describe my multiple locations within the physical, virtual, and imaginative realms.
Myron Krueger	
Garret Moore	If it's an open universe, or a closed universe, I can only start from the known, earth-sun system, Milky Way galaxy, local super cluster. I can look at the physical attributes of physical space. Because I've done a lot of illustration and whole universe imaging, basically location is subjective, it may not mean anything to anyone else. Some of the mystical aspects of the sciences, locations and distances are illusions. We create local space to define reality. There's plenty of anthropological study that shows that aboriginal cultures have a very intimate relationship with the universe, but they reach it not mechanical and conventional, but shamanistic practices, going under and over the world in a sense. The way we perceive the world, or our fundamental understanding of the universe is perceptional. Everything affects everything, as a caveat to that, for me as an illustrator, I want to communicate something. The thing closest to my heart is to recognize the beauty of things. A response to what we call God, or Great Spirit of Native American cultures...a greater being that the universe is. Beauty is fundamental to what I do, but also, that's why I'm in the science and spiritual, they're each one side of the coin, the complete picture is only relevant to the perceiver. The description of the universe has to be acknowledged in the self, then correlate to each other, how we're the same, and our descriptions are walking around the same tree so to speak. They are incomplete without each other.

Interviewee's Name	Question 3. If you had to describe the environment/location in which you live, what would you say?
Christopher Johnson	[What is your location? What is your universe?] When I think about it that way, my universe is in my thoughts, it is not actually the physical body. I did a Navajo sweat lodge, and it's four different levels -- birth, adolescence, midlife, and then death-- and you go into this tent, totally sealed and dark, and they bring in stones and pour on water. Each level they bring in more stones. About halfway through the experience, it was very interesting because people were talking and sharing their problems, what they were working with. It was a very disembodied experience. It wasn't any physical, it was just our brains, or souls, floating in space. That space existed just with our souls and we lost any kind of "Oh you're Navajo, you're black, you're white", it was just our souls floating in that space and environment. That's what I actually see as the environment of what the location where we live. Everything else is just a visual representation that's interpreted by our mind.
Donna Cox (in person)	
Jackie Morie	It depends on who's asking. If I ask myself, because I think that might give me the broadest answer, it's almost like the place I am in now is a place in space that's coalesced for me in this body in this time which is, in very practical terms is this very wonderful blue green planet that I live on that is full of magic and wonder, but it's very much a consciousness that's like a little bubble in the universe, whatever this space is that we call space. So, it's not so much about where, it's about what, and it's a bubble in that space.
Patrick Lichty (in person)	
Annette Weintraub	
Andurid Kerne	
Dorothy Timourian	I live in Northern California, in the Bay Area. In Livermore, which is a small suburb of San Francisco. [So it's the geographical location in space. How about an unusual reply?] I live in a beautiful area that has wonderful mountains, you can go to the seashore, you can go to very gorgeous physical landscapes around where I live.
Peggy Frank	
Glen Sparer	Nature is, I think, a system of a dialogue between human beings, animals, plants, the earth, the air, the ocean. This is all a nature system. We live within it. Pretty much this planet and the surrounding atmosphere. No other planets per say. It's too hard for me, right now, to do an art project on Mars. I would love to do some telekinetic work between Earth and Mars. But right now it's out of my range, so I'm just dealing with what I can work with here. I can use animals, I can use plants, I can use rocks, I can use rocks that has

	fallen from other planets--now that's interesting, because it's something I can pick up in my hand and look at and investigate where this rock came from. Now what's interesting is the life they're finding on the rock. They're investigating the basis of microorganisms, could they have evolved from this rock. Could this rock have hit the earth--now it comes within my can. Eventually it's human system, I am a human being, so I see everything from my point of view. But I'm trying to open up to other systems, other forms of life if I can.
Paul Hertz	
Craig Hansen	
Lisa Jevbratt	
Geri Wittig	
Nora Raggio	
Bonnie Shulkin	
Ben Burresss	
Ryan Diduck	
Celeste Burrows	
Wendy Coones (in person)	
Joan Gillerman	
Donna Cox (phone)	
Shawn Lani	
Noah Wittman	
Wendy Coones (written)	Warm sexy moist spot, an oasis.
James Morgan	Rich in matter, energy, and spirit.
Patrick Lichty (written)	I would say that it is both limited in physical space and much larger in virtual terms. On a day to day basis, I travel very little outside a 4-mile radius, but through electronic means, I span thousands of miles every day.
Myron Krueger	
Garret Moore	

Interviewee's Name	Question 4. If you could travel to any destination in the Universe, where would you go?
Christopher Johnson	I like to travel a lot, and go to different places and experience many different things. So, going to the bottom of the ocean, or going out towards Pluto, or even beyond that --I do watch Star Trek, and I am very intrigued by the different nebulae and everything they encounter-- so the shapes and forms and fractals and everything that appears out there...[Any place specifically that would attract your attention more? How would you get there?] Not necessarily fly. Again, living in Flagstaff, Arizona, I talk to Navajo a lot and several of my students are Navajo or Hopi, and they sometimes envision a beam of light coming out of the center of their body or where their heart is, and then they use their soul to travel along that and out into, they believe, outer space. I talk to a guy that says he actually does this and is fighting alien invaders--he wasn't able to explain completely. I envision that, traveling on some kind of light beam, but also traveling in some kind of form, or spaceship. I envision it differently than something physical. Where would I go? The moon of Io, that would be a first destination. Something like that, that is close and immediate, even though it would take 30 years to get there, something like that.
Donna Cox (in person)	
Jackie Morie	I read that question earlier this morning, and I thought, "Wow, I'd love to go to a different planet that has different physics and stuff, I'd love to be so large I could fly anywhere, all over the universe and see things on different scales". But I've been given this very special chance to experience this little bubble of consciousness in this place, time--if those things are really valid--and I don't need to go anywhere else because I'm in my most wonderful special place, which is all part of everything. There's so much to explore here. Everywhere you look there's magic in how this water is refracting light. Think of space as that pulsing, generating thing and light, or energy. And this is a special moment in that continuum where I get to look at how light, that energy, makes these beautiful things we see around us--whether it's a leaf in a tree or a stone in the sidewalk or this water and ice in front of us. This is a travel destination and a privilege, and every other one is.
Patrick Lichty (in person)	[Do you think that traveling to another location in space would be painful?] I would not say necessarily painful, maybe from a personal trauma perspective, I wouldn't necessarily say from a sensory perspective, and emotional possibly. I'd say more disorienting. [Tell me about a location you would like to travel to.] I mean that depends on the moment. [I mean, anywhere in the universe.] That really depends on the physical constraints.

	Maybe I'm being rather simplistic, but I'd really like to visit another class M world that supports life, something that would be hospitable to me, but something that would be so totally different, a different set of circumstances, it would be something compatible yet alien to me, on one hand I'd be able to survive, on the other hand it'd be something that's such a complete disconnect, it would be an entire world without me, that happened without me, and would go on, survive, without me, but something that I would have to completely reorient my entire paradigm to even deal with.
Annette Weintraub	That makes it more difficult. If you're thinking about any destination here, then you think about places that you'd like to see or go back to because they have special memories. But when you say anywhere in the universe, it takes it to a completely other level. I always thought we, people living now, are very privileged because we can go up in a plane and see the earth from above. I can't imagine what it would be like not to be able to do that, because it's such an amazing sight to be above the clouds, and see the sun rise above Greenland, see the glaciers, the oceans. [What about beyond the galaxy?] I think that would be truly incredible. Very few people have seen, had the experience, of seeing the earth form outer space. That must be completely incredible. To be able to see the Spiral Nebula. I did a piece called the Spiral Nebula that was an image of this sort of cloudy constellation of stars and spiral shaped, to me is very beautiful. I'd love to see earth from space, but also to see the nebula from beyond it.
Andurid Kerne	I would love to see the Rocky Mountains before the Europeans came to North America. Maybe Taoist monasteries in a certain point in time. [You're talking about time, and space. If you could go anywhere, if you have all the means to fly, to be projected onto someplace in the Universe?] In a certain way I feel pretty happy with where I am. I think I can answer that more in terms of process than in a particular result. I can think of places that I want to go to that I've never been to, like the south island of New Zealand. But if I could really go anywhere in the Universe, I would need different kinds of data, different information about the places I might go so I could think about that, where I might want to go. I don't really feel that I have...I have a certain amount of information about the Earth right now in particular, I'm not really looking to remove myself from that...I would want to be able to move through a set of places and I don't know where they are, and when I saw move through them you would need to see about what would be in different places.
Dorothy Timourian	Let's see, I would go up in space or under the sea, in areas that haven't been explored. I think both areas are fascinating. We've been members at the Monterey Bay Aquarium for many years off and on, I think the deep sea area where there is no light and the creatures are extraordinary are fascinating. They are beyond imagination some of them. Up in space, I think

	I'd like to see the Earth like astronauts have seen the Earth from outer space. And maybe travel through the Milky Way, seen the Milky Way clear across the heavens in Hawaii on Mauna Loa. It'd be wonderful to travel from the stars up there.
Peggy Frank	I'm not tremendously adventuresome. I'm not sure that I would like to space travel because I'm not sure I want to go to the unknown. I can think of places on this planet that I'd like to visit. As far as the universe itself--if it were totally safe, and I would not have a fear for my own health and well being, I suppose I wouldn't spending on the surface of Mars, just saturating myself with all that redness. It's something I'm a little more familiar with, seeing pictures of what the surface is like. Everything else is too much of a question mark for me to want to go to it. I've never liked science fiction, I didn't like the film 2001 only because I think I find it scary. It's not to say I'm not fascinated by what people might find, it's just that I'd rather watch from the sidelines and let the other people do the exploration. Mars, I know it's the next planet out, I don't know the distance in miles, but I do know that the surface is very red. maybe a lot of iron-containing materials, probably water over the surface at one time. I imagine it's extremely cold. I think of it as probably not that dissimilar from that red desert you might find in Utah or Arizona, but without any oasis of greenery that we would have here. I know basically from what I've seen on TV, and read, and from the findings of NASA.
Glen Sparer	Saturn. I'm very interested in, from the outside the rings look solid, but when you get up there, they're not solid, they're particles floating together in this gravitational field. I find that really interesting, how it breaks up in pieces. The closer you get to something and you suddenly see it break into pieces, like pixels, like points in a painting, and then you walk away and suddenly it's a solid thing. That relates to my interest in identity and what is identity. Is there such thing as a solid identity in an individual? Or in other things? Or do we put them together for our visionary apparatus, our senses. That would intrigue me to go to Saturn. You get there and you go, "Oh it's just a rock here like any other, I don't see any color here", things like that. I think that's why I hang out in the deserts of Arizona a lot. I'm kind of attracted to that very bare color in the sand, the particle quality of the sand in Arizona, New Mexico. Very rugged, no human beings, very raw.
Paul Hertz	The Magellanic clouds, which has a nice view of the Milky Way galaxy. If I can be well protected, the center of the galaxy, probably in a disembodied form. There's a massive black hole in the middle, generally not very good for you.
Craig Hansen	I have two answers. I kept either coming back to somewhere within the solar system that's at least somewhat familiar, it can even be the asteroid belt of all things. I like the idea of these non-spherical odd-shaped rocks tumbling

	around in a big field, and what it'd feel like to get yourself seated on one of them the best that you could. My imagining is that there would be some motion, you might see them tumbling slowly, or you might feel yourself tumbling in relation to the rest of them. That's exciting to me. Being able to be close enough to look back at Earth, or see things from a different perspective. I alternate between that idea and going very far out to the edge of our galaxy , or some other galaxy, and seeing that spiral fill the sky. I imagine the vision would be spectacular, the quality of light, of millions of stars, even though we have that now, to be able to step back from that and see the form, such a grand form from a perspective that allows you to grasp it more.
Lisa Jevbratt	I don't enough about astronomy to really talk about this, but it seems fascinating if you could go anywhere in the Universe--if there were several universes, if you could go somewhere in between universes, or if its one universe to go to the edge of universe, that seems to be the most interesting place to go. To be able to stand outside of the universe and see the whole universe, sort of. Or to stand outside and see several universes at the same time.
Geri Wittig	I'm interested in the edges, because that's incomprehensible concept of does the universe end, does it not end. There's all this speculation about the Big Bang, the two theories of it, is it going to collapse, or keep expanding, they're contradictory in terms of one is edged and one is not. I want to know the answer to that. If there is an edge, I want to know.
Nora Raggio	Definitely to the boundaries of this universe, not only that, but I think I'd like to travel into other universes, and then perhaps through black holes, etc. If there are other things that are parallel universes, I think that would be really fantastic experience. Then I wonder is there anything beyond what we now conceive as the universe. For example, I think at one time the people in Columbus' time saw only certain possibilities within earth and the celestial sky, what are the things that we don't see beyond what we define as the universe? If it were possible, I don't know if it is, I would definitely, in terms of physical space, go to the boundaries of this universe, and definitely if possible, transfer into other universes, whether they're parallel or not. I would be also interested as I travel, my transformation. Would it be me? Or what would I be? As I travel through these different spaces, my being or my identity would probably shift, that would be quite interesting too.
Bonnie Shulkin	I think that most places in space would not be very interesting to travel to. Space is so empty and few and far between. As far as things that I know, say, go to Saturn and see the rings from close up. Because you look at something like the Orion nebulae, it's incredibly sparse, you're in the middle and you can't even tell. [From where would you like to see the earth?] From

	just above the atmosphere, otherwise it's just a blot of light.
Ben Burresss	
Ryan Diduck	Probably, after visiting the planets in our own solar system, no one has seen them up close. Just pictures, haven't seen them up close with your own eyes first. seeing through telescope and seeing through your own eyes?] when you look at the planets through the telescope, you can't see as much detail because they are so far away, even the most powerful telescopes on earth, ...spacecraft that's flying through Jupiter's atmosphere. very diff from pictures, best images we get are still photographs. film see colors better than human eyes do. CCD chip or old film, nerve endings on back of retina that's seeing it. I think that when you see something with your own eye it makes it more real for you. i don't know why, maybe it's just the way people are. you don't believe it until you see it yourself.
Celeste Burrows	I might go above the disc of the galaxy, kind of the upper part of the disc, we're sort of down in it. I don't think about getting there, the only place you can really get to is in the solar system, but if you're just imagining, maybe some star-forming nebula. Well, there's a lot of action there. There's some animation on the web, you fly right in and you watch teh star forms and the planets form. You know what I would like to see is actually a very long time trend, whether on earth or in space, watching something grow and develop in a billion years. There's not a lot of information, data, on that, but there's some. They sort of know some things, that roughly the moon used to be closer, how much it's moved...when they try to run time backwards to see how far back it would have gone, and then you run into some things you have to know. The spin of the earth is slowing down, because the moon creates a high tide...the water drags on the continent and the ocean bottom, and it slows down the earth's spin, but the moon's orbit gets pulled ahead. When it speeds up, the moon pulls out. Exactly where the continents where when it dragged...one configuration...in general they know this is happening. [There are no animations showing this?] Not really. We don't have enough data to get it exactly. When I'm talking to teachers, if it's not pretty close to what their curriculum standards...then they may not want to bother with it. When they come here in the summer, they are required to keep up with courses ...then they're interested. That's how you get them to take your classes. Maybe it would help for the school classes to include more astronomy...I know some of these odd things the kids get really into it. The scale is a big issue, that's a hard one for kids. If the kids are solving a problem, or it's something that has a personal nature "what would it be like to be on the moon", the kids get a kick out of that. even things like how high can you jump, can you jump off the moon, or an asteroid? they would care about stuff like that.
Wendy Coones (in person)	
Joan Gillerman	There are a gazillion places I would like to go…..So many places…big

	volcanoes in the universe. Partly Mars. I'd love to see the rings of Saturn,….by the edge orf a black hole…Pluto because it's so mysterious….Just out in space looking back at earth…craters on the moon,...Io is ice.
Donna Cox (phone)	I think I would really want to be around to see the Milky Way collide with Andromeda. That would be a kick.
Shawn Lani	See, I'd go into the part of myself, if I can go anywhere in the universe…in the vastness of the universe, I want to go….but in the solar system, maybe Mars, or Pluto…int eh whole universe, then I think of things in a different way. The solar system is a physical thing, it's close and familiar. It's much more familiar to people.
Noah Wittman	The ones I'm curious about are the closest…Mars…beautiful landscapes, things like that…I can imagine being there and actually hiking…rather than Jupiter or one of the gaseous planets and dive in with some sort of vehicle….I like to be more than just an observer.
Wendy Coones (written)	Heart of the sun. A ride on a comet.
James Morgan	Iceland.
Patrick Lichty (written)	Realistically, I would enjoy traveling to Antarctica, Mongolia, the International Space Station (where eI would enjoy trying to draw in zero-g), or even the Moon. If I had the choice to travel anywhere possible in the universe, I would like to find a large (approximately 1.25 standard masses) Class-M planet with high water coverage, a relatively hot Class-G star and at least two large moons.
Myron Krueger	
Garret Moore	Probably change from day to day. I love large views. I would want to look at the Milky Way from a large Magellanic cloud, or the Andromeda. …as a discreet object, so I can watch it move. We're looking for the next place to experience ourselves in the universe. The ontological effect of seeing your universe and redefining it from outside. If I sit above the Milky Way, I would probably have even a greater understanding just by seeing. You can look at the world and not see it, much of our culture and politics have very narrow views of the universe, they don't accommodate many views, so they're working with narrow understanding. The more information you have, the more true it is. You get out of the subjective self, attach yourself to a greater description of the world. You lose the simple stereoscopic sensation of light hitting your eye...Stood on mountains and wondered what the sky would look like if I could see in radio frequencies. That stars, instead of photons hitting you, you would see electromagnetic waves...and echoes of quasars and black holes that are unimaginable distances away...I would love to see on that level. That would be enlightening. We're very visually oriented organisms in general...huge hands, huge heads, the eyes would be the largest. We receive so much data and are so oriented to visual data, it is

	probably the largest portal to our being. Next we would have tactile and so on. As the Web got visual, it really got notice, because people could...

Interviewee's Name	Question 5. What do you envision about your travel destination?
Christopher Johnson	
Donna Cox (in person)	
Jackie Morie	
Patrick Lichty (in person)	[How is that different from, say, going to Bangkok?] There's still a level of commonality that going to another wildly different culture, is that there's still familiarity in this earth that's around me. I still understand, from the most basic standpoint, the smell of the air and the earth and sky that are still familiar to me...I mean, I'm still a part of this earth, this closed system we're part of. There's still a common experiential baseline. [Where would you like to go, when you describe this other thing?] Yeah, I look at it as a planet, another interesting thing would be able to see inside a nebula from within the nebula. One thing I really like the idea of is something like being in near orbit around Sirius or Betelgeuse, and being able to look at Betelgeuse and seeing the nighttime sky from a planet in orbit around Betelgeuse, and then just understanding what the changes would be in that nighttime sky, and understanding that change of perspective, that's once again, alien to me. I personally find the idea of being able to shift my local, relative point of perspective and seeing something that puts me so outside the geocentric viewpoint, as just incredibly exciting. If I want to abstract the question a little more, I'd want to go to someplace that puts me outside my geocentric viewpoint, and shows me something that allows me to see a totally different viewpoint from an astronomical/universal scale than I'm used to. I'd love to see the Andromeda galaxy from close up, that would be an amazing thing. [Is there any tool that could take you there?] Was there Deep Sky? I never used it. [How can a website take you to realize your dream?] Once again now we go back to space, don't we? I think on one hand, I think there are many ways we could possibly build interfaces. On one hand, where someone can be interested in a place. From a rather formalist perspective, one could select through a search an astronomical body and elect to possibly to go there either directly, or it'd be exciting to allow them to go through three dimensional space through a virtual space and fly there, and see what gets close to them, and what doesn't. As they go out of the solar system, see what happens as they go through that, and once they go to another space they can reorient their view, or take a look at the information from various sub-tools to examine the known information about that localized area. There are two things I think would be very valuable as far as looking at this--another way of navigating this information is possibly using technology used in mind mapping, or associative mapping. This would be more of a textual space. What you would have is, during a search, you bring up a topic and a series of sub-topics that would be in a graphical display almost in a web-like format; however, what would happen is you would have the topic in the center with relating topics around it, or been related objects that could be hovering around it and be manipulated in forms of more visible or less visible depending on the relevance or the specific topic you would want to go to...and in this way, you could see bodies of information that you may or may not have been aware exist, and then allowing you to associate between different areas and be able to possibly get a fuller access to information that you may not have know anywhere. I honestly believe that search engines, sometimes, have a too literal sense of data mining. They just do not give you a broad enough range of information. I think we're working on that technology now in the IT sector, but in general people work in a broader sense as far as their consciousnesses are concerned, than just saying, "I want to know anything with the word space in it." Say, if you said Jupiter, then you could look up the interaction with all

	the moons, and you could look up Io and get atmospheric information...but then you could see this information hovering around each of these topics, or bodies, but then you can just choose to navigate over these over to another space. You could drift a little more while still remaining rigorous and focused.
Annette Weintraub	
Andurid Kerne	
Dorothy Timourian	
Peggy Frank	
Glen Sparer	
Paul Hertz	
Craig Hansen	If there were an Earth-like planet on the outer edge or even off of the plane of the Milky Way, to be able to look up at the sky and see the spiral up above.
Lisa Jevbratt	That's something I think about space, that's the most scary kind of thing. In a content sense, a most sublime place, it's so scary to think about a place where things end. You always want to know more, and I guess I want there to be more things coming, and I want to be out there to see this, both to thrill myself and get scared but also to find out that there are actually other things coming. I don't understand the concept, it's unfathomable to imagine an end to the universe. The way I like to map--it's kind of my artwork right now making maps of the Internet--looking at whole system as an environment and trying to understand the environment as a whole as opposed looking at specific web pages. But looking at the whole structure of it, it seems like being able to do the same for this world...it's getting an overview, but it's almost like a vain thing, would it be possible? The same thing for the Internet, because you can't step above it. Whatever investigations I do within that space I do inside it. It causes a little bit of hideousness to attempt to do it, but that's what I'd want to do with space, or the universe.
Geri Wittig	It's incomprehensible. It's one of those things that make your mind short-circuit, because it's not within our conceptual framework and, to me, I can't imagine things without edges because everything has edges that we experience in physical space here. But there's the possibility that there is no edge, but how could that be? And if there is an edge, what's outside that edge? It's just one of those things I consider an evolutionary cutoff that at this point we're not evolved enough to understand that.
Nora Raggio	
Bonnie Shulkin	It's a planet. I don't know that I have a huge personal, but it's probably the most beautiful, mostly made of hydrogen. So it's the beauty of Saturn that's attracting you.
Ben Burresss	
Ryan Diduck	[all astronomical data relies on technical apparatus? Virtual telescope at virtual point in space? Less real, less concrete?] it depends how it's done. I've seen some computer animations flying over the surface of mars, I've seen the Viking data the animations are taken from, the Viking pictures look really nice. It seems to make it more real than looking at the still

	pictures. if you can make it look like you're not just looking at a still picture, actually visit the places and look around.
Celeste Burrows	
Wendy Coones (in person)	
Joan Gillerman	
Donna Cox (phone)	
Shawn Lani	
Noah Wittman	
Wendy Coones (written)	Need to bring air-conditioning. It's cold and dangerous, so I would need some advanced equipment and a harness.
James Morgan	Volcanic activity, glaciers, immense beauty.
Patrick Lichty (written)	I have no idea, but the idea of experiencing another world that would allow my presence but be utterly alien to me is extremely exciting.
Myron Krueger	
Garret Moore	

Interviewee's Name	Question 6. Do you use scientific data as part of your work as an artist? What for? When?
Christopher Johnson	I don't use any scientific data specifically to create what I'm doing, but my students do consult the data. We do a lot of learning modules and so they would consult with observatories in Flagstaff to find where the planets are, and create modules to educate students on geographic locations of land masses. We also consult plants, plant books--one of the projects they did was to identify the plants of Canyon DeChaisse we got these books and we were able to redraw and recreate and sketch those out for their project. So I would definitely consider using scientific data in that way. [It's more of a teaching approach rather than in your own work?] Yes. I am not a math expert, I am not a computer scientist, I am not an Astronomer, and so I guess the access of getting that information would be the limit for me, not knowing where to go, or what to get, or how to find it. That could be the reason why I'm not using it.
Donna Cox (in person)	
Jackie Morie	I would never think of it as that, but yeah, it's a relationship that underpins everything. I can't think of anything I do as anything separate from that. In my artwork, in practical terms, scientific data gives me a basis for very tangible things in my work. It provides sort of a bed, a grid, that gives some meaning to certain things. So it gives you a framework, because otherwise things would be very nebulous. So what we know about the world, allows me to create stuff in Cartesian space or in spherical space or in n dimensions--and I think artwork has n dimensions, there's the dimensions you see and feel and experience, then there's the ones that we don't know about that affect us in resonance, in altering our consciousness in lots of different things. In very concrete terms, I look at what the discoveries are, I look at things like astronomical scales and microscopic scales and submicroscopic scales and all of that--in fact there's such a relationship in those two ends of the spectrum that make it a continuum for me-- that type of stuff informs my work and provides some grounding for it.
Patrick Lichty (in person)	That really depends. A lot of my work is really based around a lot of the soft sciences and literature, and sometimes cognitive science. I have a background in applied sciences, engineering and some physics. I'm very comfortable with that, but on an everyday basis, more or less I find I'm doing an installation that requires work with hardware. Sometimes if I'm doing electrical installations I have to do some engineering--you know with computer science, dealing with propagation delays and networks, and looking at the idea of what frequencies would be involved in analyzing what frequencies in space my installation is responding to.

Annette Weintraub	I think there is a direct influence in the water project, because I was trying to take the data and personalize it, bring it down to human level by making it into story, so people can understand the significance and the problems that we're going to face to maintain our supply of fresh water without feeling overwhelmed by the information or that it was preachy, and a kind of reverie, art experience at the same time, where the sound and color of the water would be seen in a different way. I think when I use information like that, it's my job as an artist to translate it into another medium, visually and in terms of thought.
Andurid Kerne	Well, I am a scientist. Sure. I could be interested in representing data about what people do in different ways and about geological processes, for example. It's a good question, actually. I'm very interested in the framing of science, because to me it's just another cultural practice, the same way that growing food or making baskets is. I think that framing is crucial for our survival as a species for one thing, because the notion of participation, how people can be--that's a form of scientific data I'm really interested in, what goes on inside of people-- about participation, and how to create structures where people are able to affect the outcomes of the important things that affect our lives. I have a strong concern about the role of technology in those processes. My work is substantially about that.
Dorothy Timourian	I really don't, no.
Peggy Frank	
Glen Sparer	The scientific data I use is not direct data, it's data as being interpreted by psychologists, neurolinguistics, by cognitive scientists. So it's not the pure data itself; it's how do we understand the data, how do we give a structure to the data, how can we use it for art. So my field right now is studying what we call bio-semiotics, which is a language-base for nature. How do we look at nature as a series of signs, a system of signs that can be understand by us. We look at nature as a complete sign system that is intelligible. It's been around for awhile; originally a biologist named Jacob von Ukschall in the last century started investigating what he called the "functional circle" between a species and its environment. he found that there's a dialogue between species, the evolution of it's senses and sensory apparatus, and the environment. So you can't separate the two. So no longer can you look at nature from an objective observer's point of view. So it kind of goes against science as we knew in the past. That there's always an interpretive element going on between nature and the observer. Nature as the entire system [including the planets, stars]. When I think of nature, I don't tend to think of the stars. Although it is a part of nature, but it's so far away from my experience, as to what I can perceive right now. They're coming more and more into my experience.
Paul Hertz	
Craig Hansen	I work most specifically, a project I've been working on in the last 2-3

	years, is a project on the geological story of San Francisco Bay. Pretty much on a daily basis I am either looking up things on the Web or talking to geologists or people who develop curriculum about science. As far as it goes on the Web, I am usually trying to solve a specific problem, or trying to understand some particular content or process. I would usually start looking for images or text on that, doing a little research in books. Typically the level of copy that we write to people is about a fifth grade level. But understanding doesn't need to be necessarily extremely deep. I need to be able to know it well enough to integrate it, to explain something complex in simple terms. I am pretty much on a duty basis, kind of reading on science.
Lisa Jevbratt	
Geri Wittig	We're really focused on a lot of GPS and land-related art. The project we were just recently working on was to compare--there was an article written about it - the cultural differences between San Jose and San Francisco. The author was interested in quantifying that. Her idea was very different from what ours was. She wanted an illustration of the difference. What we were working on was this database of USGS information that one of our members, Brett Stalbaum's been working on this software interface so you can put in different GPS coordinates and map out maps of certain areas and get all the elevations and standard deviations of the area. That was what we decided would be interested. We ended up picking 5 cultural sites from San Francisco, getting their GPS coordinates, and putting them into our software and figuring out the equivalent in San Jose. And doing the reverse, 5 cultural sites from San Jose. Museums, galleries...so, because San Francisco's such a hilly place, San Jose's such a flat place, a lot of what came out in terms of San Jose that was equivalent in San Francisco were areas that were undeveloped, like China Basin, open space industrial areas. And the more hilly stuff down here is the housing that's in the foothills, San Francisco's equivalents ended up being a lot of residential homes. We created images of the different landscapes in 3D modeling and then took pictures of the different locations and built these wire frames models. [So you're trying to understand the cultural perspective through the physical, geographical situation? As if the landscape had an impact on how they relate to each other?] That was something we had an interest in, but that was not going to be the definitive thing. Those might be the parameters, but they might not necessarily be followed. You get a place like Las Vegas, a desert, that's been turned into a huge residential city that's the fastest growing city in the country. You're really not going by that kind of idea, because if you did you would say that that might never have happened. That's one of the things we didn't agree with the point of view of the article, that that was necessarily going to be the defining element for what could develop somewhere.
Nora Raggio	In some ways I do and in some ways I don't. A part of my artwork is very

	much related to the genome project, in fact I did several pieces that are related to the 3 sets of base pairs that code for the 20 basic amino acids. So that definitely, in that set, that segment of my artwork, is very much related to the scientific aspect.
Bonnie Shulkin	
Ben Burresss	
Ryan Diduck	
Celeste Burrows	
Wendy Coones (in person)	
Joan Gillerman	
Donna Cox (phone)	From the early days of my working with scientists and the art I was producing I thought about the data in 2 different ways…information designer, I was working in the sense of designing representational icons and glyphs and creating ways of representing the data....that point of view. At the same time I was creating artwork that was being shown...and selling artwork. I would always get permission from scientists ...to create that artwork. I used to characterize this process. different types of data like types of scrap material...recomposing or re-contextualizing that data into different forms...Two very different ways of working...factual and true to the data as possible. I wanted to make sure I was working in a consistent way...colorizing to bring out the details in the data for analysis. ..As an artist, i was taking those images and data....poetic and, one might say, exploratory way...forms that looked very organic. Astrophysical simulations...jet that I had hoped to visualize, and I re-contextualized that into a different format...diff kind of look. l It looked like a sperm, so I called it "Cosmic Sperm"...so taking the data and re-mapping...transfer it like a Rorschach test...often these forms are very abstract, I would bring the abstraction...mythological context...my research as an artist was exploring myths and icons. Now, today, the way that I work is still along those very lines. Today my research for KYA star, I'm still researching the different kinds of myths we incorporate into our culture...such as Discovery Channel and re-contextualize them into personal myths of my own...creation myths and other types of cultures and how those cultures dealt with stories of the universe....Discovery Channel is more of a narrative form, not as true to the data as true to the narrative that's being told. Collaborative narrative with scientists....trying to bring those narratives to the public so they understand them and don't go over the heads of the people. bootstrapping process...artistic license...scaling things differently so we can travel the universe in a timely fashion. I really believe in that...I believe that they'd already paid for it...tax dollars...collecting this data. The instruments that are involved, the maintenance of those...the pictures that come back to us,...are the people's. The way the people will be able to understand...artists are integral to bringing those images to the people.

Shawn Lani	The Chabot piece is called Icy Bodies, they are bits of dry ice that float around on dark water background …I was working on an exhibition called Boundaries, and I was playing with dry ice in a flask…I was trying to look at the different layers that might form with mist and water and air...it was just a mess…It was self-propelled and had these beautiful clouds that floated…and I cross-lit it…it was really beautiful thing. It was a great way to talk about comets...if you blow with your breath you push back that...a lot like a solar wind. ...I found something else accidentally...Ned Cohn, an artist up there, kind of found a project that fit the prototype, and I've built a few copies, one in Japan and one in Switzerland...It's always the same with me, it always start with a material...Given the talk of magnetism, I'll go talk to some scientists/teachers... I see what kind of demonstrations they have...and they talk about the science of it, the content of it, which I'm always interested at it... but only after I find an interesting phenomena. The artistry of something has everything to do with the content of it, with the educational opportunities.....Science is just a way of looking at things, it's a language, it's a body of knowledge. Everything is in little bits. You can't just have a pure aesthetic experience with no context, no content, no educational opportunities...it's not strong enough, it has to be all of the above, the more of those walls you tear down the more you stop thinking in those categories. It's so much more rich when you think of it in terms of all of these things...Why would you cut one of those out? It makes the whole work so much stronger.
Noah Wittman	
Wendy Coones (written)	Creative biofeedback displays. Extensive amounts of math and spatial comparison in music.
James Morgan	
Patrick Lichty (written)	Yes, but mainly the "soft" sciences, such as sociology and cognitive science, and more abstracted disciplines such as mathematics. Considering that a sizeable part of my offline work incorporates electronic hardware, perhaps it could be said that applied topics in engineering (mechanical & electrical), as well as applied physics may have some bearing on my work as well.
Myron Krueger	
Garret Moore	

Interviewee's Name	Question 7. Do you see any possible interaction between the kind of work you do, and scientific, astronomical data?
Christopher Johnson	
Donna Cox (in person)	
Jackie Morie	I've used imagery from both space and constellations or specific viewpoints into space we can't comprehend. They're the way we can comprehend space, because they give us sort of a field of view, a fulcrum, to give some definition and boundaries to things. But the imagery itself is beautiful. So I have things were I've used some actual images that were captured in space or through telescopes, microscopes, through everything from particle accelerators to Hubble Space images. It's interesting how similar they get at both ends of the scale. And I've always been fascinated by stuff like that. You look at that and inherent in that dead little still picture is energy that created it.
Patrick Lichty (in person)	From an astronomical point of view, I just tend to be a little more terrestrial, not saying I'm not interested or not considering astronomical data as an option.
Annette Weintraub	
Andurid Kerne	
Dorothy Timourian	Well, I use a lot of photographs in my artwork and in my teaching of outer space. Also new discoveries of outer space that I read about we talk about in the classes that I teach art in. I'm very interested in science and I've gone to many lectures and planetariums and looked through astronomical telescopes…I've been to Jet Propulsion Laboratory and AAAF meetings. I'm always interested in new developments in space.
Peggy Frank	Sometimes they want to know distances. I have a little collections of books on astronomy, and we'll pick one out and look things up. Distances and sizes. Other data they are interested in that I try to find for them is what the surface might be, the words we'd use might be solid or gas or molten or liquid, and if it's liquid water or other material. These are questions that they ask quite frequently when they want to do art. Whether they're portraying real objects, which would mostly be planets or the sun or asteroid, or whether they're trying imagine a fantasy place, their own planet.
Glen Sparer	I listen fervently to stuff about Mars, recent discovery of water on Mars. But I don't have enough understanding in terms of astrophysics, the stuff that's going on right now. I would like to, eventually. It'd be nice to have a place where I can go look at this stuff. Right now my interest isn't focused primarily on that area.

Paul Hertz	I've used some in a performance piece about 15 years ago. I did projected images of the earth. At one point I was also working on a composition that used an arrangement of constellations in the sky. The distances between stars, trying to map out paths for a camera on the ground that would map out lines in the constellations, 25 years ago. I am fascinated by it. NASA images.
Craig Hansen	
Lisa Jevbratt	My self I've been mostly concerned with Internet data, but some of my students have been getting all sorts of scientific data off the Internet, raw files and doing lots of new sensations with that, comparing data and playing with that. Using SETI data and making their own systems for interpreting that data, I make them do stuff that would prove that there is something out there in the universe. So instead of this depressing SETI@home thing where you never find anything, they would have to make something, using the same data, find some pattern in it so that, tweaking their systems, they did find things in it. So we did find life out there. The approach as an artist when you work with these things, artistic license is like you don't have to be true, or you can play, or it's more obvious that your methods aren't truthful, although I don't believe scientific methods are truthful in that sense either, but I think we can be explicit about that. There's two ways we can do that: one, we can pretend that the data doesn't have any significance whatsoever, even if I know it has all these layers, like you said it's scientific it's been through all these assumptions and systems and knowledge has been added to it to sort it, but to completely disregard that and say, well, these are just numbers. I do that with the Internet a lot, I just assign colors and I just use them in a kind of whimsical way, and I think you get something out of that. It's the naive approach, consciously naive approach to data, but the other approach is to say, this is meaningful, even when you know that it's not. You hope it's going to be meaningful. Like with the SETI program I forced my students to find meaning in it even though there's probably no meaning in it whatsoever. That's the approach I'm taking to this kind of data.
Geri Wittig	Dealing with data, it doesn't change my perception of art, because I've been doing it for so long. There's been a long history of artists working in sciences, and going to school in this environment here, there was so much the resistance to that idea from the other media. To me, it's just a given that those things are cohesive.
Nora Raggio	I don't think I've thought very, very deeply, though, about space, although as I have a background, my undergrad was in chemistry, we definitely worked with those notions of both micro space and macro space and thermodynamics and quantum mechanics that in some ways deal with space. Currently, the closest I come in terms of using scientific data is

	working mostly with genomic data.
Bonnie Shulkin	When I'm preparing activities for children, it depends on what activities I'm preparing, for a high school, then if possible I want to work with the authentic data, to mimic what scientists actually do with it.
Ben Burresss	
Ryan Diduck	
Celeste Burrows	
Wendy Coones (in person)	
Joan Gillerman	
Donna Cox (phone)	
Shawn Lani	
Noah Wittman	
Wendy Coones (written)	Could be astrology as well as astronomy. The nice thing about this project is that objective data helps bring forward a change in subjective data.
James Morgan	Interaction between humans and immense data sources can be quite interesting, I am starting to work more with databases and have begun to push some work towards the level which humans cannot directly deal with it.
Patrick Lichty (written)	Possibly, in areas of cognition/association/narrative studies, and in examining astronomical data as a metaphor for various experiential narratives. Actually, as I write this, I do. I have had an idea for a work that uses the metaphor of the unmanned planetary rover as a vehicle for our perception of our own environment (not necessarily in the strict ecological sense).
Myron Krueger	
Garret Moore	

Interviewee's Name	Question 8. Have you ever visited web sites about space and astronomy? Which ones?
Christopher Johnson	Actually I go to the National Geographic website because one of the things I saw there was the Peruvian bundles they found. With the illustrations they had there, and I was able to unwrap each one, I was really able to grasp what they were trying to do and why they were doing it. There is also a website on rainforests, and what each rainforest level means. I respond to things visually, that's why I really like to go to the National Geographic website. [You never checked out the NASA website?] I actually did check it out, the Mars rover project that Rodrigo had worked on, that's one of them that I did look at, looking at how they used scientific data to recreate Mars and create a CD-ROM for education with that data.
Donna Cox (in person)	
Jackie Morie	I don't do regular, but the Internet to me is…information to me in this day and time is the way we travel to different information. Just like we're out there with telescopes and space shuttles and rockets trying to penetrate the vastness of space, there's an information space that the Internet is our rocket to. So I visit things, not always in a logical way--I love the fact you can make these leaps; it's time travel. It's hyperdrive, you've got hyperdrive on a website. Wormholes everywhere. The navigation is as rich as the person using it. I wish there was a way to get a little more quality to some of that navigation--then, it's the unexpected things, the detritus you didn't want in your search that takes you to new destinations, which I think is amazing. There's some really good sites out there that have wonderful imagery--I tend to gravitate towards sites that have imagery or stories. So can I tell you what they are? Probably not, because I find them through this time warp travel. I have probably thousands of bookmarks that are probably useless.
Patrick Lichty (in person)	[Have you ever visited any websites that kind of work like you describe? (in question 5)] Absolutely. Personally I happen to like a lot of the things Plum design has happened to…in some of my work I have used Think Map associative tools, and I like what they do. In the most reductive sense, my own "Grasping at Bits" essay does this to an extent. The Experience Music Project's website out in Seattle, does this. The Plum Visual Thesaurus does this; that's very interesting. If I can diverge from this for one instant, another thing that might also be important from a visual perspective, I think you can have really dynamic 2D visual interfaces that allow a person to see a general part of the sky. Something that was very interesting in the Emerging Technologies area is this screen that had a high-definition outer area and a very high-definition inner area. One thing that I think would be very interesting

	in an interface would be to be able to...because there's such huge astronomical spaces in the universe, if you could zoom and zero in on that space and create some sort of gravitational pull that would pull a lot of that localized area together and then allow them to see things in a slightly tighter context. [Do you mean like a bubble around for establishing another central coordinate for the way you see the universe?] Yeah. Let's use Betelgeuse as an example: on one hand, the objects say within ten light years would be very close, and within 20 would be twice as closer than they normally would be. So basically pulling things into a localized pinch, so people can get an idea of what is nearby, but understanding that there's a localized distortion of the space. This is just what I'm envisioning. Because astronomical space is so large, they might be useful to people to create this localized distortion. A metaview of the localized structure. I think it would also be interesting if you can visualize, something like radio or x-ray spectra--just being able to shift form one set of data to another. Take Sirius A and B for example. Sirius A is an extremely bright star, but in x-ray, Sirius B is extremely bright. You know on that hand you can take a look at things from different wavelengths.
Annette Weintraub	I just did a project about water. Because of that project, I visited a lot of sites, particularly the National Oceanic and Atmospheric Administration, U.S. government site. It has a huge public domain library of photographs. Most of them are water, swamps, estuaries, scientific photos, documentary photos of scientists taken on their expeditions to glaciers, so I used that site a lot. Did a lot of research on the EPA site, Environmental Protection Administration, and some other primarily in terms of earth science and atmospheric science and not astronomy or outer space.
Andurid Kerne	Sure. A certain amount, that's what I would say. One of the preset collages that I created for collage machine has a bunch of space sites in it. I think the imagery, some of it is really beautiful, I have a certain curiosity about that.
Dorothy Timourian	I really don't do that, no. Actually, I've used websites for medical information and looked through different sites for things like that. Haven't for astronomy.
Peggy Frank	I haven't pursued anything really online. If there's an article in newspapers I'll check it out or if I happen to see something in the magazines I usually read it. I'm fascinated by anything I might see on television. My husband, a physicist, is very interested, so between the two of us, we follow findings, we read, and we talk to each other about what we might read in the news. I don't aggressively pursue.
Glen Sparer	No. When I come across them I am intrigued by them. But I don't directly go to them, because of my work not geared that way right now.
Paul Hertz	I check out the HUBBLE telescope sites. I also check out frequently landmasses and diff forms on the earth, particularly human habitation on the earth
Craig Hansen	One that I do go to frequently is any number of the USGS pages, as well as a lot of the NASA pages, which show aerial views of the planet, again, particularly I've been focusing on the Bay Area or California. I tend to be more

	interested when I'm doing searches like this, more interested in images than in text. Probably it's more just the content that I'm working with. I'm usually looking at sites or looking for sites that have a pretty good collection of photographs, especially if they're well-indexed and thumb nailed so I know what I'm looking at before I go searching through many many pages. Sometimes, even just out of personal curiosity, I'll explore SOHO satellite photos, movies of solar activities. Because part of my duty as an employee here involves keeping up with the touring exhibits which come through frequently; we get things with astronomical content. We'll be looking at whether or not there are websites related to that. Some of the Hubble images we have up on our floor. We look through those.
Lisa Jevbratt	I've been looking at a lot of sites with raw data you can look at, like the Human Genome I've been using with students because it's easily accessible data, they have text files just raw you could just load them into their programs and work with it. I don't go to science sites to just read about the data. Just a naive kind of digging into it as if it were soil, or clay and you just grab the pieces and do whatever. Of course, I respect and care about the assumptions that go into the data, but the data itself is more fascinating.
Geri Wittig	Primarily, when I go out to scientific sites, it's for research papers, because I read people's research papers when I'm doing research. I was doing a lot of research on auto-poesis, so I was reading a lot of Maturana and Varella.
Nora Raggio	For that part of my artwork I do, yet I'm also am very interested in other aspects of the culture that surrounds us, so I'm also interested in cultural aspects of science. So I'm not only interested or based on sort of the scientific side of it, but am also interested in how that science works within a cultural context. Off the top of my head, I definitely visit all the NSF, an information database on genomic, I visit that frequently. Then there are hundreds of links that go to specific genomic data, whether they be human genetic data or animal genetic data, and there is correlation between human and genetic data. Also there's plant genomes that are being discovered. So I'm at this point, fairly much in the wide scope of the research. Then there are specific sites that have news on the genome, and I generally visit those too. If possible, I'll try to send you the specific URLs by email.
Bonnie Shulkin	Right now I'm all over the place looking for earth-science curriculum. Nothing I go to over and over. Sure, but I usually start out with Google, get an inventory for what's out there. Sky and Telescope site for information about telescopes, that's a site I've visited more than once. NASA site? For NASA, if I'm going for activities I'll go on the space link.
Ben Burresss	
Ryan Diduck	
Celeste Burrows	I start on Google, that takes me everywhere. SEDS.org, night planets. And then I ended up using Solar Views, Calvin Hamilton is the person, the problem is that it's commercially financed, so stuff pops up. But he's got good stuff. Archives of videos, Magellan mission, simulate the radar mapping. I show them the Magellan clip....flyover of Venus. That's a website where I got all of

	my animations. Textbook...Universe, Friedman and Kochmna. CD with animations, what Venus looks like, Mercuries landforms, little things. Formilab.com the part I use if solar system live. It shows simulations of virtually all the asteroids you can name, near-earth asteroids, path of orbit, you can tilt it up down side to side. Also for comets, you can see if it has an orbit that will cross the earth's orbits. Most of the children really don't know how the planets orbit. Some planets orbit faster than another...they get all excited. They cheer it along. Show the comet. Tilt the axis, it really wasn't going to hit the planet....[32:00]I spend most of my day searching the web for stuff, picking out the best...I know the teachers don't have time for that. That's a limiting factor for things. How to use the stuff that's there.
Wendy Coones (in person)	Most of the time when I'm looking at astronomy sites it's purely for research stuff…I usually end up with NASA sites and university sites, those are the ones I can trust. pseudo-science sites…glance at them, see what's going on in the latest hubbub in alien research.
Joan Gillerman	Yes, I do. I do a lot of research on the web, that's primarily what I go to internet sites for.
Donna Cox (phone)	
Shawn Lani	I'll do a general Google search…what I'm looking for is specific researchers or people not into the business of making exhibits…the articles that are really kind of ignored, because they don't have context... those are the things I look for, those little gems…I built an exhibit that blows air rings, and so I searched up on Google and turns out that at Scientific American they did an article about the fact that dolphins make air rings and play with them….and I thought that's before it was an exhibit about blowing bubbles, now it's about dolphins, it's about play and you're blowing bubbles, and they are blowing bubbles... and it turns out they teach each other these dolphins. They kind of show each other how to do it...and now you have an amazing angle...now the whole thing becomes beautiful...now all these things tie together into the final exhibit. I have a reason for looking, to go in search of info, this thing that I've already taken as ...the next step for me, is that I want to know more about it.
Noah Wittman	Sure. There are two sites that I remember looking at. One of them is Views of the Solar System, or solarviews.com. Put up by a retired NASA scientist, but he was an imaging specialist, so the photos on the site are particularly beautiful. Another space-related site is the Milky Way at multi wavelengths...it was a poster at some point. This one site allowed you to look at the universe at different wavelengths. It really makes you think, one of the first thing you learn.. you really understand that human beings are operating within a very narrow bandwidth...energy out there that with modern technology we can access...much wider broader view of the universe.
Wendy Coones (written)	Yes, SETI, looked up horoscope, looked at pictures from the Mars rover and of Hubble images. I've also seen a computer program where you could view the solar system from any point you choose in the solar system. It was amazing, and fairly low tech.

James Morgan	Most of the sites I visit are referenced by slashdot or memepool, but I do occasionally go to space.com on my own.
Patrick Lichty (written)	Yes. www.nasa.us.gov., mainly for its large body of images, information, and resources. Also SpaceNews when prompted by friends for specific articles.
Myron Krueger	I almost never go to a…I'm not a regular visitor of any website... I have no websites I visit with any regularity, I wrote down the name of some website. I have a few files full of website addresses that I never follow up on. ...some kind of prediction of magnetic storms...beginning of getting hold of the northern lights idea. but I never visited the site.. usually when I go they tell me too much. I find most sites quite frustrating, it's very hard to FIND THINGS. it's usually difficult enough that I don't do it for fun anymore...then I end up at whatever site I end up at. Search in the site is harder than the search to the site. ..I went on the HP site yesterday, get to the HP printers, some link to MAC products...doesn't' link to printers...got printers somewhere there under "printers". [supermarket arrangement?] ...respecting the customer and providing the customer what they want. Their time is valuable...as fast as possible, because if you can tell them you don't have a solution and let them go about to find the solution you've done them a service, if you just waste their time, they're going to resent you...3D studio max, I went to Autodesk website.. it was absolutely impossible to find out about the stupid product, they expect you to know absolutely everything about the product...and yet it's an expensive buy. Finding out about how you would ask questions or something, there was no way to do it, the site would constantly a link, "contact us", those links never resulted in you being able to ask a question, just keep pointing you to different places in the site...no admission that there was no way to do it...They would just wear you out, following promising links and then you would ultimately give up.
Garret Moore	We have a very narrow band of perception with our eyesight. We might have been able to see in ultraviolet, it might have evolved out of us.

Interviewee's Name	Question 9. List your favorite and least favorite science sites and why are they so?
Christopher Johnson	The National Geographic website.
Donna Cox (in person)	The one I like the best is down in the Anglo-Australian Observatory. Why I like it is that it's organized, it's got nice colorful images, but the images relate to one another. The huge organizational problem of where these images come from and the different types of field of view we're getting in the sky—I as an artist I want to use these images. Personally as an artist I see all these astrophysical images as kind of abstract art. And they have this 3D mysterious, almost longing, but adventurous, that I have to explore the heavens. When I just have to deal with raw data, I don't know how many times I needed just a visual tool that would enable me to be able to see how these instruments are physically pulling the visual information down and then when I see the 2D image, how that 2D image maps back up in the heavens.
Jackie Morie	
Patrick Lichty (in person)	
Annette Weintraub	My favorite sties constantly change depending on what I'm interested in and what I'm working on. The site I have on my homepage is an information site called Refdesk.com, that's a portal with a series of links to newspapers, research sites, dictionaries...it's just an incredibly rich set of links to where you find information. I use that site a lot, when I was researching water, and my next project I'm researching about hospital architecture. That site is always there. If I think of a word and I want to look it up and see it in another language, or see if anyone's used it in a quote, that's the site I go to. It's my favorite site, because it means every piece of information that's on the web is at your fingertips. There are art sties I like, and information sites, but that sort of portal is important. I don't look at the sites I don't like. Sites with advertising, with things popping up that you have to turn off. I don't think there are any sites...there are sites I choose not to look at, but I think it's great that's it's all up there, that people can put stupid things up, because who knows when you might want to find something stupid. When I was doing the water project, I found these incredibly interesting sites that weren't visual, terribly designed, on the history of plumbing, of bathroom design, of bathtubs, toilets going back to China 3000 years ago, but it's terribly interesting. So there's just wonderful stuff out there.
Andurid Kerne	I actually tend to like how collage machine provides navigation to those sites better than the navigation of those sites themselves. Because they give you certain blending of the images and let them function as navigation to the

	different topic and content areas, I just find that to be more visceral and more engaging in a certain way. I don't think of sites in that way {least favorite, uncomfortable to navigate}. I tend to just muter under my breath more for some than others. Like how many clicks do you have to get through in order to get what you want. It's funny because I rarely browse the web in that kind of way these days. It gets very patterned in a certain way. I'm just thinking of some classically bad sites...A good site is one that provides multiple clear ways of accessing information, different kinds of classifications, themes. On the one hand you want to be able to do searches and have them work. You want to be able to...the architecture and the information has to be clear. Well organized information, where there's a lot of attention, you want good visual and data design and you want to be able to get to the things you need with a minimum number of clicks and scrolling. And a bad site is one that really makes you click a lot and doesn't have clear navigation and data design, and you really have to hunt around to find the things you want.
Dorothy Timourian	I really didn't pick that out, to see which sites. We usually just go to the internet and look up medical information from the mayo clinic and some of the medical sites like that, National Institute to Health, places like that.
Peggy Frank	I love one for the Museum of Modern Art in New York. It's a great website. You can actually check out their collection, name an artist and they'll zero in on the work they have. I do a lot of ordering online for materials, some are better, clear and easy to use, others are definitely inferior, enough so you get cranky when you're using it. There are definitely are some websites that are better designed than others. I like ones that are clear without complications that lead you around back to the beginning. Things like that make me cranky like an inefficient voicemail would.
Glen Sparer	
Paul Hertz	
Craig Hansen	I think the things I know I appreciate in a site are very very simple and limited selection initially. I'm thrown off by pages that through too much at me too fast. I'd rather navigate in a more step-like fashion. To me, the Google opening page is great, because I'm undistracted, I know what I need to do and I do it. Occasionally, if I have to deal with some of the NASA space image libraries, it takes a little while to find what I'm looking for. Often times I'm 10 steps into the site before I'm even told that the images aren't even available to be looked at, they're only available to be ordered. That can be frustrating.
Lisa Jevbratt	I want them to be complicated and complex and I want the data to be accessible in raw format, I want it to be text files that are set up so my programs can easily parse them. They should not be made cutified or polished up…if it's complicated stuff I want it to seem complicated. I don't want it to seem simple if it's not simple. If these things are not simple, I don't want the data to look simple, and I want to allowed the excitement of thinking that I can find that I can understand something that is complex. I have a feeling why I don't look on these scientific sites for popular science sites is because I feel like I'm being treated like a kid, like a discovery museum. Like the

	Exploratorium museum in San Francisco, which is a good place, but something with that kind of making science accessible--just like making art accessible, I don't like that either, you should allow art and science to be complicated and complex and think that people are smart enough or have enough interest to dig into it themselves.
Geri Wittig	I don't remember the name of it, but I found a site recently, somebody was doing a GPS project, they were going around to all of the points on a map where latitude and longitude meet in the world, and photographing what was there. They had a site that was just really beautifully designed in terms of visual representation and logic and they had a lot of data they were dealing with. I thought it was one of the best information design examples I had ever seen.
Nora Raggio	
Bonnie Shulkin	Google is good because it's an easy way to find information about other websites. It works in the way I expect it to. Yahoo is more like a directory of things on the web, not a search engine. Most search engines are equivalent. [Not a portal, no pop ups...] Sure that's a nice feature of a website. Simple and not commercial. bad site--all sorts of blinking ads and stuff is bad, I don't like that.
Ben Burresss	Mostly what I use, gathering images and information as well to use in exhibits and classroom curriculum. Solar things as well. Hubble site, Hubble images. The SOHO site, real-time today's image of the sun. a lot of good info of science they're doing, day by day what's happening on the sun. I use a lot of Planetary photo-journal, I used to use NSCCD, that one and the photo-journal had the same thing. As websites they're pretty basic. But what I do I don't really care how polished and glitzy the website it. If they dug a little bit, they're a little more technical, planetary photo journal is easier...sites that take people by the hand and explain things, that's what we want to do with the Chabot website, that'll be changing in the next year or two.
Ryan Diduck	Because I do a lot of research, very visually oriented, I spend a lot of time on JPS planetary photo-journal page. Hubble web page, pretty nice, gives you a little info, I wish it gave more, I think the public would at least like the option of clicking somewhere and getting more info...what's it made out of? why does it have this really bright streamer? [analogies?] exactly. I don't find that on that page. Photo-journal works fine. being able to search for diff images specific images that I need, I can limit my search to Viking mission, fairly simple to go and find it, not a lot of time to searching for it. toughest time of web is you need to be really creative in your searches. Those are the two most useful sites. public enquires, I need to watch space.com, the tabloid-ish type pages, breaking new story, public hears about, and we get calls about it, so i need to know what the article is talking about. [CNN site, that was my entry level. I got more information. the impact of CNN releasing that information..] 99.9% of the public.
Celeste Burrows	
Wendy Coones	

(in person)	
Joan Gillerman	Not favorite or not favorite. I've got a gazillion bookmarks of scientific sites. …same site. Rather than thinking of a favorite site, there are certain things that irritate me about sites, …things I like. When I'm looking for info, if I can't find it fairly easily, that really irritates me. I realize there are technical things happening. If you do a good search and you know several different ways to say the same thing to get the info. Sometimes it doesn't exist. My example...why total sol solar eclipses don't occur at the poles. A partial can happen, I know that as a factoid...I did a lot of searches. I'm by no means it's not there. ...I couldn't' find a reasonable explanations...research context as a fact. I like websites to be visually interesting. I like to feel comfortable using it. ...big block of text, it didn't engage me long enough to stick around...
Donna Cox (phone)	There are some that seem more esoteric. The ones I've been frustrated with is the SLOAN data…access some of the SLOAN pictures and they said they would be there and they weren't there and you couldn't' download them. Australian Anglo Observatory…filled with images...can peruse them very easily....well-funded project, one of my favorites is in Australia. There's a nice site, American Museum of Natural History, they have ..., Berkeley has a very nice site.
Shawn Lani	I rarely use science sites, religiously. I love live stuff. Where the tides are. Live cams of the Bay Area from a top of channel 4…satellite images. Anything real I'll jump right at…at first it was really sexy…now I've fell back to my favorite books...I'm a bit of a ludite in terms of finding information. Internet often is frustrating after about an hour...There's so much information, and so much of it is writ-media. It's so two dimensional, you're sitting looking at a computer screen, trying to gather information. It's just not very dynamic.
Noah Wittman	Exploratorium.edu, of which I'm very proud…worthwhile destination for almost anyone. Sites I commonly frequent are Google for search engine, sites where I can do research…compare information…sites on topics that I'm interested in.
Wendy Coones (written)	SETI is cool. Horoscope simply gave me some things to think about.
James Morgan	I cannot say I have a least favorite.
Patrick Lichty (written)	I enjoy the NASA site for its breadth of information, despite its frequently unwieldy structure from facility to facility. Also Space.com for its timely coverage of space-related items.
Myron Krueger	
Garret Moore	The IAAA is one of my favorite, international association of astronomy artists. I can tap in visually to a lot of amazing things. Artists that have found a unique way of observing a galaxy, or extrapolated what a planet would look like around a certain type of star. I imagine those things myself. When you have a rudimentary understanding of astrophysics, the possibilities are infinite. I love to look at other artists work, it's inspiring and informational, it expands your

	database visually. Then of course any source of information, the NASA site, JPL, those are favorite also, that's because I enjoy doing research. Then I enjoy any artists work, in these subjects, or just well-executed art. All the sites associated with NASA. Simple, visual, where I don’t' have to use a lot of proprietary controls to get around. I like to absorb visual data really fast. I love it. I like captions, but I always had a problem with lots of copy, because to me I like to get it more immediately. The better the visuals, the more I enjoy it. Well-done graphics, good photographs, good illustrations. I really enjoy a visual site. I do that with ManyOne, and before that I did it with OneCosmos.

Interviewee's Name	Question 10. List your favorite websites in general, and why are they so?
Christopher Johnson	
Donna Cox (in person)	
Jackie Morie	
Patrick Lichty (in person)	
Annette Weintraub	
Andurid Kerne	It's been a while since I've thought about a favorite website. The websites that I like tend to be, per say, expressive ones. Like Stephanie Strickland's Sand and Soot one, which is a hypertext poem about sand is silicon and soot is carbon. It's very lyrical and very beautiful, and the expressivity, and the way form and content are very integrated.
Dorothy Timourian	
Peggy Frank	Alan will mention something he may find on the computer, and I'll come over and look. I'll check out some of the sites with medical things, I check out things related to art and art education, museum sites. As far as sites for scientific things, it really hasn't applied to me. I don't spend a lot of time wandering around online. It's just not my favorite thing to sit in front of a screen. For art related things I have a large library. I'd rather pull out a book and curl up in a chair with a book. Although my new laptop is so small I could curl up with that. I just don't spend a lot of time surfing the Internet. I never really found need or want to do that. Certainly art related things we'll check out. If students are interested in particular places or animals or if they want to draw a particular flower. We'll look things up. Very, very basic stuff. Centimeters and inches, miles and meters. Nothing very complex. My work as an artist, virtually nothing. As far as the students, there are some things they will need to know, they will want to know distances at times, make measurements of things, many of them are familiar with metric scale. That's about all that we actually do. As far as outer space, since that is a subject that they like, sometimes they want to know distances, and I'll try to look things up.
Glen Sparer	I can't remember. I've come across things that are very, very interesting. Some of the typological data of the earth from different directions, different heights, that have been interesting. The way they presented the data… I can't remember the specific name of them. I saw one thing that had to do with language, categorization of language. You click on a word, and that would

	bring up--the whole interface would shift around in space to other words in other languages--so you've got the whole structure from a sentence, the whole hierarchy of where that sentence came from. So you've journeyed from information frame to information frame, through space. I think someone did that with Shakespeare's text. The words actually shift in 3D space, and you shift around them. So it's a more interactive and dramatic appreciation of the language. There's a temporal dimension and a spatial dimension.
Paul Hertz	
Craig Hansen	
Lisa Jevbratt	
Geri Wittig	I'm not a huge surfer because I do it for a job. I think in terms of aesthetics the design sites, like Communication Arts, those people really know visual logic and language. Any type of design site like that. [What is your definition of a good website?] That it's clean and uncluttered, that it's visually striking and the information is easily accessible in terms of the logic of what you need to find. That you know what's on that site when you get to the homepage, and that there's not tons and tons of stuff that you don't know is there by going to the homepage. I think that when you get to a homepage you've got to know what's on that site, that's their 2 seconds to get to see if you're going to stick there or not. If the homepage is hugely cluttered, or there's nothing there, I usually say I'm not going to stay there.
Nora Raggio	
Bonnie Shulkin	
Ben Burresss	
Ryan Diduck	There are some new NASA sites that have gone up that repeat a lot of what you can find on older sites, or sites from a different branch, JPL vs. AMES, or Goddard. I find it repetitive, especially if it's not complete. But not all the stuff and not what I'm looking for, I find it's just a waste of time for me. I stick to the other site I'm used to for me.
Celeste Burrows	
Wendy Coones (in person)	Yeah, definitely,…the ones that work the best for me are the ones that are very well indexed and cross-referenced. If I need a very specific piece of information about the lava on the moon and how it's made, a particular kind of moon rock, when I'm reading through a site, hot spot that will take me directly to an article that's been written about it, or another page. A lot of times I don't necessarily know how the scientists have broken down the information, I don't know the ...tree of learning, how a particular scientific knowledge is broken into...geology...paleontology, ancient earth science, extraterrestrial earth science. Because I'm not familiar with how all that stuff is broken down, I need to find information accidentally.
Joan Gillerman	
Donna Cox (phone)	I definitely hate…5 original supercomputer centers, one of which I'm still at, and have been since they prototyped the Internet. What I hate today is the

	screens start popping up…extra windows that start taking over my system…I don't want what they're trying to sell me. I just hate that. That did not use to be the case years ago. My favorite sites...issues of navigation I do like is whenever I am in control and I can see where I've been and where I'm going...kind of a roadmap so I know where I am...that abstract their own territory, and provide me with where am I...not too many that provide that...gallery site maps, diff types of flows in which you can flow down and back up, and frame buttons on the sides, there are certain standards that have evolved...but in complex sites, I want to be able to know where I am.
Shawn Lani	
Noah Wittman	
Wendy Coones (written)	
James Morgan	I like the diversity of the news presented on both sites, diverse yet focused. I also follow fuckedcompany.com and a blog or two. I get regular updates from rhizome.org though I infrequently visit their site.
Patrick Lichty (written)	To be honest, I have become increasingly disaffected with the web, due to the fact that there is little that really relates to my body of research and interests online at this time. In addition, I am currently in a transitional point in my work, so I am spending a great deal of time in offline activity. I buy most of my equipment on ebay.com, and I usually enjoy checking in on the research being done at MIT-Aesthetics/Computation Group. I also hope that my intelligentagent.com site will be a favorite, but development plans are currently too early to make such a judgment.
Myron Krueger	
Garret Moore	

Interviewee's Name	Question 11. Do you find these sites useful? Do you consider you learn something when navigating these sites? Why?
Christopher Johnson	Complex and inaccessible in some way, even though I use my…I'm not sure how to incorporate the data that I would get into a Maya application, mostly because I haven't done it before. It could be intimidating in terms of amount and what is out there. Maybe a tutorial --as an educator I don't have a lot of time to spend a week just to figure out how to import the data-- if there was a tutorial that could show me how to do that in 10-15 minutes, or "these are ways we have used the data, and this is how we did that", I could figure things out. I could point my students in this direction as a resource.
Donna Cox (in person)	
Jackie Morie	I like sites that have questions, that have information but don't know it all, that ask questions that allow you to be part of the discovery process of the information. We were talking before about "what if". I like sites that make you, or allow you, or send out energies to you--they may not ask you "what if" but they send out energies that inspires you to say "what if"--so that, to me, is the perfect site. "What if" sites. [How much supplementary information would you like with your images? Captions?] No, I would like very deep explanations. I would like them in several levels. I'd like, "This was taken with a certain telescope with a certain refracting lens blah blah blah, you know this was before the corrections on the Hubble Telescope," but I'd like the poetic descriptions too. "This is the image of Earth taken by Neil Armstrong from the moon"--has so much poetry in it. It's factual, it's poetry. I think, again, a lot of the things that we look at that are captured out in space--there's been changes to that, coloring, whatever. I think it would be good to explain the interpretation, because every image has been interpreted in some way, just to make it an image. People don't realize that, they take images as fact. And that limits you, not knowing that that's one interpretation, not realizing that there are hundreds of interpretations is very limiting. So, I think that as you dig deeper into an image, perhaps on a site, it would be interesting to see other interpretations, not only to see factual descriptions but to see what I call poetic descriptions and I don't mean that in a flaky sense, I mean it like I said, you know, picture of Earth taken from the moon. Those can be life-changing things. Just seeing the image may not be, but having resonance with a description or several descriptions can make a huge difference. You can't put all that out at once but I think if an image moves you, that can be enough, but it would be interesting to have lots more energy flowing around that image to move you in different ways. For me, I usually see the image, because I'm a visual type of person. I will always have my understanding of the image. Everything else that helps me to interpret that in different ways

	gives me different views into that image. So I have mine, which might be "zero, zero, zero, zero, zero" center, and then I have the other things build up that sphere, that more holistic complete thing. It's like building up a cloud bubble around this image. I don't like to look at things and just have that one direct, "I know what that is". I want to understand how everyone knows what that is. I want to understand how many different ways people can know what this is. Because then I know that I understand more about the essence of that thing.
Patrick Lichty (in person)	
Annette Weintraub	They are very different in terms of their design, whether the information is presented for a regular audience or a technical audience. There were a lot of sites that presented data that wasn't usable for me. Scientifically it was very valuable, but it wasn't in a form that I could use because I create narratives and use images that are cinematic. I can appreciate that this exists and that our tax dollars paid for it to be gathered and categorized in a way that people can use. There's so much information, I was overwhelmed by the amount of information. I talked a little bit about how you deal with overwhelming quantities of information. How you can gather that information, it's available from so many different perspectives for so many different uses, it's interesting.
Andurid Kerne	
Dorothy Timourian	
Peggy Frank	
Glen Sparer	
Paul Hertz	The NASA site for earth sciences has a huge number of interesting images, the database for it is kind of bad and buggy.
Craig Hansen	I think as far as text or other kinds of graphic representation things I think it has more to do with how …if I'm confronted with a huge mass, a huge array of options to choose from, and no real sense of how to pick through them, that can be overwhelming. I'm not set off, when I know that I want to read someone's paper on a particular topic and I choose that, and an Acrobat document opens up that's 30 pages long, that's okay because I know that's just a vertical column of information that I can read. The information may be very complex, but to me, that'd be like reading an article. I think when it gets overwhelming is when every single page has so many options, no clear sense of containment or organization.
Lisa Jevbratt	
Geri Wittig	I go to NASA's site, because I'm interested in seeing the space shuttle land in Florida. I would say in general they're pretty dry in terms of design, usually poor aesthetics. NASA I think is a different case. But science sites that I usually look at are academic, those are usually really poorly designed.
Nora Raggio	For example, in a lot of genomic databases, I think even the ones that are available publicly, they are generally geared towards people who are in the know, and who are looking for specific gene sequences for a specific trait. So

	I think that one needs to really digs into that, and I think it's sometimes frustrating that they'll use acronyms or very much scientific notation. One needs to dig back, or for me, is to talk to experts in that field, because as an artist, obviously, I don't know all the latest acronyms and the latest buzz words that are being used in that particular area, although doing the research one learns about it. I think that it would be really helpful if some of those databases were organized in terms of...like the particular website that you referred us to, had one for public, one for education, and one for scientists. So I think in some way categorizing that would really help to know where to start, if you're say a beginner or intermediate person in that area. And then, what would be really helpful if one wants to go deeper, is definitely to have an updated glossary on scientific terms. What I find alot too working with genomic data is that the sequences are not presented, they are just given a string of letters, continuous letters without any...the way in which the data is provided is I guess, if you have computers and software that are willing to take that data and then crunch it into ways that are visually more interesting, or more comprehensive, or even more understandable, that would be great. I think most of it is just thrown in as just raw data, which I can see the benefits of that, because with the raw data you can crunch it several ways. That's the beauty of raw data. On the other hand, it would be nice to have the raw data, and in addition, ways in which that raw data could be interpreted, for people of different levels of understanding. That's really asking a lot of a scientific site. I think that in many cases you can tell as you go from the sites that are more meant for the public as you go into more specific sites that are given for the expert, you can tell that the information becomes more cryptic and in a way short code it, and also that the raw data is there, but the tools to interpret that data are not always there. So, as an art piece, it's kind of interesting, because then one can take that raw data and try to make it interesting.
Bonnie Shulkin	
Ben Burresss	
Ryan Diduck	
Celeste Burrows	NASA seems to be regularly putting up new. Right away I go to teacher's pages. Or Favorite images or archives or images. Earthcam, pictures from above the earth, you can do activities with your students to analyze the pictures. It jumps out at me what I can do. Lesson plans, that focuses what I can do.
Wendy Coones (in person)	
Joan Gillerman	
Donna Cox (phone)	Yes they're problematic for artists in general… There's a huge chasm between the kinds of tools scientists use and the ones artists use… because we're dealing with video and images and audio...that's true for scientists. I don't' know if they see it as video streaming or audio as an important part to NVO...but important to artists who are working with NVO creatively...with

	NVO data. One of the things when i was talking about being able yto link into other areas such as, in my dream fantasy tool, I go into a site where I just had a major collaborative...data that's from coming from all...make comments, and those are put into the repository that I'm talking about...across data which we need more information, we might need to link into a library setting, or have a humanities description of how this data was treated before...other than scientific journals...in a sense that might reach out into how the media has treated this are of the universe...multimedia format...as part of a \\...really getting into news media, back up articles, humanities that might have to do with the data.
Shawn Lani	
Noah Wittman	
Wendy Coones (written)	Yes useful. Yes learning. Enjoyed seeing SETI's method of problem solving. Now I know what Mars looks like.
James Morgan	The sites are useful for raw information, leads to possible areas of interest. I am also able to keep up on certain news items, I do often learn from these sites, but often the information is trivial.
Patrick Lichty (written)	In the most basic sense, yes. I certainly do not learn when visiting Ebay, but the MIT site frequently offers valuable insight into problems in A/C that I am considering.
Myron Krueger	
Garret Moore	

Interviewee's Name	Question 12. Are there any problems you encounter when navigating these sites?
Christopher Johnson	[Is it the language, the visual type of approach, that scares you, or stops you from feeling comfortable…What is not friendly about scientific data?] Maybe the language? Probably more so, even the mathematical approach -- I had two years of Calculus in high school, but I've forgotten a lot of that unless you practice it day-in, day-out, you even forget basic trigonometry. Definitely, a tutorial would be helpful.
Donna Cox (in person)	
Jackie Morie	
Patrick Lichty (in person)	
Annette Weintraub	
Andurid Kerne	
Dorothy Timourian	
Peggy Frank	
Glen Sparer	
Paul Hertz	Good categories but hard to get to the info. It's something I've noticed on a lot of sites. It's difficult to get to the info becomes you have to use this forms interface and popup menus to narrow down before you even get to the image.
Craig Hansen	
Lisa Jevbratt	
Geri Wittig	Get a designer, to design the aesthetics, functionality, information design, the logic.
Nora Raggio	
Bonnie Shulkin	
Ben Burresss	The ease with which I can find w accurate reliability. Information errors and discrepancies. Comprehensive too…
Ryan Diduck	
Celeste Burrows	
Wendy Coones (in person)	
Joan Gillerman	
Donna Cox (phone)	
Shawn Lani	
Noah Wittman	
Wendy Coones	Good websites with lots of pictures since the data is fairly dry.

(written)	
James Morgan	inane comments abound, and occasionally the subject is misleading
Patrick Lichty (written)	In cases where sites have a large quantity of data, I have great difficulty locating certain bodies of knowledge quickly and efficiently, even using search engines. One possible solution to this might be the use of associative topic display metaphors (i.e. mindmaps similar to The Brain or Thinkmap) which allows for the dynamic viewing of multiple associated topic fields of varying depths. In addition, John Klima is experimenting with other interfaces at Intelligent agent that might be of use, but I am unsure at this time how these devices will be received.
Myron Krueger	
Garret Moore	

Interviewee's Name	Question 13. What kind of interaction would you like to have with web sites presenting scientific data?
Christopher Johnson	[If you were to design a site presenting scientific material, or help NASA design a website, what kind of tools would you like to have? What would you expect to find?] Actually, I imagine putting on a sort of virtual reality helmet and being able to fly. Like, first be able to see the Earth, and the Sun, and the solar system, and then being able to click on Mars and go into Mars, and then some mediator or Avatar that would ask me what I was interested in, or these were some of the options, not all of them, and from that the Avatar would learn what I was interested in, but would also have other things that would pop up. Maybe talking about, "This is where they stepped on the moon", and why that was important. But then, if I were able to look around that area I would see some very interesting cliffs. I live near the Grand Canyon, so I know there are some huge cliffs on Mars that are 5 miles high. So to be able to go see that and compare it to being at the bottom of the Grand Canyon that would take me a 5 day backpacking trip...to be at the bottom of that, to see the immensity, where the cliffs are so tall, taller than buildings in New York...when people line up at the edge of the cliff and look down at the river, they don't have any perspective of how the walls of the cliffs are towering over anything you would see in New York or Chicago or LA. [So what you're talking about is the scale of this, the perspective, and the point of view? If you could change the perspective and the point of view, it would change the space around you?] Definitely. I would even be interested in the chemical makeup of the rocks and how they form in such a way and what made them do that. They have the story of the pygmy who's always lived in the jungle--he herds cows-- and he's used to a cow being a certain size. One day somebody takes the pygmy and takes him to the savannah where he sees a little cow 2 miles away and says, "Oh, that's a small cow". He doesn't even understand the perspective in there. I'm like the pygmy. In terms of the scale of the universe, I don't even have the perspective scale...even when I see the animations where they zoom in and out.
Donna Cox (in person)	
Jackie Morie	
Patrick Lichty (in person)	Here's the thing, it really depends on the level of engagement with the subject you're doing. For example, if you're someone that's able to understand, has a little bit more of a background in scientific culture like I do, I don't mind getting a little more information. In the gaming culture there is something called the level of detail. What happens is that an artist might not need perhaps, the level of detail as a person dealing in radio interferometry of neutron stars. To traditionalist fine artists they're not going to be interested

	in hard data about radio interferometry.
Annette Weintraub	
Andurid Kerne	That's really pretty broad, one question I have about that is how much is this about presenting information, how much of it is about engaging people in processes. Is this function of this to report on work that's done and make data available? Is the function of it to teach people in a sort of deeper way about these ideas, about the universe and travel and what it means to be somewhere. I would like to create engaging processes that cause people to reflect on some of these broader questions, so that the experience of engaging in the interactivity makes them think in a certain way and affects their perspective, adds to it somehow, as well as giving information it should convey an experience and there should be a certain kind of basic human generosity as well as an imparting of knowledge and the sense of human generosity of knowledge and experience and information and forming and those should be synthesized in, I could say, an ecosystem sort of way. There's a bunch of different kinds of goals. One's experiential, there's something about sharing and teaching and informing that happens together, you want as a part of that to give people choices and let them come in from different kinds of perspectives. If you're coming in for certain information, it should let you get in for that certain information and don't force them to go through this whole experiential thing. But if you have people who are there for exploration...
Dorothy Timourian	
Peggy Frank	My direction would be visual. Color, texture, pattern. Ability to get around the backside of something.
Glen Sparer	
Paul Hertz	
Craig Hansen	
Lisa Jevbratt	I understand that an informational site has to have more of an educational structure or easily accessible structure, but I'm not interested much in that. I would say the only way to use the structure of the web itself to do this, the whole open source method for it, you basically provide a way for people to submit their tools, have people create their own tools and come up with some kind of smart system for that to work so it's easy to use, different levels created by the users themselves. So I who really like creating tools for understanding data will use this more as a creator and go in there, use the data, create the tools that maybe I could upload there for other people to use, and maybe even have some kind of reward system. Not pay one person to do tools but have it so if you have people out there in the world developing things for this, it's open source but they can still be rewarded economically for participating and helping other people to understand it. There are great open source movements where this happens, but I think informational sites, government sites, are not using the web, but just one person telling someone else what's there. With all this astronomical data it sounds like you have an excellent opportunity, if you have time and resources to set something up, to

	try to do it in a web open-source sort of fashion. What's it called? One big site where people organize open-source development....looking at those kinds of sites and getting ideas from that. It's better than getting a designer to set up the site that's going to look a certain way, and have someone deciding what kind of tools we're going to use to harvest the data.
Geri Wittig	
Nora Raggio	
Bonnie Shulkin	[tool for all users? Accessible, intelligible to everyone?] It's certainly possible, but not the most complete or sophisticated definition of a nebula. An astronomy textbook? [model of hyperlinks?] well, you guys know about rollover and mouse over, something can pop up, that's another way to do it. [The information would be brought to the same screen?]
Ben Burresss	I think it's hard to put the example I just gave onto the internet. Starting from a top level down, I think visualization technology is a good way to convey things to people, images and the difference and sameness between Hubble images and art, I think people, especially non-math/non-technical, might not learn much from equations and numbers and ratios, going at them in the direction of visualization, simulations, it's been in the past or right now a bandwidth problem...We went down to Silicon Graphics on the peninsula they took us into their reality center, it's a big theatre and navigate large databases, whether this Egyptian tomb or this part of a star catalogue, it's huge screen, nice immersion environment, which may be achieved with just goggles, really put you out there, or in there. Tech Museum, Neferretti's tomb, high-res you can navigate around inside and get really close to the details on the wall, scientists have even done studies through this database. Almost as effectively as being there, same visualizations good for people to understand there...out in a place we can't go, navigating around the star. you can fly around basically wherever you wanted in this database of 8000 stars, fly around the Orion nebula, or see the constellation Orion in 3D and go around it, adds a whole dimension, rather than a 2D star field.
Ryan Diduck	
Celeste Burrows	
Wendy Coones (in person)	
Joan Gillerman	I definitely relate to the way some scientific data is portrayed in some ways than others on a site. I don't like reading a lot of little tiny text on a screen…I recognize that with a lot of scientific…I don't mind going through a lot of text in that context. But if I'm not going very specifically for something, I don't stick around if there's not something interesting.
Donna Cox (phone)	The issue here is …smart portals that would recognize you, a tag you might be wearing, and send you to a diff place than other people, because you're identified, it sends you to the right place…you would get …doing a project for supercomputing where people can volunteer to wear these tags and go to a kiosk web browser...takes them diff places depending on their expertise, where they are,./...specialized situations like that is privacy. My first order

	answer to your question is yes, it would be nice to have portals that would be customized to your audience...using them for diff types of purposes. That would be desirable. The down side is, those people have to reveal info about themselves, they identify certain things, if that info gets into he hands of commercial entities...lots of junk mail, or solicited on the telephone, you're divulging your patterns, behaviors and...misuse or abuse.
Shawn Lani	It's always nice to have a guide, for me. Some kind of character you can feel comfortable asking a question of. …that's there's a personality there…either a playfulness or some feel for the design, or the way of ….how you navigate, it feels like a personal touch. There's this great video game that's called the Journeyman Project...the interesting thing about the game ...there was a little AI character...that popped up in your head...through Da Vinci's workshops...he was kind of there chirping away, and all of a sudden you have so much context...on your shoulder, essentially, who has a sense of humor, he's got a bit of developing personality. Often he doesn't say anything. rather than saying something out of the blue, a little light would go on that says he has something to say if you're interested.
Noah Wittman	You really want to go with the big concepts, which is scale, location, and change over time. I know I've seen Silicon Graphics put together…or Rose Planetarium in New York…a 3D flyby of our universe. That's something I've only seen in limited form, and not really with real data....both scale and location. It's really interesting and humbling to see that we're just the third planet from an average star. I think you'd want to open it up to people who are familiar with different audiences and have them try to design it.
Wendy Coones (written)	AV presentations. Interactives. Like the old Mac program where you could make your own solar system based on real principles. It gave you a good idea how difficult it is. Pick a planet and go there. Simple programs that demonstrate properties. When I see sophisticated images with childlike interactions and prose, it is much more boring.
James Morgan	I would like to be able to download the data, or query the database directly
Patrick Lichty (written)	There are a number of different issues that need to be addressed when answering a question like this. First of all, I would like easy, intuitive access to the data in a way that makes sense from a standpoint of cognition/topic association. Secondly, being able to ....
Myron Krueger	I have a concept in terms of education, …I'm on the board of a charter school here…we had this incredible system whereby kids go to school and spend hundreds of dollars on textbooks, and the authors of those only get 10% of the text price,…we have people doing research under pressure to publish, but not use to people in their field. You have lots of people that could be producing content that could be accessed through NASA. Information resource could be built partly by the public, a LINUX system, rather than the government doing it all... [people could feed?] Right. [hackers?] Two parts to the site, or multiple versions of the site...sort of edited. parts of the site that are just encouraging participation. I built a model of New York and Chicago and San Francisco and Los Angeles, and you got some kids in Rio working

	on virtual Rio, but someone came along and did a better job...both versions might still exists...link to the more advanced model...different models based on complexity or function...maybe just a flavor of the city for the tourist or the planners to know where the pipes are...grandiose in terms of effort and complexity might be. When I was starting in CS, 1966, I took an AI course and found it really exciting. Then when I went to teach at Yukon, AI was really considered beneath mention, and its' still that way, no one is really working on artificial intelligence...even though we're solving some of hte fundamental things...speech synthesis is becoming understandable...the HOW interface from 2001 will be possible to sketch out pretty soon. But for 35 years people are not working on the problem. the Internet can have the same kind of problem. We put all sorts of money into telecom and Internet, everyone thinks we spent too mcuh money....but we didn't solve the problem. The companies that survive are going to be the worst, not the best. But nobody has any enthusiasm to try anything. and yet the Internet works just fine, but it is not ...the first ideas have been tried, and I don't see anything new being tried now. My fear is that the Internet might just stagnate. I was starting to see that when I was going to SIGGRAPH, 94 was the last year i was a real participant, and I went again in 98, and i feel that not much has changed... you don't have to go every year...partly it was it's own fault, but partly the paper side of SIGGRAPH was people doing the nuts and bolts of graphics, uninteresting and mechanical...different kind of computer graphics conference, but not trying to change the paradigm. That's what any scientific conference about should have to do, or die...some companies decide not to show, cutting down on their budgets...It's definitely part of maturity, but part of the fact htat it is an established and stagnating, that the hard problems have been solved in the core areas, and they have not really embraced ...a very enlightened thing to do, to have a showcase for new ideas, that would not have the same budget constraints of exhibiting. if they didn't subsidize those things, people will stop coming. I remember going to SIGRAPH and he showed some of his early images, an you just thought, Oh My God, these images are just incredible and you've never seen anything like it. People just stamping their feet and screaming in glee that such dramatic and exciting things were happening. Part of the fact that you get closer and closer to perfection...the steps seem less impressive. Much more about behavior and about what is there that remains to be done...what would it take to make it real? That's really what the issue is and people are continually doing the same level of stuff they were doing before. .....Simon Penny, he basically sent in only interactive work. Computer art from now on has to be interactive to be cutting edge. That was a statement worth making, I would do something like that with a technical program.
Garret Moore	As much info as I can get. If I see a photo, I want to know everything about it. What kind of optics, radio telescopes, how it's interpreting that, I want to understand the image, be able to take that and plug that in as many places in my own personal database as I can. Different spectra of the sun, I want to

	know that, duration of exposure. Any of that is good for me. I want to give good information, the more comprehensive, the better choices I can make.

Interviewee's Name	Question 14. What kind of information and data would you hope to find in a website about astronomy and space science?
Christopher Johnson	
Donna Cox (in person)	
Jackie Morie	
Patrick Lichty (in person)	What I like about many of the sites is I usually like obscure data, obscure things. I look for obscure things. I usually look for things that unusual. I like seeing things that I haven't thought of before. Lately there was an image that was put out on Space News of some of the new Hubble stuff, from an object they possibly considered as being 16 billion light years away. That is really inspiring. A lot of people say, "What does that do for me?" But it gives me a sense of perspective on my entire existence. On the other hand, this is really pedantic, but I really enjoyed the Mars sojourn project. I'm really enjoying watching some of the Martian probes. The way they're displayed...I like a lot of visuals. They are visual. What would be interesting, on the project where they had the sojourn to Mars they sent a microphone to Mars, I never heard any of that, I'd like to hear that. I love to challenge my senses. Either from a visualization standpoint or from actual data but in ways that are intuitive, that I can easily get to. Some of the NASA sites are fairly good at that. They have good hierarchies of image organization. But what we're talking about here is getting to the next level of that.
Annette Weintraub	I think I've looked at a few things, and there were a lot of photographs from satellites and images that had different levels of detail, you could zoom in on. I know that the information being collected is very rich and complex, but I think the problem is how it's being collected and categorized, and what the interface that the public sees, what the design is, how the design enables the viewer to access the information, rather than distancing it
Andurid Kerne	
Dorothy Timourian	I expect pictures of the phenomena of the new happenings and discoveries, besides written data. I think the space pictures really capture people's imaginations.
Peggy Frank	I think good visual imagery, pictures, good basic info and the ability to look into that info and cue in certain aspects and go down for more depth. Also, see the visual picture and let that picture lead you to other images. for ex, a nebulae, a way to go into part of it, see it in more detail. layers, going from general to more in depth would be the best approach, so it's not overwhelming with complexity.
Glen Sparer	I guess there would have to be a database where it's all hidden and individuals can access it by clicking on some visual representation of that which he was seeking. If a planet, there'd have to be a breakdown -- I see the

	planet, visually, from an artist's point of view. Next thing, what aspect of the planet are you looking at? Are you looking at the environment? Are you looking at the terrain? Or the life species? Are you looking at the history of the planet? There's a lot of things that can relate to the planet. Psychology of the planet. It would have to be that--I approach the planet, I'm turning towards it, and then, it has to be divided down into what aspect, what interpretive frame am I looking at that planet from. Something like that.
Paul Hertz	
Craig Hansen	That's the kind of a challenge we deal with at the museum. Typically the only way we know how to get around that or deal with that is to layer the information. To start with very simple things first, but let people who want to know more, let it be clear that there is more information to be found if you dig a little more. So we usually gear the interface and the initial impact for as general an audience as we can. Then make it pretty clear that the next steps there is more to be found. But you need to open up something, or pull something up before you see that.
Lisa Jevbratt	[What about a slider to control the complexity of the information?] For me the important thing is to come up with a system that would define…the problem is, how would you define when something is more or less complex? And the slider is fine, but it seems like the task is still.. one person decides? And you can't have one person sitting there and saying this is too complex and this is...
Geri Wittig	What I'm interested in is the high theoretical aspects about space and conceptual frameworks for thinking about the universe. What would be useful is for highly technical information and a vocabulary that's used in the profession, that there's something that explains the vocabularies, a sort of glossary. I would be interested in discussions, seeing discussions going on between the key people in the field that are talking about different theoretical frameworks. I guess I'm not necessarily interested an expert describing to me those types of very factual things because I can find those things in my almanac. I'm interested in the professionals that are having a discourse that I don't have access to and I don't understand, because I don't have the vocabulary or education. Stuff that's on the theoretical frontiers. The theory, and why the theories are and what backs up the theories. I'd be interested in seeing the field from a whole what the theories are and which theories contradict and who is regarded and what is the state of the field now. What is considered the most authoritative, what's not considered very valid at all, where the consensus is if there is one, i'm assuming there isn't one, but I'd be interested what the perspectives are and how much is given to each of them. I'd be interested in how they disagree with each other and how they address each other.
Nora Raggio	Whenever one classifies, there's always a danger in doing that, because how do you classify? Out of the US population? Out of the global population? Out of an extraterrestrial population? But there's always a danger in classifying the level of understanding. But I think that would be one classification, but also of course there are ways one could access subjects and this kind of topic. Again,

	if one goes into a subject that is fairly esoteric, and if it's written in language that is very specific to that scientific community, there is a jargon that is being used that is sometimes not accessible to the person that is a beginner or an intermediate. Frankly, that would be one classification system, but I can see immediately what the drawbacks of that would be. I don't think that age would be that good of a classification system, I think that it's the knowledge of a specific subject is not necessarily age dependent, unless we're talking three years or less. I think that fairly young people, as well as older people can be so fascinated with a particular subject that they could be expert in that area. So age is not something that would work. But when I look at other software packages that seem to be easy to use, there's a level where you can start as a beginner, but as you start, you automatically say, this is not enough for me. If there is some way to easily go from one level to another while you're in that topic, I think that's the main thing. I know that's very difficult to program, but I think that in a way you can self-evaluate, saying, this seems to me that this is something that I read before in a textbook and this is not of interest to me, I could read this anywhere, I could read this in the New York Times, maybe I need something that's more intense or more specific, then I can easily jump into the next level, and see how I feel in that environment. I think being able to change the environment fairly quickly within a subject would be something that I'd like. Because then if I'm being confused I can always go back...it would basically be more in terms of what that particular community sees as deeper levels of understanding.
Bonnie Shulkin	What I just described: sets of data, carefully prepared classroom ….
Ben Burresss	You can design one with that audience in mind, but I don't know if it'll be very useful. How to structure the website and present it? I think giving the wide audience some control is important, which level do you want to get? Everything?
Ryan Diduck	That's always a really tough thing. For the public, we have to write it a grade 6 level, that covers 75% of the audience, there's still 10% that's it's still too complicated, 10-15% that are really craving more. Those numbers are probably more, 10% that's not happy with the content level, based on responses we get after the show. You could tell that they understand the....they really didn't need to come here to learn about the topic, but came to be entertained, still found the show entertaining, looking more for university-level information. You'll never satisfy those people though.
Celeste Burrows	When I teach the teachers they may have a question or two that's more complicated, they don't seem to mind, they just want activities for the classes. Usually the teachers don't know much themselves. The same level I teach the students. On your website, you might want to have extra stuff. Two different levels, probably not. NASA has a lot of nice websites with pieces of them, you follow links and go to another one, you go deeper and deeper into the part you want...NASA's educational parts are very well done, they're very nice.
Wendy Coones	It works really really well. If you imagine being able to have every physical

(in person)	piece in an exhibition that had a hot button on it…a little thing that says, "read more", that you can go further into it…icons into it. For instance, on the moon rock, that you would be able to go up and look at it...hear what the moon sounds like, smell what the moon smells like, read more about the information they found out about the moon...maps, and a whole library behind each specific piece. In exhibitions, the only way you can do that is to add more components...do flip books, or have to have very long daunting text. Science centers are looking very carefully at putting computers on the floor. Because they're very single user. There also is issues of maintaining and keeping hackers of them, the upkeep issue. What we try to strive for in an exhibition in a museum...components are able to facilitate family interaction...fits into the curriculum that the teacher has been working with them on. Powerful learning experiences in a museum setting is to a certain extent a shared experience. Computer usage is usually not a shared experience, sometimes it is...they really have to be able to navigable by more than one person, or they encourage more than one person to work on them...scenario at home...like they're in their own rooms, they all have DSL, and they're all totally insulated. They're not talking about shared experiences or their perceptions. Really important to have any experience on a .....
Joan Gillerman	This is something I've thought about a lot. In how much data, in museum exhibits, what's your target audience, what level do you want it to be at…From a user's point of view I do want to have more information accessible even if not all at the same place at the same time...I can. I always want to go that next step....As a designer...advanced info for people wanting it...it loses k-12 kids all of a sudden, or somebody who doesn't understand it, isn't interested. Learning should be fun, so you should always keep that in mind. There are ways of making an interface friendly enough...just dealing with the information....specifics about history information...that's fascinating in a history context...eclipses a really rich history of eclipses. I've seen a lot of websites where they have a little camera for video or a "H" for history, I think it's clear, but I'm not sure I like it. I think you can have a holistic view. I think it's really challenging to think of how. It's one of the things when we start off to do an exhibit w e spend a good lot of time talking about stuff like this....some things that we were going to do to make the interface clearer...visually it destroyed it, made it more complex as an interface....Balancing act,...a lot of ways to do it that's interesting. We decided to, at a fairly early stage,...to break it up into sections...might be historical, might be cultural, might be science. We sort of held to that. That to me is one of the strengths and weakness of our installation, Shadowdance...if you just want science info you won't know how to get it necessarily...not to, visually it would destroy the look of it. The other choice we could have made, a little bit...all at the same time. There's a lot of different ways to break it up. It's been really interesting watching people use the exhibit in this sense. There are certainly things that would be different if we did it differently. We were told to target it to 6-60...interface itself is very accessible to kids...I just want to create another eclipse...I've observed school

	classes there, and they'll spend time in the science section to explain what...learned about tin their classroom the week before.
Donna Cox (phone)	[adjust complexity?] There are methods that's called , techniques that have been developed for revealing …progressive disclosure of complex information used commonly in visualization…approach to that on websites….even on interactive art or museum exhibits, level of complexity keep going down down, depending on...the web interface would always provide either a button or some kind of mechanism to bypass the choices that are being provided...diff routes of exploration. Nobody would be locked in, if one wanted more information, mechanisms are there to go deeper or get more information.
Shawn Lani	[layers of complexity of information?] It's pretty seldom that I build an exhibit I put a slider or a simple lever…I like it when the whole object has dynamic motion…the way you interact with it is complex, it's not just a control lever. It's almost like some of the stuff you've seen in sci-fi stuff ...or push things around more intuitively...the more fluid you are...like sculpting g with clay.. the material begins to influence what you do...it molds to you , and you feel much more part of what's going on...unique to the person that's using it. That's really goal of any interaction...real intuitive input. Even on the computer screen...I have little magnifying glass I hold up ...like it's a map...it's kind of a neat thing.
Noah Wittman	The presentation would need to be very simple and elegant to be successful and …wealth of data and sophistication on the back end to be useful in the long term.
Wendy Coones (written)	Search engine, cross reference index. True color. Features a new picture or cool thing every day. 3D maps of the universe, map legend, the astrophysics to know how things are working. Click on a Hubble picture and it will connect you to a recent article that explains why the image is pure.
James Morgan	pictures, movies, animations. illustrations of theories.
Patrick Lichty (written)	I would hope to find quantitative data from previous missions, current telemetry and interpretative visualizations from current missions, and…
Myron Krueger	My fear would be that if they have a solution for everybody it'll be a solution for nobody. It may be you can have the same site support multiple entry points, but not that you have what appears be the same site work for everybody.. It may be the same effort, but you learn to access through this site rather than that site...you're a kid you want to learn about space, you don't' want to know about their specific missions, or their politics. you want to come in at a certain level of detail, and you don't' want to go into the data. ...Yes, most of what NASA presents is data...but as a finished information product. That comes through, is delivered to, what you have in many sites, the "frequently asked questions". If NASA had a means of capturing what people want to know when people go to their sites...in a form that is visual, rather than raw data or even raw pictures. I would basically have an online museum. That basically you have the Air and Space Museums about objects and things, you can have a virtual Air and Space Museums, meant to be

	interesting to tell people, neat, visually neat, and it should not try to do more than what people's internet connections can give to them...downloadable...spherical model of earth or Jupiter or Jupiter with it's moon, you can run in real time in your computer, you don't expect the site to deliver the experience but if you have DSL line maybe you can.
Garret Moore	

Interviewee's Name	Question 15. What kind of tools do you expect to find on a site presenting information and data, such as imagery, on astronomy?
Christopher Johnson	Tutorials. Even educational classes where I could go in and learn about astronomy. I've been at Lowell Observatory and have really appreciated the information they have there. But to gather more and grasp that…
Donna Cox (in person)	
Jackie Morie	Here's something that just came to mind, I haven't thought of this before. So I'm on this website, and I'm loving so much about what's on this website, and I'm making bookmarks right and left, I think it'd be interesting to be able to have once you have visited a site, you know you put cookies everywhere, why can't you have a cookie-flavor thing? I've got my bookmarks within that site, when I go back to that site, it says, well you've visited these things, here's some stuff we think you might be interested in and here's your links to all the exciting things you kept seeing in this site that you've kept that you want us to keep track of. It's sort of personalizing the site for you. I imagine now in the primitive state of the Internet, Yahoo would make your own front page or whatever. Suggesting things, but not too firmly, because it's the chance things that take you to different journeys. I don't mind too much, even though it's a pain in the butt, when Amazon does that. But I'll tell you, Amazon is totally flustered by my choices. To me, analytical tools aren't as important. Analyzing is the opposite of knowing in some sense, for my definition of knowing. Creating this sort of bubble of information is more important for me than analyzing it. Artistic analyzing doesn't have to be like scientific analyzing. It takes those leaps and little wormhole trips--there's a logic to it, but it may not be linear. The n dimension. Personally I don't need those tools. The kinds of things I like that are like the brain technology, where you can set up this dynamic structure where you set up the links of your own data, and it's just like bubbles with lines and other bubbles with lines. That to me is the closest to the way I think. It's a very organic organizing.
Patrick Lichty (in person)	I think in the most abstracted sense a context builder of some sort. One could either use a series of key words, or even look up a given structure or body and then one can build up a context upon…I'm not even talking about just data, but one thing that would be very important to this site, over a long period, are things that are a lot more alliterative than hard connotative data. I think there's a qualitative perspective that accompanies astronomy, that's extremely important. Say, historical context that have affected things like the cultural significance of the return of Halley's comet. People are going through the site, and also dynamically creating associations. Am I being concrete enough? Creating paths. We could learn as researchers from what people are seeing as important. But I think it all needs to be included [historical, x-ray information]. And possibly we could have a slider at the bottom that could go from the hard sciences to the soft sciences to the humanities, so that people could then, say, twist the prism through the part of the spectrum that they want to see. I'm even looking at it from a disciplinary point of view. The one thing that I also think is important, there has to be a tiny bit of noise in it. Because what happens then is, if we're only allowed to go where we need to go, then we'll only go where we need to go. I'm not talking about this as primarily a research tool. Because if you're doing

	specific research, you need to find certain amounts of information...but then it might be good to use that branch of mathematics, like how Amazon says you might be interested in such and such, you know, experience tracking. But also giving you ideas you might be interested in. I think it's important to be able to allow people to go along a certain route, but I also think it's important to keep things broader than that because then people create deeper and deeper ruts and they will narrow their possibilities, and I think possibilities need to be constantly presented to people, because they may be ones they never thought of. Not that they didn't want it, but just that they never thought of.
Annette Weintraub	If someone asked me to design this site, with this idea of providing information for various different kinds of things at different levels, I think I would try to design the site from an information perspective so you get different levels of detail of information depending on what your understanding is, but it's all present all the time, so there's maybe a more superficial level of information for people that don't have a scientific background, then you could dive into water, go deeper on deeper depending on your interest and background. But keeping it somehow transparent and very fluid so it's all present all the time, and you have a choice to go. It might also be interested to see the same piece of information, a satellite photograph or graph or data, from that perspective. So what you see as an intelligent observer and what you see as a scientist. Because I don't think people understand science or scientists. People in the age we live in now are so superstitious, and they're people who don't even understand the difference between astronomy and astrology. It'd be good to sort of demystify science, make it more apparent what the benefits are, many people are afraid of information and science.
Andurid Kerne	One thing that comes to mind spontaneously about that is you could create a space--if there's a lot of information and data-- that allows people to create their own configuration and own annotations. You could let them share those with each other. You could let them share those on diff levels, you could let them make these spaces and navigation spaces through your stuff and let them exchange those, and create a way to organize those as well, a kind of index system, knowledge classification system. You could let people engage in that authoring process together that would be on an even more participatory level.
Dorothy Timourian	We went to a NASA Challenger simulation place in Sacramento where we actually were in, like the NASA place in Texas, where you control things from outer space and you get information from outer space and you document it, you talk with people from the Challenger, there were three different screens and they showed you what the Challenger was seeing and some of the different experiments going on. And then we went into simulation like being in the Challenger and do experiments. It would be neat to have something like that on the web, so that...This place I went to was mostly for children, 4-6 grades, maybe junior high to high school. So you learn about NASA and you learn by doing it. If you had a simulation like that on a website, adults could do it, something where the general public could participate in that rather than just school classes. I think we did it for 2-3 hours.
Peggy Frank	Just the best photography that they have, and make it available for people to look at. Rather than the data or anything else. From the Hubble spacecraft, from our shuttles and things, things that we could not see from here. That makes some of those distant specks into the fabulous things that they are. I have some old photos 10-15 years ago, I think they're actually from the Jet Propulsion Laboratory, given to me by a parent of a student who used to run a little telescope shop here in Livermore. They

	were pictures taken of Saturn and some nebulae. Close-ups of the planet and it's rings, really stark and clear. Despite some of the books and things I have for the children, these are my favorite. is that really Saturn? it looks so crisp and real. some of the great classic pictures taken from surface of the moon at the earth. that still boggles the mind. stunning photography, have it avail be.
Glen Sparer	Some stuff I've seen, NASA and other science sites, for me it's very important to easily access the information but also have the creative interface. So I'm actually, 3D interface, actually experiencing the information in an interactive way. So the actual form of the interface would be like traveling through space, for instance, where I'm actually journeying through the site, I have a journey through a system. Since a system of information could actually match a system that's in space. Like you're journeying towards something, something comes into view, it becomes large, and then out of that, there can be various data that explains what I see. I'm very visually oriented, and spatial.
Paul Hertz	What really interests me is the appearance of the earth itself, the fabric it's made out of. It has all kinds of patterns and unexpected incidents. I'm first interested in the kinds of patterns that show up. So what does a river delta look like? Too big to have as concept for it. But from a satellite you could definitely see it. An entire globe of the earth, and find the Amazon, and slowly descend on the Amazon and see it in a number of different scales. For some of the planets we have enough mapping we could provide a 3D scalable images. I think it's possible [sliding scale for info]. Probably, first, you have questions of how things are represented, the direct sensual experience of them. So you can tailor that if the person who is viewing it informs you what they want, the level of information they want as well. Ideally, the user makes decisions about what level of information they want. Web interfaces, have a menu system of some sort, which sends queries to a hierarchical database, or relational database, designed by the experts, to give varying levels of responses. You want people to be able to use at least hearing and sight for the things they're seeing. Also being able to navigate through it. Bring the explanation up, have levels of complexity they can gradually dig down. It depends how much you're trying to explain at once. Rather large areas and large gaps in our knowledge. You tend to look at more cohesive elements. You can talk about macro scale and galaxies or clusters of galaxies, that's one kind of experience. The problem of moving from one level to the next becomes difficult because we don't always have the info to fill in what we don't know.
Craig Hansen	I know I keep focusing on images…I guess I would be curious to see something that's organized around where things are located in space relevant to me, in a way allowing me to tour from where I am to these various places. So if I want to initially just look around at what my own planet looks like from orbit, I can start with that. Then extend my vision and step right out into the solar system and beyond. Even if at some level there was something that was graphically or three-dimensionally showed my location in relation to other familiar things so I have a sense of where I am. Even if the final thing I end up calling up is a still image, a photo, from Hubble, if I can get a sense of what direction is a particular body or galaxy from the Earth. In a way, some way to help me three-dimensionally place these objects in the universe around me, as opposed to being photographs of things that are very far away. I think there's a couple of websites that begin to do that. There's one that gives you views of the Earth from basically any...you can see in real-time where the terminator line is on the earth. You can pick a city and see yourself in relation to the passage of that

	line. You can get an orientation that's straight down on the Earth and the moon and you can see where the moon in relation to the earth and where the light is hitting it. A really wonderful thing to see, a straight down view of the Earth and moon, then look up in the sky and see. To be able to both be in your chair at your office looking at your computer and also to step back rather quickly and look at the arrangement of bodies in the near universe, in our solar system, or beyond it. This is almost like a weather report. Not many things change that fast, but some things do. And to me it's a wonderful thing to be able to three-dimensionally visualize where those things are. There are a number of sites that have developed some spectacular zooms which show the earth from a distance, focused say on San Francisco Bay, and you run the movie and it ends up focusing in on Fisherman's Wharf in San Francisco or some other spot. I find that kind of thrilling, to see the continuum of here's something that's on one end of the spectrum of images that I'm used to, and if I zoom out, it goes out to showing me the whole planet. I can then kind of connect that to things that other sites show me about how the earth is related to the rest of the planets.
Lisa Jevbratt	Let's say you have a system where people can come in on different levels. It's going to be confusing for a real simple user, like a child, to come in and…maybe there are ways within this to set it up so certain things are filtered through to that level. But again it seems that it has be an automatic...I can see a system where you have all these different things happening, and you label certain tools and some kind of metadata so it ends up showing up in a certain interface, but you can still have different interfaces, but the whole general system has to be set up so it's very dynamic and can move from different categories. In the end, there might be a way of sorting out the different...You have all these different ways of dealing with things, different tools, and then you decide that things that are more accessible for children and these things here show up on this interface here, and these things there show up in this interface there. But it's not a fixed either/or, this is still the whole system. Not pre-programmed packages, but sedimentational almost, everything you have in this system has a weight to it, so if something floats to the top, it's something that maybe children see, but not pre-label those, because someone working on a lower level might develop tools that should also be shown to the children. Not one content editor, but it's something that happens automatically within the system. That this is a tool that has been developed, a raw tool that has been continually developed, and now it's so refined it's very easy to use, and it floats up and up and one day, boom, it's available for children. You don't really know what you can do with this data, you have to let it express itself through the tools and you have to let people be able to develop things, and from that you might get tools that are simple to use. It's like saying, "Oh we shouldn't let people out in nature, because they don't understand photosynthesis and all the biological things that are going on to make these trees." You can still go out to nature and enjoy the wind, feeling the smell of the trees and so on. It's kind of the same thing. No one says, "Don't let children out in nature because they'll never understand the whole complexity behind how trees are created and so on."
Geri Wittig	What I would be most interested in is a synopsis of the most recent theoretical positions on space theory and the universe. Some things that was easy to access in terms of it's all collected somewhere, and you can easily have an overview of the latest and greatest. I don't think you can have one for all. I think that a kid's informational tool is hugely different from a 40 year old informational tool. I would think it would be impossible to reach all those audiences with just one. I guess I

	don't think that you're not just creating a site that would have all those things, that you would create multiple sites. When I think about it, I think about the 2 things that are the most difficult in terms of level of development that if you try to reach all those people at the same time it will be completely superficial I would think. If you want anything of value to any of those groups, you have to go so much deeper for each of them and have such a difference language, and such a different understanding. I would think at the very least people can decipher where they think they can fit in, but you have to have languages, children versus adult, laymen versus professional. Those are different categories that you should spec out so if somebody isn't sure if they're laymen or professional that's when they go in and explore. I think you have to at least define those categories and recognize them.
Nora Raggio	
Bonnie Shulkin	For me, the fact that it would be a website would only contribute to how easy it was to find and get the information. In terms of using the internet in classrooms, it's not always realistic, you don't have computers of fast, reliable internet access. ready activities where you can use the data and activities, more of an access point than where the activity takes place. [Kids would love?] Image processing type tools, realistic type tools. I don't think it's realistic anyways for schools to think of computers and internets....practical to use in classrooms.
Ben Burresss	[Scale of magnitude on the web?] There's the website that does the powers of ten explanation, notches. That's one. It's less effective, obviously. That's just delivering the information over the internet. [What kind of tool are you talking about?] Particulars? For instance, there's a another virtual observatory out there, it had levels. you picked the spot in the sky or an object, and you picked one of many overlays and basics, beginners' level, intermediate and advanced, levels of capabilities. They would pick capabilities that they figure that the advanced would want, but not give it to people that would be confused by it. [Dream website?] An example is the solar alcove we have upstairs. Navigation bar, a sliding scale or buttons you can choose? The effect would be to add or subtract layers of information. Similar to the way we lay them out on the panels upstairs...a basic skeleton of the, reading the large font size. Then more information in the smaller, more dense looking paragraphs, if people want to go and delve into it. Cohesive story just from the top level. i can see how you might do that on a website, a selector, hide or show diff levels of information.
Ryan Diduck	
Celeste Burrows	I think what I saw in where all you have to do is enter the name of the asteroid, there were a few in the newspaper, but they had the names, you just put that in. It was very real live stuff, simulations, I never seen that kind of stuff before. If I could get a simulation of where in the solar system i wanted to be, and when in time I wanted to be there, maybe going around a planet, putting myself around one of Jupiter's moons, looking at different places. We have an exhibit, planet Track, it zooms you in, you can't control it, you just tell it where to go. I'm looking for educational things to grab the attention of students, something easy for the teachers to get to. [What about cultural, historical information?] That should be in a little corner of the site. The schools like that because they try to integrate that in their curriculum. That would probably be helpful for teachers...there seems to be a fair amount of that out there...I've been recently researching the history of astronomy. Currently I'm searching the history of calendars, there's not too much organized about that.
Wendy Coones	It's almost like being able to have your cursor, to be able to have a search function

(in person)	in that, search under images, sound, words…a lot of times if you go into a search engine for a particular site, the word you need to search under, specific…you're not at the page you found it at. pop-up window, this particular...search for everything else having to do with this. So that it's sort of like overlaying a bunch of spider webs so you're able to find one thing in particular you're intrigued by and then find other connections...somebody that's going to build that spider web, understand the information well enough to say, this particular image is related to yadda yadda yadda.
Joan Gillerman	For me, it would not be on a screen…all day, that's one of the biggest limitations of the multimedia world is dealing with one screen. …Something more holigraphically real…talk about those wall size screens that would do something…it's never happened. I would be immersed in a 3D space environment where I really could fly around these planets or in space to get the different perspectives. I would be able to go to it. I hadn't thought about the scale. I think that's what would be not practical, accurate, and not okay with me to not have a scale...on the other hand, I guess I do want to know ....out through the rings....I always see the same picture of Saturn all the time, from inside the rings. In an interactive website, i don't have any problem with touching something and getting something...it's something more visceral, more intuitive rather than more didactic. From the data point of view, and I'm researching, ...I have no problem about clicking down on areas and getting info...if you can get there in a beautiful way that's all the better.
Donna Cox (phone)	There needs to be an extension of what a new approach to the web browser approach to access the data…trying to get to the data and control the instruments is through a browser kind of schema…take it further in terms of online collaboration and online libraries and textual backup in terms of explanations. It's almost like we need a portal ...simultaneously, notebooks and keep track of our NVO notebooks...repositories are much more friendly that trying to type in stuff in a chat line...or newsgroups...as people interact over the data. When people look at the data...one area of the universe, but looking at it in..dyfferent wavelengths...Those collaborative groups may or may not be in the same location...different locations, different locations. ...definitely grid-based...don't' need to know all the details...friendly interface that I might be able to use in a classroom or with my other colleagues, or bring into a gallery setting...the laboratory should be a distributed laboratory...something that we draw from , something we contribute to.
Shawn Lani	I'm thinking in terms of what I've seen…Hubble and Deep Space the more I think how unbelievable these things are…like jewels with details…scale beyond imagination…and very very complex, and very unexpected. So when I think about the universe what I'd love to see is emerging patterns, the spiral nebula actually spiraling...to see the development of those clouds...we can't see it in terms of scaled time. In he world I live in my exhibits...there's some sense of control, but also some sense of process...if I had some special tool for the universe I'd love to have a time dial...how planets formed out...where did the moon come from... I love those animations of a forming planets or a sun exploding...it's like front-row seats for something you could have never seen.
Noah Wittman	What I think is the most powerful thing is access to the data. That's where I think this is a really great project, try to build a database where people can easily…layer some sort of skin that would allow you to view things in diff ways…Open it up to the community to design that navigation… you could navigate along certain themes....leave it to natural selection, leave it to the online community to pick...

Wendy Coones (written)	
James Morgan	verbal descriptive tags to make it searchable
Patrick Lichty (written)	I would expect rigorous menuing and a solid search engine. However, I hope that eventually other tools for finding information I might not normally think of might be incorporated into the site.
Myron Krueger	IT had a concept they used when they talked about the newspaper…superficial entry information. You say "more" and you get told "more"…it eliminates a lot in terms of navigation…problems with adjusting complexity, at each level of complexity the composition is different...detail, it starts to become, it needs to be written by a different person, designed by a different level of skill...i tend to believe in incremental implementation. simple but entertaining things first, from that try to determine when you can get levels of detail....we had lots of ideas for small planet but we never had enough time to implement it...showed it at SIGRAPPH, ..but we thought of small planet as having lots of possible applications. One ...fly down close to the surface, you would get down and fly into New York and be flying around a virtual model of NYC, that's pretty obvious, you could do it with Rio, lots of places, or even just have images in those areas rather than models...Afghanistan. There's lots of earth data...I know they're working on something ...there are a million applications for something like that, clearly that's NASA data and that should be available to people. That's a project that's just starting. That's the key thing. I would approach it from a knowledge point of view, rather than a mission-product point of view…A very simple thing…everybody, there ought to be, and I thought of doing it myself actually, and that is a star finder form that can be tailored to any location on earth…I can printout something and go outside and know where to find the stars and the planets. That's a very simple thing. I think there maybe be programs that do it, but that's something NASA should do. What NASA wants to do... In the late 60's I heard a presentation by NASA... and it was all the political justification of why we're going to the moon, and by the end of the talk I didn't want to go to the moon anymore. When I was at the SSC at the University of Wisconsin...4 year project...weather satellites. So all the data came to us first. We were funded by the environmental satellite service...to come up with weather graphic techniques, which they could then give to the public, which they can then justify their budgets...There's a marketing side of NASA which is that NASA wants to have the public predisposed to fund NASA...There are very few things that people know they want to know about space. They certainly could find.. The one thing they want to know is the stars in the sky...occasionally would be magnetic storms and northern lights. I've never seen people predict when you get that....That's another thing that I think if people knew that the northern lights would be on display in certain places they might even travel there...See, people come from California to New England to see the leaves change. You could have scientific tourism...northern lights are the one thing...
Garret Moore	Probably have to incorporate some form of AI, will not exist any time soon. Something that emulates the kind of searching we do in our own head. Search by color, form and shape, I'd like that. "more like this", "more like". A visual intelligence search engine, put in subject, resolution, where you would have a little pad, and use your mouse or tablet, to draw a basic shape that would define your search. If you wanted something fairly central focal, you could draw several circles. or triangles, or cut and paste into this window. You can search for anything resembling color, form

	shape, even recognizing language, if there's some text in the image. If you're searching for the shuttle, and cut and paste the image you do have, you want to search lots of images of the shuttle, it would recognize the text on the site, US on the side, flag, shape and color, you can search visually like that by building parameters.

Interviewee's Name	Question 16. Should there be specific tools for artists to explore the Universe? What kind of tools?
Christopher Johnson	The website would be the tool in itself. I can't think of anything right now. It's hard to grasp what all the data would be, the information can be very daunting. I guess one immediate tool I can think of is a way to take the images and incorporate them into my paintings and drawings in pieces. [Do you feel attracted to new imagery, say when the Hubble Telescope comes out with new images?] Yes. I announce them to classes and show them to specific classes because it ties together the science and the art we're doing and the visualization and how people view images. I definitely feel it's important to have that because it really pushes other areas also. It makes it accessible. But throughout art history we have forms in the sky, of Scorpio, or the Big Dipper--when I look at that, I don't see anything else but the Big Dipper-- or Orion's belt. So to be able to look up and see those shapes in there would be a very useful tool, to learn the history behind those shapes is very important.
Donna Cox (in person)	
Jackie Morie	I don't know, what came to my mind was, "Give me stars to paint with". You'd need a big palette for that.
Patrick Lichty (in person)	This is a big disadvantage because this is an area I'm not overly familiar with. From a traditionalist standpoint, there would be people who are interested in historical and mythological aspects of astronomy and how it relates to contemporary trends in astronomical research. There are people who are very interested in generative work and chaos mapping and graphics. One thing that's fascinating to me is solar prominences. They are beautiful things, sunspots. So people who are interested in the beauty of things like that might be interested in doing research around those, even interactive work around that. Here is something that would be very interesting: near-Earth data and geographical data, geometric data. There are many people who are interested in doing work in geoscience. We're looking outward but I've been completely ignoring near-Earth. That's also a big component. I think that there could be alot of collaboration with people working on things like that. Social activism, deforestation, population expansion, atmospheric data...I would be interested in the formation of solids in microgravity. Doing sculpture with viscous solids, using resins in microgravity and see how it goes. I'd love to visit the ISS.
Annette Weintraub	First of all, artists do research, they steal images and ideas, they go out into the environment looking for things to bring back into their art, and there's so much imagery in literature and language and film that relates to astronomy and the universe. It's not an obscure reference, it's something we live with all the time, in our history, navigating before they had instruments by the stars. There are all sorts of ways it connects to their lives, and artists draw upon this rich history of information. Even if they don't understand this data, they're borrowing the images or using very simplistic understandings of basic scientific information.
Andurid Kerne	
Dorothy Timourian	I think a trip through the Milky Way on a spaceship in a website, stop at certain stars through it.

Peggy Frank	
Glen Sparer	It's hard because I'm not an interface designer. I'd like it to be active, so there'd be motion. So now they're using Flash and stuff like that. But mainly I'd like things where if I click on it, it's not just point and click. Maybe it swells or does something that is like the information, so then I get involved in it. And as I get involved in it, it changes. So I don't know how that's done, or how that would be done.
Paul Hertz	One thing that would appeal to me, some astronomical data, you know there is higher resolution images out there but not being able to access them. The capability to zoom in and out for detail. A wide variety of images, zoom in a section of the sky, I have to be confronted by decisions....An ideal tool will allow me to do a great deal of zooming in and out...choose from a wide range of sources, because there isn't one image of the sky we rely on. Rapidly move up and down scale and move around. That's something I wanted to do with satellite images of the earth.
Craig Hansen	Some of the things I already talked about are from my artistic passion, which is in a way, a continuation of my and probably other's childhood dreams to travel far and fly to different sites. I used to the word "continuum" a while ago, but to be able to have a navigational approach that feels less like flipping from a page to a page, and more like moving through space and flying from one spot to another. For a real-time it will give me a basic knowledge of where things are. I tend to be more interested in the local solar system, I guess it's because it's easier for me to grasp. I think also if I extend that out to farther reaches of the universe, with Hubble images, of course I want to know what it is I'm looking at, the processes of stellar evolution.
Lisa Jevbratt	
Geri Wittig	
Nora Raggio	I think as I mentioned to you first of all, that the information would be segmented or classified in terms of levels of complexity. So that if I'm a beginner I go to one page, then I can link to an intermediate page with more information on that, and then more towards an expert stage. More kind of like ski slopes that have different levels of difficulty. So classifying the information that way would be great because then I can easily go, if I'm already at the expert level, that's where I go. That's number one: categorization in terms of not only difficulty, but comprehensiveness. Then in terms of working with the raw data, for example in genomic data, what's available to people who work for Selera, or who pay Selera, is software that interprets the data in many ways. So as an artist, I'm interested in knowing how scientists are interpreting that data. And the rationale also behind the software to interpret that data. So not only that I get "use this software and this is what you get", but what is the rationale, what is that particular software doing with the data, how is it crunching the data. What kind of parameters are being used. That would be really important as well. Not just the software to interpret the data but also the rationale behind the software. For two reasons: First of all I want to know how robust thinking behind the software is, for just a conceptual reason. Then, number two, if possible, I would love to understand how it's being done, and as an artist, one always likes to change some of the parameters that are being used and see how that affects the interpretation of the data. That's part of what artists like to do, is push the limits of the rationale behind the software. But I think that should be something one can take away from the site, and if it's interesting, to be able to "hey, look what I've got", to post those different iterations on a particular perspective on a particular software package.
Bonnie Shulkin	

Ben Burresss	
Ryan Diduck	
Celeste Burrows	
Wendy Coones (in person)	One thing that I am a little bit concerned with is the issue of bias, the issue of being able to make very clear distinctions between what is data and what has been manipulated data. Not that manipulated data is worse in some way, …it's all manipulated...maybe even being able to document that change for the scientists that are working on some of the Hubble images, ...some of the colors they have, helps people to be able to understand it. You can also backtrack, it's almost an image-making history...come up with the exact same or similar image. Artists are going to come up with whatever tools they need, that's just the nature of art. Being able to really show the history of where the sampling has come from, and what the original stuff is, is important, because it allows you to better understand. Part of the purpose of doing educational exhibitions is to inspire people. What's really inspiring is very beautiful compelling imagery, but what makes something beautiful and compelling can be the conceptual part of where that image is. What is the conceptual framework that the woman use that makes sunspot and sunflowers work together. Another thing I have a great concern for is misinformation...that's a beautiful mistake that they probably have wonderful memories of in their adulthood, but I don't want adults to misconstrue...more and more information, that it's really important that scientists and artists have some way of documenting the changes they do.
Joan Gillerman	
Donna Cox (phone)	
Shawn Lani	
Noah Wittman	I think the very fact of putting it out there, and making it easy to find. Once people know there is a resource…That's what invariable happen with the Hubble images, they find their way into popular culture, and artists pick up on it….this portal idea probably has a lot of potential for artists to come in and frame the content.
Wendy Coones (written)	Flight simulator around the universe. A voyeur system, like NASA select where you can watch the earth rotate or download the current data and astrophysicist is working on. Make your own solar system like Sim City. [How would those tools be implemented on the web?] Make it share ware.
James Morgan	The artists brain is the only requirement, beyond that anything is a tool for exploring the universe.
Patrick Lichty (written)	I'm unsure in regards to this.
Myron Krueger	I think they should enlist and support artists to try to use the data. A lot of artwork has been particularly about new ways to interact with images, new display techniques, new juxtapositions of information with experience. I think that they should admit that they don't know everything they want to do with this, and they should enlist artists that have different ideas than they do...NASA website, and you're definitely sure that they do not have the answer. Some artists have a record, and the community, or doing surprising things. And some of those surprising things have turned out to be practical and better than the established practice. ..the Cave is another, ...The boundaries are already drawn, and who gets the high ground...the art world wants to stay on the fringes.. The museum world and the art commerce world have this idea that art can only be about art history...raw material for art history to be written, and not stuff that actually connects to the people as the work is

	being down. Museums believe they don't have to have any connection to current contemporary work. artists should assert themselves into a role in society. art gets pushed back, endowment for the arts get its funding cut because it offended some conservative people, art is supposed to offend people, they always offended Republicans...guess what in a democracy....
Garret Moore	

Interviewee's Name	Question 17. What kind of on-line tools would facilitate use of astronomical or space science data in your creative work?
Christopher Johnson	
Donna Cox (in person)	
Jackie Morie	
Patrick Lichty (in person)	I think for readily available tools like VRML, something as easy as that…you could use a microgravity paradigm and allow people to do crystalline sculpture. Now, if you wanted to go really far with that, possibly allow people to download a mesh that would be generated from that VRML, and go do rapid prototyping from their own microgravity experiment. That'd be so fun! Or, possibly do graphics from extrapolations from geometric near-Earth data, or from crustaceans or global warming, a lot of GSI simulations that really creates beautiful things. If you want to extrapolate out, graphical tools to put yourself relative in some part of the night sky, look at the different spectral analysis of the sky if you can do that. You could create some incredibly beautiful imagery. That could also create different perspectives on astronomical data that scientists might not be looking at. Sound, sure. I'm not so sure about smell. About mapping smell to digital media. There was a company called Trisanx that was going to put out a smell monitor but they folded. Now we get into the physics, the physical reality...We know Venus stinks, from the high sulfur content. Some people would be interested in that, but that's a little too abstracted for me. [What kind of tool for sound can we provide on this website?] The Italian astronomer Ferraro Terrenzi has done all sorts of mappings of radio astronomy into sound mapping, that's exciting. That goes back to the Pythagorean music of the sphere which I think is extremely exciting. You could experiment with different mappings of astronomical data into sonic translation--like we were talking about earlier with graphic translation of data. I've always had a wonderful idea for audio mapping of network activity-- to go in and hear different frequencies and different tonalities. How would you structure that? There should be some tools in which people could re-map different frequencies over time, and be able to be mapped into different audio spectra...That's kind of a fanciful thing, but I think it would be a good qualitative tool for the experience of quantitative data. Some of these tools could be interesting--we've seen this in Contact [the movie]--we as organisms are very good at ascertaining pattern. It'd be interesting to listen to data and see what patterns we can come up with. Right now we have some human control interface problems to go through. Myself I'm working very much with feel, with force feedback devices. If someone was willing to have an iFeel mouse they could feel the Martian terrain, feel the pulsing of a pulsar. That might be something that would create a much more

	tangible experience without being pedantic. I don't think we have to be pedantic about these things. People should be allowed...we could do this parametrically. We could go from something that's rather broad, and allow people to focus in to things that are very specific. You can get the gist, but if people want more, you can allow them to do that through the use of parametrically based experiences. One could possibly hear what a windstorm on Mars sound like from the information that we have. That in itself would be an interesting research project. It would be a Martian atmospheric simulation mapping onto sounds, using some of those tools that would be available to the public in a much more accessible way.
Annette Weintraub	
Andurid Kerne	
Dorothy Timourian	
Peggy Frank	
Glen Sparer	
Paul Hertz	
Craig Hansen	
Lisa Jevbratt	
Geri Wittig	
Nora Raggio	
Bonnie Shulkin	
Ben Burresss	
Ryan Diduck	It would be a web page that again was completely 3D virtual reality and would use some type of 3D viewing whether the flipping LCD headset that transmits the signal 60 hertz, 30 hertz, kind of like the new space station. Something like that that allowed you to go anywhere, start on planet earth, view from orbit, zoom in, fly over the surfaces of the planets. We've totally mapped Mars and Venus, those flyovers are possible. then fly to gas clouds, into nebulae, or orbit the new extra-solar solar systems we discovered. Always have the option to click somewhere and have the original data, the original 2D picture taken by the Hubble telescope, you can see what the VR world is based on and compare it. Maybe to some extent a planetarium can do this, I'm not a big fan of buttons, i think it's distracting in the show, people will get disappointed when their choice isn't selected, you have an audience of 200, 150 want to go here, 50 want to go somewhere else. If we avoid the button, and have the live presenter, the more personal talking to the audience, getting the feel for what they want, interactive conversation, we can get the same results without disappointing people. [Intelligent agent?] Right. I think that would be ideal.
Celeste Burrows	
Wendy Coones (in person)	
Joan Gillerman	
Donna Cox	

(phone)	
Shawn Lani	
Noah Wittman	
Wendy Coones (written)	
James Morgan	The data itself would have to be available, the instructions on how to use the data, and perhaps live access to databases.
Patrick Lichty (written)	Probably forms of visualization software that would allow me to ascertain patterns and correlations between various sets of data.
Myron Krueger	
Garret Moore	

Interviewee's Name	Question 18. What kind of interactions/collaborative work could be fostered/provided by a site on astronomy and space science?
Christopher Johnson	Oh yeah, definitely. All kinds of collaboration. One project that we've been working with…Anthropology does this Mars project, where they get a group of students and travel to Mars in a simulation. They learn more about how they interact with each other culturally than they do about going to Mars. They learn about how to build structures, what are important, and why and who does the work and why that's important. All those social aspects. Then they're able to go back and look at past cultures and present cultures and ethnographies and really look at what population have things and what populations don't. Definitely tools where you could collaborate. But meeting spaces, where I could access, say, a lecture by Nicolas Negroponte, wherever it is, and breakout sessions would lead to other connections and talking to other scientists...that's one thing I've noticed at this conference is that a lot of people don't communicate with each other. So any way that we can facilitate the communication between computer science and art, the better, it really helps develop projects on both sides.
Donna Cox (in person)	
Jackie Morie	[Do you see yourself collaborating with other artists, online, about this website on the universe?] That would be a wonderful thing for a website to have. I love collaborating with other people. [How can we collaborate? What tools, activities would you like to see?] Okay, I'll get practical for a minute. It would be very cool--I'm doing my PhD online right now and one of the things we have is this iVisit, which is this way to chat with video, audio, no draw window. I'd like a draw window, a shared whiteboard that I know is out there, why aren't we using it? I love seeing the other people, I love hearing the other people, but I can't share with them like we can share a napkin on a table right now. I want the Internet napkin on the table. And then I want to be able to save that image--you can make such beautiful artwork from this low-res capture system. I would like a shared drawing image space. I'd like to be able to pull thumbnail file into that space and just have it there and let somebody work on it and tell me stuff about it and point at things, and they could pull another thumbnail on, and we can play with sliders and show how they're combining. I want Photoshop interactive on the web. Something like that.
Patrick Lichty (in person)	[Do you see collaboration as a possible thing? Viewing the website with someone else, navigating with someone else…] Yes. One thing I was talking about from a generalization perspective is gathering information from interaction from the site. That is a non one-to-one, it's a generalized form of collaboration in itself. It might be interesting to create collaborative communities of people who might want to explore together, who have an

	interest. I don't' know exactly how you might do that. For example, there might be people who are interested in the Centauri system, and other people who are interested in near Solar astronomical structures. [They would be grouping around the topic?] Yeah. In the most simple sense they might be threaded forms. It would be interesting for people to get that data and possibly have a space that would be around them, almost like a Minasa sort of thing. I realize NASA has its constraints. But a Minasa type portal and having Minasa groups...this is almost a Yahoo-ish sort of thing. The Yahoo groups now are very very large groups.
Annette Weintraub	I think artists love the idea of collaborating with scientists but I think scientists don't really love the idea of collaborating with artists. There was a group called Art and Science Collaboration, and there were many artists registered who wanted to collaborate, but no scientists. They are very focused on their work as are artists, but scientists don't need artists for their work, and artists need their work. It seems like it's a very rich opportunity to collaborate, especially with the web, it allows you to bring together a lot of information from disparate sources and make connections between things.
Andurid Kerne	There's a lot of things you can do with that. Collaboration can come on diff levels. It can come on a very basic level where people have experiences together. But then you can have avenues for collaboration for people who have more of a definite sense of projects that they want to conduct, you can support both of those kinds of activities. I think it's about a certain kind of granularity of open creative experience that people can share.
Dorothy Timourian	They had a whole program, pre-programmed to people that ran the program, and I think they were trained by NASA to do this, NASA built the facility. It's in Sacramento. We all work together. There were different people monitoring the different experiments, there were maybe 3-5 different experiments going on, some people were doing that, some people were in communication, some in safety, some people were monitoring the fuel that the Challenger was using, and the time element. There were different things people were monitoring in the command center. People on the Challenger were doing different things, some were doing more human kinds of experiments, with blood pressure and heart rate, somebody else was analyzing rocks. [So it was a pleasant experience from the point of view of a team? It was a team collaboration, right? So this was a by-product of the whole thing, not only learning but also sharing and working together to achieve a goal.]
Peggy Frank	certainly, not myself directly for my own art, definitely with students, taking pictures, perhaps as a group, doing a part of a larger whole, murals or tiles or large sculptures, large collaborations based on this one theme. We've done projects where each young artist does something part of a larger whole. I can see students collaborating with NASA, space sciences, series of artworks, posters, murals, anything based on the theme. stunning results.
Glen Sparer	Oh, that would be great. Different points of view on the same information. Someone could pick on one computer, some kind of drop down frame, and they choose that and it changes the information. Now, both viewers are

	looking and talking about the same object, but one picks that frame, and the other one picks a different frame. You've got two frames interpreting the same information, it would change the information, and possibly the way it looks. That'd be interesting. Like different cameras set-up on the same information, where each camera represents a different frame, or point of view, or context.
Paul Hertz	Depends on me or doing it for students of a certain age. As an art form, mainly to experience, or didactic tool, mainly to teach. That's very different ways to organize the material or orient the user to the material. I don't think it's possible to make one thing to please everyone. To a certain degree you can achieve it. But the problem from the programming end, the more you have a generalized, the more complex you get on the programming side. Less likely to deliver a functional product. You're better off serving 80% of the people giving 80% of what they want.
Craig Hansen	I'm in a position where those two, if I work it right, can be the same thing. I would be able to make what is personal interest to be useful and inspiring for other people as a professional project, depending on what are the things we're working on. I envision that this would initially be something that would be personal exploration, the information would be something that I would use to develop an idea. My tendency is that when I'm excited about something I want to share it. That site might be a useful way of exploring, or developing an idea into something that can be shared with other people.
Lisa Jevbratt	
Geri Wittig	
Nora Raggio	My sense is that our exploration of space in the wider sense, in the cosmic sense if you're talking about astronomy, from macrospace to the very microspace, I think all of that work is being done elaborately by a network of scientists and artists and people who are interested in space or many other reasons. So I think it would be just fantastic to be able to collaboratively navigate that. It's not clear to me what a collaborative navigation would look like, because I don't think I've ever really experienced that. I haven't played a lot of online games, for example, which are supposedly co-navigated, or co-played. But I think it would be great form an educational perspective to be able to go on a trip with a crew and people have different ideas of where they want to go and what they want to explore. I think multiple navigation would be great, but I also think it would take a tremendous amount of skill to do that effectively. I definitely see this exploration of space as a collaborative work. In fact our relationship to space is in a way collaborative.
Bonnie Shulkin	[Collaboration as an interesting tool, technique?] I don't know how the logistics of that would work. An astronomer online at all times to manage all the schools all the time? Totally bombarded or just sitting around taking time. Interesting, I suppose so. It's really hard for me to remove myself from the practical...[long suggestion...] Yes. Definitely, different levels of complexity for the information. Not all levels are appropriate for all ages. Someone should define, or the kids should try to understand? Suggesting kids would go

	through all the activities and see what's most appropriate to them? Ultimately it's up to the user, but some guidelines would be helpful. [Would kids go to their entry levels?] Some kids would and some kids wouldn't. Some kids would take whatever information they can find, others would get whatever and leave....
Ben Burresss	I think so. An example, our Challenger learning center is doing e-missions,….our thing, and remote kids out in the classroom, basic internet connectivity and communication, and run a challenger mission remotely. Some interest of students is that they're doing this in real time with a place far away. how really that differs from really coming here and running a mission in the center. a different spin on the thing. you may learn different things...whole point, learn things as a team, use basic mathematical skills and problem solving.
Ryan Diduck	[Collective experience?] I think there's a percentage of the population that would like that. There are some that are new to exploring that aspect of science that might just want to follow along, want someone to lead them. That's why tour groups are so popular, they don't have to worry about their next destination or how to get there. I think that would be popular. [The planetarium is a collective experience?] I think it makes a difference, when there's not as many people in the live audience. full show, no problem getting responses, not so afraid to ask questions, I don't' see that, yeah i see that it's over there. The more people you can get into an audience at one time makes them a little braver than the questions you would get otherwise. [In terms of a website, how would you transpose this collective sensation?] That's a lot tougher. A scenario that I would like is if you have all the data on Mars, and from all that we've collected in the last 20 years, compile a 3D model of the planet, have regular web-based tours where scientists from JPL or science centers take people who log in ahead of time on a tour, they can input questions on a little chat window or something, do a virtual tour of mars, zoom in on different regions, show close-ups and 3D panoramas, encourage people to ask questions on what they're seeing on their own screens. I don't think we're too far away from that now. Fiber-optics into their homes rather than remote science centers, data transfer would be so fast. [Planetarium session in parallel to other hubs, lots of people logged into hubs. multiply this...] I think that'd be incredibly popular.
Celeste Burrows	That I don't know. The schools have children work together in groups, it's probably the best way Whether they continue doing that when they have a choice I don't know. I just enrolled in a graduate program in astronomy in Australia, online, already we're collaborating with people, asking thought-provoking questions. You have assigned materials, you're required to do some interacting through web-group postings. It's fascinating. Because people raise questions that I hadn't thought about before. There's courses I know a lot of the content, someone will raise a question...a certain way the moon orbits...where it rises and sets in the sky, I really hadn't thought about it. That's an example. There's some questions I would like an answer to. The

	people in the class come from different backgrounds, primarily observers, primarily physics backgrounds.
Wendy Coones (in person)	I'm not sure how that would work. ..You can have a computer that you log on to that is set inside an architecture of a larger exhibit that has larger things with it, a large graphic panel…or that maybe has a very large image of the telescope that you can virtually view from this computer. What's nice is that you can step outside the monitor box in exhibition design. What it becomes is one single part in a conversation...unfacililtated. When I'm designing, I have to assume there's not going to be a teacher standing there all day, explaining it...no volunteer or staff person. Fairly maintenance friendly. Perhaps an exhibit about telescopes, I can have a cut-apart version of a telescope...real telescope you can look through, then maybe have some other things that talk about lenses and refractions and things like that. Then show some historical data and current data...look at current data that's being collected by whatever telescope in such and such a place...this is the kind of data they're looking for, and discussion why they're looking for it, why they're looking in this particular region....in order to that, the only way I can show people real-time astronomy is to encourage them to come back at night and look through our telescopes or have someone standing there talking about current projects....no way to hook up people with real-time astronomy. I've heard of projects between Australia and Wisconsin, opposite sides of the globe, they use one another's telescopes to observe...that's also tricky, how do we get school kids here at 10am to do observing at night...especially if it's going to be real-time, you can't do real-time night observing with school kids. One thing too is, assumption with exhibit design, you try to tackle big ideas, but knowing you're not going to be able to teach everybody the whole thing in one visit, you give them general concepts...you've given them some kind of entry point for looking into that domain in the future. Young child, what purpose of the viewing is, if they're generally able to get the concept that...that from that point on, foundation of knowledge for them that will help them understand astronomical endeavors from that point on. It doesn't matter what those other kids on the other side of the globe is looking for, world is slightly different, to give people small pieces along the way. Like offering them a buffet or smorgasbord, they pick what they want, maybe they don't try one thing, or don't get it, or miss it, or misunderstand it. 5 years later. Kids in Australia were talking about the Southern Cross and I've never heard of it, it's a southern hemisphere constellation. If a fourth grader doesn't walk away with that, but they get it in eighth grade...began to understand the concept of being on the globe in different places, it's all a constructed pieces of knowledge. we just feed in little pieces at a time.
Joan Gillerman	It's like a crowd dynamic. I actually like the idea of fostering cooperation, I think the world could use more of that right now….single user system. One person could actually use…I definitely think it is. If I chose to do a piece on the web, I'd definitely do that. I think there'd be an immediate....I've thought of taking a class here and connecting up, networking up with a class in South

	Africa on the same topic, and find out what perspectives are diff...project years ago called "Hey listen up!"...environmental justice, they tend to be put into low-income neighborhoods...don't even know what they're living next to. I was collaborating with another woman in doing this, and we did it in LA, as part of the pilot program, we had people come in and talk about the quality of the air/water in LA...interactive CD-rom, high-school age...we didn't get that far, pilot ended after they made the CD-rom...what we talked about as a website, which I still think is a great idea, is to connect up people in the neighborhood we were dealing with, with a neighborhood outside the US. Not that you can't do something interesting within the US...a consortium of museums within the US....I think that that would make a big impact on a younger person. when we're talking high/junior high/grade school, they haven't had a chance to see the world like this yet...exchanging research is extremely valuable....boundaries of the physical continental boundaries. Medical research there's a lot of cross-research.
Donna Cox (phone)	
Shawn Lani	For me, the net was really amazing early on...with the well, and with the first chat rooms, they were really frontier space, there wasn't a lot of graphics, it was just people…Discovery Bay Museum, 12 years ago, and there was a community of people that gathered...now there's chat boards...old Mustang that I fix up...I can write up online and get back information from people that are interested in the...that's the most powerful thing on the web...but the human interaction is really the most amazing part. And that's the part that's really fallen off the wagon...dwindled to only a small part of what the web is. It'd be nice to see it go back to the way it was before. [cultural collaboration?...] i haven't seen it done well...there's a physical understanding. The first step when I put an exhibit on the floor...naked, I call it...what I'm most interested in is the level of conversations they're having, the kind of really key phrases and questions, are they investigating...leading them towards process of enquiry...those are human specific...I really try to get rid of those differentiations...that's a good thing for a kid, but not for a 70 year old man, or a 25 year old woman with a child...can that mother lead that child through a process of trying diff things and discovering diff things? ...that's not culturally specific...
Noah Wittman	My first thought was just presentation, but ultimately a good experience…are people connecting with each other and sharing information.
Wendy Coones (written)	Interactive create your own universe. Everyone can create their own solar system, then glue them together to see what happens. ("Your planet has been eaten.") Make your own planet, then go visit other people's planets. Have parameters explained to us so you can see the diversity of the universe. Get together with Mapquest, "How far away is Venus, if your head is earth?"
James Morgan	Access to scientists. Access to data / data streams. Conversation. There has to be a true collaboration between the scientist and the artist, someone

	has to be available to answer questions, "where did this come from, how did you get it, what do you think it is, why does it look like this, what makes it meaningful, why is it interpreted in a specific way"
Patrick Lichty (written)	That in itself is a very interesting question, with great potential. Perhaps a range of interactions could range from children's programs on art and astronomy (interpretation, history and the arts, etc.), to resources for traditionalist artists (for example, I once wanted to do columns that were embedded with neon representing the emission spectra of various stars nearby earth, such a forum could allow artists to discuss, make collaborations, or even put them in touch with resources to realize these goals).
Myron Krueger	I always had the idea of, I did it when I was in Wisconsin, there was some sort of veteran exhibition, connect the veterans by telephone to kids that want to ask questions about World War II, say…tell their story, Battle of Bulge…ask about the Battle of Bulge, and be connected to some guy that fought in the Battle of the Bulge. Who is going to be on the other end of the phone if NASA wants to support this. If there are individuals who are available, retired or people, science teachers or kids who are expert about things [amateur astronomers?] right. I would agree that it's back to that minimum investment concept.. and you get an answer, then you may ask another question. The time to teach a kid something is when they have a question. With the current NASA site it's so hard to ask any question you just give up. Partly it's bandwidth issues, it's organized for their conveniences and not anticipating what you'd come in with...and organization that's putting out the product the results of the ...than anticipating what their customers would want to know...natural mistake...person with a question leaves without an answer.
Garret Moore	Sure. I haven't seen really good ways of doing that yet. It's important because I see myself as subjective, I have to. I really enjoy other people's views of the universe, because you'll always find views you didn't see. I can symbolize, or represent this concept, by taking a child square block with a letter on each side. One person will see one side, another person will see another side of that block. Two valid descriptions from different angles, but if you collaborate you can put it together into a description that's a lot more attainable. We have a lot of compartmentalized, or opposed views on things, they're all valid, all views are valid and carry information, the more you composite these and allow for any kind of subjective interference you get better information by collaborating. Your picture is more of a metaview than a subjective singular view of something. I discount my own views because my subjective awareness has real limits, unless I use a shamanistic method. I can only try to take as much info as I can and composite it as much as I can. I think we're pre-intelligence, we're too subjective in viewing the universe. So we're too subjective. Collaboration is where we step out of the nest of the earth. As we try to understand other person's perspectives, I think there will be an exponential growth in our understanding. I think languages are barriers that

	can be overcome. Visual information is available to everyone.

Interviewee's Name	Question 19. If you could choose a unit to describe the distance between the Earth and Mars, which unit would that be? Would that make it real to you? Why?
Christopher Johnson	For me, the pool is always a good kind of unit, just because it's 25 yards, or 50 meters, and to calculate, how many laps would you need to swim to get to Mars, that would be an amazing unit. I could calculate day-in day-out, well okay, I swim 3000 meters in a day, and in so much time, you could say, it would take you this many days of swimming or hours.
Donna Cox (in person)	
Jackie Morie	The first that came to my mind when you said that was, "Thought beams". So, I can be in Mars now, because when my thought beam is directly thinking about Mars I am there. I got to do something with JPL a few years back where artists and scientists talked to kids about themselves and how they did their work but then give ideas to children who were visualizing a Mars colony. What would we tell people that were going there? And that unit of measure was a thought beam. Distance, measurements are irrelevant if you think about things from a different way. All that stuff only works if you stay in one mindset. You almost have to put yourself in that little box and think about things like parsecs and angstroms and all that kind of stuff. That can be useful in some ways. But if we want to think about what it's going to be like to live on Mars, we can't think about the distance in order to have those thoughts. We can think about distance when we figure out how to travel there, or what the communication line's going to be, all that stuff. We do this without thinking, as human beings. We don't realize that it opens us up in all directions in many ways, and it takes practical distances and measurements and throws it out the window. We don't think about this when we say we're visualizing something, but that's what we're doing, we're throwing it all out the window.
Patrick Lichty (in person)	Well, units are kind of an arbitrary construct, aren't they? There were times when I was partial to cubits. In general I tend to like the SI system pretty well, it's history is kind of humorous in and of itself. If I were to possibly use units to redefine everything a problem is that everyone has defined themselves in terms of SI and English. In the short term I think that's what we should probably use. It would be interesting at possibly looking at multiple of one of the wavelength emission spectra of the hydrogen atom, or something. that could be easily translated to another species, would they be able to come here. We're talking about a tangible unit of measure for us would be one troy in Angstrom, but of course that's based on a certain, pretty reducible idea of excitation of primary elements. [This would be a universal unit?] If I were to define units, I'd really like to try to go to something that would define wherever you wanted to go, from very very basic physical principles. Being

	the fact that I've dealt a great deal with light and sound, doing a lot of things with dynamic analysis of sound in some of my current installations, doing real-time spectral analysis to create various triggers--I am very comfortable with kilocycles, not hertz that's more arbitrary than i like, megacycles or kilocycles I'm find with that. Of course, Angstroms...I tend to use nanometers rather than Angstroms. I may be at a bit of a disadvantage because I may have too much of a familiarity with the sciences. If I could shut off the applied scientist in me, it's hard...I think one unit that's very good is the astronomical unit, because that's something that's very tangible, a terrestrial unit the distance from earth to the moon, or a Martian unit the distance from earth to Mars, possibly use those basic astronomical units as a very basic, visceral sort of thing. A light year is good. A parsec is too abstracted, what is it, 2.whatever it is. It's sort of like considering Avagadro's law, 6.28 x 10 to the -23 degree for gasses and such. I was looking at things like the astronomical unit as a relatively friendly thing. This is something that has a very visceral sort of referent. If we ever had the technology possible, I would say that it would be mandatory for every person to leave earth at least once to get a viewpoint of the relative nature of human existence.
Annette Weintraub	When I was doing the water project, the research for that, a lot of the information that really made sense was information that was rephrased in terms of commonly understood elements. If all of the water of the earth were in a jug, the fresh water would be a teaspoon. Anything metaphorically expressed so you can envision them, otherwise it's very hard to imagine how far the Sun is away from us, or the diameter of the earth. Ways of expressing vast numbers or quantities or relationships that take them back to our physical space, because it all comes back to the body, we refer everything back to the body in terms of locating things in space.
Andurid Kerne	That's the powers of ten metaphor. The powers of ten is very clear in how it does that, and it's very effective. You need a unit that people can relate to like feet or meters or hours or seconds, that are part of people's everyday systems, and then on top of that, a representation of orders of magnitude. Those could be subjective units as well as objective ones. That could be very fuzzy and associational like degrees of separation in ideas. Well about Salvador Dali's clocks piece? The one with folded up clocks in it. There's some notion of hours and minutes in that piece form the clocks, but then there's this much more subjective notion about the way time feels and how that can be confusing that's conveyed. That seems like an appropriate kind of sensibility to me, if you want to bring human experience into it expressibly. There's a whole range of qualities in addition to scientific measurements. That would take the work to another level really. That would be much more interesting than just having the scientific data just by itself. Bringing it in to people in that way. The human experience.
Dorothy Timourian	Miles, millions or trillions of miles. Most people think in miles. I know sometimes they talk in light years. I understand light years, I don't know if the general public does, the time for light to travel from a certain place in space

	to earth. [What other familiar unit would you chose?] How long in days. Weeks, or months. Time units.
Peggy Frank	to mars, miles. Then light years. I don't remember exactly how far it travels. Other things I know are much larger units of measure.
Glen Sparer	
Paul Hertz	Astronomical Unit, the distance from the earth to the sun. Light years or kilo-light years. I might have an intellectual understanding of them. I'm comfortable with the notion of the light year, again, you have to be able to explain that. There's a number of complexities hidden in that as well...relativity, ability to measure distance and times. effects of relativity on measurements. The effects that show up if you could drive up, the universe is changing perceptually because of your motion. There are non-trivial aspects to it. [The unit has to be fast enough, big enough, to give the scale of the distance?] You could try to map distances on to things that are familiar to human beings. You could talk about the average height of the human being unit. Graph the planetary system, relative to your own body...we often think of those measurements. You can think of it, the universe as a set of absolute scales that are fixed, then you can graph it onto your body, your city, your country, your world, your swimming pool, how you drive your car. What's interesting ....there are implications we don't get in all of those other scales. Implications of time, relativistic of time distraction, your measuring stick changes...you probably want to avoid those things at the most basic level. Those start to become really important to people. To understand what we think about our middle scale of things don't hold true on the macro/nano scale. The same physics seems to work on the macro/nano scale. When we talk about cosmological origins, big bang, we talk about influences that appear on the nano scale, subatomic particles. nothing has to do on the mesa scale, where we are at...The problem is that we're not willing to stick around long enough for a more realistic simulation to work. I've seen.....attempts to show with a speedometer how fast you would have to be traveling, and graph real time into video time.....fast rate, but one which could not exceed the speed of light, or half the speed of light, it'll take quite a long time to move from one place to another. A light second out to the moon? I can't remember the exact number. To Mars, 1-3 minutes, something of that sort. You can travel at the speed of light across these planets, it's still going to take you minutes, what if the time it takes to get out to Pluto is hours. Suppose you have this restriction in a VR piece? They give you this idea, you can travel very quickly, but it doesn't.....you really have to scale things up even to show the size of the planets accurately. mercury the size of a ping-pong ball. Some are informative at least, you feel pretty comfortable. ..Exactly, I heard of a number of these. Switzerland, you could hike through the mountains and discover...
Craig Hansen	
Lisa Jevbratt	Meters? I think all types of measuring systems that are consistent are fine to use. Again I don't like…I think light years is a difficult concept. It's strange.

	Meters for me would be the unit for everything. I think again it's good to avoid measuring things, comparing them too much to...I think it's a cultural thing. The United States seems to be very much describing things from the human experience, all the time. You describe the distance between two places by the time it would take you to drive there. That's very strange to me, it's very confusing. I just want the measuring system that aim to be objective outside. So if someone could introduce a type of measuring system for the universe, and then use that, but avoid that whole thing it's as far as the moon it would take you to driving twenty times around the earth, whatever. Avoid those comparison type of things. {So all your comments have been: keep the data as it is, don't try to make it cute, or friendly?] And don't use metaphors from our daily life that one could think would help...you think that when you describe things to children that they would understand when you make strange comparisons to things they could know about, but I think you just confuse things. This is something completely different. You can't think about it in this and this way.
Geri Wittig	
Nora Raggio	
Bonnie Shulkin	Kilometers, because it's standard, it's something that's very easy to relate to other numbers. Miles would be okay, it's just less common in the scientific community. I don't have anything that's new and different, the general scale analogy and the speed of light type stuff, but I don't think I have a very good feeling for it, so I don't' think I have a good way to give other people a feeling for it. I just think it's something that I as a human can have a very good feel for. like visualizing 4D, because I'm a 3D creature, it's just part of my limitation.
Ben Burresss	It changes with the scale. Within the solar system, especially when I'm teaching a class to kids or trying to explain, millions of kilometers and astronomical units, or possible how long it takes light to get form this place to that. A SECOND to get to the moon, 5 hours to get to Pluto. That's why when I'm trying to describe the scale of the solar system, move out there from moon, sun, Pluto, nearest star, out of our galaxy. then so large you lose them on a technical level, it still sets the stage. at least you tell them the size of the universe is not comprehensible. summer camp. scale model of solar system, relative size of the sun and planets. 8" inflatable ball is the sun, peppercorn is earth, sesame seed, Jupiter was a small potato, Saturn, small onion, kidney beans were Uranus and Neptune, they drew the orbits. We developed this summer for the first time. Then we took them out with the distance scaling. By the end we were all the way across Chabot and up to Neptune and we didn't complete. wow, it can't be that big! now we're out at Jupiter, a few hundred feet back at the sun, they can kind of see the sun, earth the size of a peppercorn out there, planets are just specks in the solar system. Works with adults also. I think it'd be useful for anyone.
Ryan Diduck	
Celeste Burrows	

Wendy Coones (in person)	
Joan Gillerman	I know how long my studio is, my warehouse is 40x30 feet. A lot of times I think of things in studio-units. I've been there a long long time, and I know exactly what it means…I have a telephoto lens, can I get that all in frame…space is difficult…eclipses are great because they can fill up the screen....very serious telephoto lenses. We've done lunar eclipses the same way. Not very successful...getting much from stars because the light is so dim. ...My eyes can see it just fine. That was even happening on the lava on the mountain...the cameras kept adjusting for it...manually you have to ....with my normal camera stuff. But with a telescope you have a very narrow point of view...you don't get the wide expanse of a camera. You have to make choices. Totally painful, that's how come we design this panning device for eclipses...battery operated.. Mauna Kea,...one of our cameras (Rob Terri is my partner I work with a lot), 3 video systems, 3 photographic still systems....videotaping the total solar eclipse of 91...panning device specifically for that...there's a lot of stuff happening around you...horizons turn all these wild colors...we built this device like a camera obscura. It has a mirror on it, and the mirror rotates, and it gets the 360 around the horizon. We like showing that using a camera obscura looking down...1 rpm motor, every minute it comes back to the same place, ...so you still have all of that. I set out to do that when I was a kid....I haven't seen it yet is the northern lights. I love doing that piece because of that, it's personal.
Donna Cox (phone)	
Shawn Lani	
Noah Wittman	You probably need to have something that's real along with it. [the problem of real-scale]. A logarithmic scale is tough for most people, but that is a way to shrink it down and make things relative and be somewhat of an accurate...
Wendy Coones (written)	Earth to the moon should be standard. Have the distances be calculable by the person's home state or country.
James Morgan	Well no static unit would be sufficient, but I think I would assume the Universe is based on a hyperbolic geometry which yields an absolute unit of length. I do not know what that length is, but since it is my choice that would be it. Real? The circumference of the earth is beyond my experience, I can conceive great distances, but I don't know that I will ever truly understand them.
Patrick Lichty (written)	Possibly one Terrestrial Unit, one Mars Transit (MT), or one Martian Travel Unit (MTU), I have no idea whether this would be more tangible to me or not, as I would not know whether this would be defined at closest transit, furthest, or any other point of measure. From a personal standpoint, I think I have a general idea of how close the two planets are in astronomical terms, but perhaps a term injected into common parlance might make a difference.
Myron Krueger	
Garret Moore	

Interviewee's Name	Question 20. Do you find scientific measurement units meaningful or too out of context from daily experiences? How so?
Christopher Johnson	
Donna Cox (in person)	
Jackie Morie	
Patrick Lichty (in person)	
Annette Weintraub	I think scale is very important. There have been a couple of VRML browsers that allow you to fly and see the inner relationship of things in terms of proximity. There's one for Apple called HotSauce, and I've seen another browsers that were built like that. I think they're helpful because the movement between one piece of information to another gives you a sense of scale, a relationship of importance, because it's analogous to a physical location, because it'll take me 5 minutes to get to the front door, or half an hour to get to the airport, so you have some sense of distance and time, and I think that makes it more meaningful. I would like to do some projects in VRML or web 3D, but so far the technology is not there, and it's been a great disappointment to me that web 3D has moved so slowly. I think that once it becomes really viable on the web, and not based on heavy processing but on Mac and home computers, it will be a tremendously important tool. Not only to sell clothing or toys, but it'd be powerful because it'd give you a sense of scale and movement through space and explore. A lot of that material that is space-based can really be understood in a much richer way.
Andurid Kerne	
Dorothy Timourian	
Peggy Frank	
Glen Sparer	
Paul Hertz	
Craig Hansen	
Lisa Jevbratt	
Geri Wittig	
Nora Raggio	
Bonnie Shulkin	Yeah, but if there's a unit I don't know, I try to translate it to a unit I do know. Very very large numbers, you can go with astronomical units, it's really hard to visualize unites in space. I can't tell you I have any sort of idea about the space between earth and mars. In relation to anything I have experience with.
Ben Burresss	

Ryan Diduck	
Celeste Burrows	
Wendy Coones (in person)	
Joan Gillerman	
Donna Cox (phone)	
Shawn Lani	It doesn't work on the floor. People don't have that background. It's really shocking how little people know. …say you have magnets and lines showing the lines of magnetic force, 80% won't know what you're talking about. It's depressing. …we're just a piece in the pie of the solution...we're a great resource tool for teachers. ..if people come out of here not knowing certain things I don't' mind...it's a really strong format to inspire people, demystify science.. make it a little more accessible...get them physically involved...what an amp is...static forces, static electricity. .Every exhibit we have now we try to put some sort of photo to give some sort of context for what they just did....heat sensitive gel.. the heat spreads diff according to what the material is...actually pots and pans, and then we have pictures of cooks working in kitchens with these materials. Those things can be culturally specific...cooking utensils are pretty amazing adaptations if you look at them...how does the heat move through things...through experimentation and mentorship from the pot maker...Looking at this project, I don't think this would be enough for you. We're such a physical place. ..what we think is important. What this is, I think it's nature is different. you need to stick to your guns to what you think is important. That close focus is really important for any institution...Frank Oppenheimer...he started this place with a very strong vision...adolescent...hopefully for another 30 years...a whole lifetime to come up to a starting point...just to launch it, then another 10 years to mature. The web seems like it matures so fast...slowly evolve,...create a culture around it that supports it..I don't get a sense of culture around the project.. who are the personalities.. who are the people behind it. There is a spirit behind the Exploratorium. A huge part of this place is social interaction. H...have the physical exhibits lend themselves to social interactions...people like to play.
Noah Wittman	No they don't. There's a famous classroom activity called bicycle years, those concepts help people relate to concepts like light years. I don't think light years are meaningful to anyone but scientists.
Wendy Coones (written)	Yes and yes. Powers of ten was good at bringing it to your daily life.
James Morgan	Meaningful, and relevant. From angstroms to parsecs.
Patrick Lichty (written)	Because of the fact that so much science (as opposed to technology) is decentralized from our culture, everyday relevance regarding scientific measures is problematic.
Myron Krueger	

Garret Moore	

Interviewee's Name	Question 21. How do you relate to light years, Angstroms, terabytes, joules, nanometers, etc.?
Christopher Johnson	[Do you relate to these other units? Scientific units and scientific measurements?] Not really. But I was thinking that it would be great to do a project that I could relate those to. So, a terabyte equals that, but how does that relate to Ping-Pong balls or bouncing balls or something that I could exhibit and show. If you walked into a room that had a terabyte of Cheerios, how many Cheerios is that? And to have this Plexiglass case with all these Cheerios in it, that would be very very interesting. Yes, units have to relate to my immediate space, what I was talking about in the beginning. Whatever is right around me, what I understand and experience with a physical connection.
Donna Cox (in person)	
Jackie Morie	Sure, when I need to, yeah. Absolutely. [What's your favorite unit?] So my most practical, personal unit? It's so hard to say. I might say days. Would I like about day as a measurement is that it's new every 24 hours, you've got a whole fresh start. There's a basic cyclical renewal every day because you've always got a birth in the morning, you always have a death in the evening. But I think the other ones are so romantic--I mean, when you get down to nanometers, I love thinking on that scale. When people ask me, "How are you going to make the holodeck?" I just answer, "Well, it's just the nano-display. You have these molecules that are coming together and making what we think is a solid object so we can sit on the chair or walk up the stairs". There's no display as we know it today that surrounds us and reconfigures. Then when you think in terms of light years and parsecs and things even bigger--what are the measurements between universes? [So you're comfortable with the micro and macro?] Yes. They are just different ends of the continuum as we know it. That's why I say, "What's beyond on both sides? Do they ever overlap? Is there someplace where they come together?" Do we have terms for beyond a universe? I don't know past a parsec where we go.
Patrick Lichty (in person)	
Annette Weintraub	
Andurid Kerne	
Dorothy Timourian	
Peggy Frank	only distant bells from physics classes. Light years I'm familiar with, nanometers because of my husband. Other things, angstroms and joules, I'm sure I knew them, but I don't use it, I forget it
Glen Sparer	

Paul Hertz	
Craig Hansen	
Lisa Jevbratt	Since light years is a unit you use a lot, there is reason to try to explain it.I just heard someone saying the other day, actually, that they found the speed of light is changing, that it's going slower. Some research in Australia, it seems that light is going slightly slower than before. So that changes the whole concept of light years. I think those things can be explained the way they are. I think you should not try to bring in other...it does make sense, you can describe to someone what a light year is and it might be possible...but again, because it is in a time frame that's so different, because for us light is just here. It's not like it takes time for it to travel from over there, because we are not in that time scale. It's just really important, that's why I think it's really dangerous to add something like interactivity that takes us back, then explain something about light years when you just anchored people into their time frame. You have to come up with a way basically to kick people out of their human visuals. As opposed to taking the concept of light year down to the human, bring the human up to that time scale. If there are going to be metaphors, those have to be the metaphors. A student that made a project that I liked with SETI was thinking that there are very plain text messages in here, over such an enormous amount of time. You just have to look at every millionth character in this and it will form a message. Working at this scale, the compressing and blowing it up, and taking it down in different scales, I thought that was interesting. My students made software that read in the SETI data, they mimicked what the SETI@home thing does, they read the data from the Berkeley lab at even intervals. It had to interpret the data in a way that made it like there was life out in the universe. They could do it any way they want--with visuals, they just had to have a theory like here is a line, you could just plot the different characters of the data, turn it into numbers, and have this image. Every time you see a circle this sort of shape, they were trying to tell us this. They could claim whatever. But it had to have a theory, like looking at the different scales of the data, and if you look at the right scale, you find the message. There were visualization projects...They took the data and interpreted in some way that would predict stock markets. The sign of intelligence would be that it would earn money. It actually did always seem to predict, slightly always more winning than losing. The SETI data always seemed to predict. He showed that this data was maybe aware of our economical system, so there's so many different ways you can prove the connection. It's not like communicating between one person and another; maybe one entity out there that's communicating with us as a whole entity, or the internet as a whole, or maybe it's an enormous amount of entities just trying to communicate with you.
Geri Wittig	
Nora Raggio	
Bonnie Shulkin	
Ben Burresss	

Ryan Diduck	
Celeste Burrows	
Wendy Coones (in person)	
Joan Gillerman	
Donna Cox (phone)	
Shawn Lani	
Noah Wittman	
Wendy Coones (written)	Yes, mostly. Horsepower is still easier to "know" than a joule. Can't quite remember how strong a joule is.
James Morgan	Being outside my experience it takes quite a bit of manipulation to discuss angstroms or parsecs, but enough angstroms or a small enough fraction of a parsec are within my experience. Scientific notation is good for this. My daily reading touches on these, the newly discovered planets are parsecs away, the new microchips are pushing atomic scales, and DNA, is a billion combinations.
Patrick Lichty (written)	Being that I have a background in applied science, I relate to them quite well. However, I wonder how the average person, or even the artist without a background in the sciences might relate to them.
Myron Krueger	
Garret Moore	

Interviewee's Name	Question 22. For your kinds of projects, would a 2D or a 3D representation of space science and astronomy data be more important?
Christopher Johnson	I see things in 2D and 3D. I could see both being used, but I guess it would have to be represented 2D. I saw a past SEGRAF animation that dealt with traveling through space. They used an actual cube and had it traveling through it to the other side. That one really represented that idea they were trying to explain completely to me. I've used that in subsequent classes that this is a way you can represent that idea, but I guess that's a 2D representation of a 3D space. So I'm not sure what 3D data would look like other than like a pie chart or something. [When you talk about your VR helmet, is that 3D?] Yes. [So when you talk about navigating..] Yeah, you would navigate through 3D space by the movement of your hand or body, or some motion through that. [If someone shows you a 2D image, do you wonder about the back, the side of the image?] Oh yeah. 2D would be more quantitative data, and 3D would be more qualitative data (is there qualitative data?). Richard Salmorgan does a really good job of dealing with data, and he put together a book called "Understanding USA", and in that he gets 4-5 artists, and people who deal with information and technology, and they work with 3D to show the data sets he gives them . That's a great book I always show every class. You could look at it this way, and it's just a traditional 2D graph with really good illustrations and is done very well, and then I show them another one that has 3D objects that fit together dealing with AIDS patients in Africa and the population. That one almost seems to have more validity as a piece of data, than the little illustration of how many people are educated, or how many gun deaths there were in the US.
Donna Cox (in person)	In a sense, all we do get back are images for the most part. Even when they put cameras way out on the wings of these probes, D3still an amount of 3D relief, but for the most part they are 2D flat images. And it takes a kind of interpretation, visual process, to be able to translate these into three dimensional structures that can relate to the three dimensional space that I think this body resides in right now, even though sometimes I question that space. And that goes off into some of the philosophical and conceptual questions that we're going to go into.
Jackie Morie	It could have both modes. It's like saying you want a boy child or a girl child better. They are both wonderful. I don't think of myself as a 2D or a 3D artist; I think of myself as an artist. So as many dimensions to the tool that you could give, given the constraints of the technology, I think would be wonderful. [Hubble Telescope images are usually 2D. Do you usually feel that there is something lacking in that?] I think 2D abstractions give us a beauty...it's one of those things that give us a window into the world that is very valuable in and of itself. I don't always want to experience things in the same way. 3D

	gives me things some times, and other times 2D things give me things that are so wonderful.
Patrick Lichty (in person)	The back image of an object 16 billion light years away? That would be wonderful, because that would be so outside my paradigm. The crazy thing is what is the spatial distortion? Now we're getting into really abstract crazy astrophysics…what are the spatial distortions created by the temporal shift that's intrinsic in being 16 billion light years away. The structure of the universe is completely different by then. I'd love to have something more than 2D images. They convey the information, but I think it would be highly imaginative to have something different. However, our solar system as it exists now, didn't exist then. If you went into that and looked back into what would become our general area of the universe it would be totally different. I would say that probably the most pragmatic representational method of doing this would be to allow the snapshot that we get from our localized time frame and allow ourselves to abstract out through the creation of light, through time, back to 16 billion light years away. Looking back from a 16 billion light year distance, going back to a 2 million light year distance, allow ourselves to look through that gradated temporal well in which we're at, because I think that is probably the least abstracted way--some people might find this terribly abstracted--to represent things, to be easily accessible to the largest number of people. The idea of relative abstracted time...it's a very difficult concept. Something that would be interesting, from something that would be fun--if we had the Andromeda Galaxy, however far away it is, 2 million light years away--I think it would be interesting if we had a tool that we could take to look at a 3D space, maybe the Andromeda Galaxy and Milky Way Galaxy, to have a tool that would extrapolate where it is now. As we go out further, of course we have less and less data, but it would be interesting for people to see what we're seeing versus where they might be now.
Annette Weintraub	I think 3D helps you to understand the images better. I mean, I started out as a 2D person, so I can read 2D images very well, but also if an image is beautiful I look at it as a beautiful image, 3D really allows you to understand it more completely. The thing you can't do on the web is to get a sense of scale of things. It's like seeing sites of paintings, everything is the same size, which is the size of your computer monitor, so you don't have a sense if something is an inch.
Andurid Kerne	My first take for things like that tends to be 2.5D. So you could do things with…it depends. As much as you're organizing data a and knowledge in the first place in 2D, then 2.5D things that allow you to create perspective systems as part of navigation, if they are zoomable or allow you to create piling effects. I think those metaphors work really well and tend to map more easily than 3D metaphors and 3D structures. You could have specific elements that are 3D elements, if you're creating some simulation or model of some process, 3D could really work for that. My tendency would be to still think of those as elements like 2D elements that you would arrange navigation for those things in, ideally, a 2.5D kind of way.

Dorothy Timourian	2D is representation of something that's usually 3D. 2D works fine for me, becomes I'm very visually and space oriented as far as map reading and finding my way places. I know for some people, 3D works a lot better. 3D is very good though. I've seen mockups of the Challenger, and been inside one, and seen a lot of space capsules, we went to Florida where they launch the space rockets and such, Cape Canaveral. When you actually go to a place and you see a 3D model, of course it's more meaningful than just seeing a picture. 3D on the computer, when models turn around and you see them from different sides. I've done that, that's very interesting. I think I've done that at Lawrence Hall of Science. It's fun.
Peggy Frank	I think 2D is probably most informative, but 3D would be great. If there was a way, for example, on a planet, to see what it would look around on the backside, maybe there can be something actually rotating, or a swirl in a nebula as it moves. I would find that fun, I know the kids would absolutely love it, as far as being inspired. 2D, I'm thinking about the absolutely fabulous photos of nebulae, etc. Anything that'd give you ability to see something moving, something rotating. If it's a chunk of asteroid or whatever would be wonderful. I think it would be almost a luxury, but I would like it whenever possible. It'd be fun to see something turning around. For example, if you click on a picture, and you have the ability to zoom in and look at something close-up, or to have it turn or move around, I think that would be very inspirational.
Glen Sparer	I guess we'd be verging on 3D modeling now. 2D is two dimensions, 3D is three dimension and you go into it. You're talking about a virtual reality. [4D, because there's time also] Time is very important. That's one of the elements of science, time and space, you have to actually use that in some way, in such an interface. Like VRML would be something like this, where you could go in and navigate, as it were, like you're an astronaut through the space. Maybe the interface is a spaceship and you have this whole concept of cosmo-vrml, they have an interface kind of like that, you go in and you turn it, you can turn the spaceship as it were in the space. If time was involved, then the faster you travel, it would change the passing information, because you've got this time continuum, theory of relativity.
Paul Hertz	3D or 4D, at least. 5D for sound? It adds a dimension. You could have 3D or 2D images, but 3D is implied, in deep space astronomy certainly. The surface of the planets have that. 2.5D.
Craig Hansen	When I picture 3D I don't necessarily mean putting on 3D glasses. It's just a navigational approach that uses the illusion of three-dimensional space, even if it's rather crude to begin with, something that enables me to even choose different perspectives on a particular location that I might be reading about. Different viewpoints, perspectives. I might be reading different viewpoints, perspectives, to say this is in this relationship to our solar system and if there's a way of zooming in and out on a scene to try to get some comprehension on the space and distances involved. That's useful to me because it's something I'm interested in as a desire to comprehend what it is I'm reading. I think I'm pretty good in any kind of web environment reading

	about the content of most astronomy and it's something I was more interested in as a young adult. I feel that almost any, even a poorly put together website of astronomy stuff, I can read the content and understand what they're talking about, but I think what I've become interested in lately is how these different parts relate spatially and even temporally. It's something that would help me increase my visceral, or physical understanding of what's going on. Like how the solar flares work, or understanding bigger systems between bodies. On the Solar Observer site it shows the time-lapse movies of the solar flares and mass ejections and stuff like that. Those are not only extremely beautiful to look at, but it gives me an entirely different appreciation and understanding of how the sun works. It's a different kind of learning, and it goes beyond just being able to explain the process of what powers the sun, and why there are storms on the surface. Seeing those images inspire those questions but seeing those images also just conveys a kind of motion and activity that you can't get any other way. Probably one of the most astounding things I saw on that website. It showed the sun over a period of time, and you can see in the background, stars moving slowly from one side to the other. The view was from Earth, as it moved around the Sun, the background was changing. That gave me a sense of myself moving through space that I never have gotten before. That's a privilege of living in a time that has this technology that allows us to see these things. It's not necessarily useful to me in any practical way, and I tend to not really be bothered by that, most of my interest in science comes out of a wonder and a joy of learning this stuff, and trying to get a clearer and richer picture of what's going on.
Lisa Jevbratt	I could talk about this for three days. I don't believe in 3D visualization, it's like a personal…people who get into doing 3D visualization are like faking other types of environments. You take data and compare it, even for stupid things, like 3-dimensional shorts, it makes no sense. Why take data that has it's own shape, so to speak, and turn it into a big building blocks and put them behind each other? It's so forced...I think we are so 3-dimensional, we see in 3D, it kind of locks us in too much. And it forces our sense of space, the normal or norm space, non-data and non-emotional space, onto data that might be about emotional space or some other scientific space. Maybe we're forcing Cartesian space onto other types of spaces. I think it's easier to see other types of spaces in data if we keep it 2D, because it kicks us out of the normality of three dimensions. Which might seem contradictory, that it's possible to show more dimensions if you have two dimensions as opposed to 3, and maybe you can do it with 3, it's just that I haven't seen it happening. So far 3D has been simplistic. I think there's so much to do with two dimensions that I don't see done either. [In terms of space science, wouldn't it add another dimension?] I don't think so, because the dimensions people are talking about in space, if you start talking about curved space and so on, you can't understand it in a three-dimensional representation. It might be easier to understand with a two dimensional representation. It might be more easier to understand it with a two dimensional animation. Usually animation is used to

	show three dimensionality, but there might be ways of using animation that doesn't show us three dimensionality but some other aspect. It would very interesting to stop using 3D. It seems to me, that when I hear about space and the universe, I'm not supposed to use my Cartesian coordinates system to understand it. So it seems better to take that out of the equation, and try to describe it in other ways. Maybe even sound would be better than a three dimensional representation. [So the "z" would be time, or sound, or another sense, but not necessarily a third visual dimension? So when you're talking about animation, you're talking about motion along time, so that would be the "z" coordinate?] Yeah, exactly.
Geri Wittig	
Nora Raggio	That's a real challenge, but it would also be a real beauty. Right now, even when I've read all this book "The Elegant Universe", who talks about string theory, which unites quantum mechanics, which is very, very small space and very cosmic space in the theory of relativity. He talks about hidden dimensions and folded dimensions. I think it would be so beautiful to be able to explore those kinds of dimensions. I'm not sure one can do it on a website. I think that'd be great, that would be really super to be able to bring in the experience of another dimension.
Bonnie Shulkin	I think 2D, there's a lot you can do with it. 3D too. Not dissatisfied with 2D, but 3D adds a lot.
Ben Burresss	I look at the captions we've written as information that's available if people want to find out more. Ooh beautiful image, but maybe don't understand what's going on in that particular image. Some will be interested and some don't. Hubble images right no. ...I might give them some basic information, ive3 them problems to solve , or a treasure hunt, this characteristic, or basic information of the temperature of the star and the size, give them clues, go out and navigate and study the stars within the limitations of the database. clues and a problem to solve. what they learn along the way. if and when they succeed, that's reinforcing what they learn.
Ryan Diduck	I guess it's closer to actually being there than just looking at a picture of the place. I think people always want to be there first, that's why we have explorers that travel up to the top of Mount Everest, because they want to see what's it's like from up there. The closer we can make the audience...the more real it becomes, then just pictures of some place they'll never see.
Celeste Burrows	2D is limited. And I maybe see some of that when I see kids see pictures a lot…they build planets out of clay, they have to keep dividing the clay. Comes form project family gastro, developed by Denis scats, from Seattle. You start out with 5 lbs of modeling clay, then you divide it into 10 pieces. 6 for Jupiter....you keep dividing into 10 pieces, you can hardly see, that last little piece is Pluto. Jupiter is a huge ball like this. The students laugh, they think it's funny, but they're amazed, yet they've all seen the pictures. So the pictures haven't done much. The handling is important. Even 3D is important. When you look at pictures, when you can look at the axis around, that's really more effective. If you had images you could swing around and look at from

	different...it's a lot more engaging, interactive.
Wendy Coones (in person)	Yes. 3D goes over very well…technically savvy, they've seen a lot. When museums are having to compete with cable television and movies about aliens, you have to be pretty snazzy and jazzy. When you say ….
Joan Gillerman	Definitely a difference. I can be very happy with 2D images as a painter…that doesn't bother me at all. When I'm thinking of molecular structures…that there's more operating that just the moon goes in front of the sun…I think 3D helps a lot…from the side. I like seeing diff perspectives...we're always on the exact same perspective. ..I love looking at it.
Donna Cox (phone)	
Shawn Lani	A 3D thing is always more interesting than a 2D thing…all these video games, and all this information on-line... in the end, no matter how high of the quality of the computer screen…you're still sitting there, looking at a computer... Where with the physical thing, your whole body is involved.. you're hearing things, you're smelling things, so your level of interest goes way up automatically. Actually looking through a telescope…that's much more powerful than clicking on something and seeing an image on the screen.
Noah Wittman	
Wendy Coones (written)	2D is order to make things with the data. The technology is simply not good enough yet for 3D, but it should be kept in mind.
James Morgan	3d with time included.
Patrick Lichty (written)	I would prefer 3D, or a 2D representation that was able to scale distances to highlight associations between bodies or sets of data.
Myron Krueger	That's a thing that has been interesting for me, because I have always perceived the body as a 2D video image. …had I received funding I would have carried it forward into 3D….but I found that 2D were sufficient for me to operate in 3. One of my crazier ideas which was having the body perceived by video cameras control a robot is something that NASA now has a project to do. It's back to the idea of the body as a transformation, that can then be made to mean anything. So I always had a little bit from a 2D background...just a technical necessity, it was easier to see in 2D than 3D for the computer. I also saw a big tension between symbolic information and spatial information, most of the things you're interested about in science were 3D phenomena, on the other hand most of the language of science at that time was 2D journal articles. There was a big tension which exists to this day....one of the reasons VR hasn't been mainstream is because everything people do with computers is still 2D. In space there is an issue in space that the distances are so vast that to treat things as 3D often gets you into trouble. If you were to do...model of the solar system, old mechanical model of the planets going around the sound. if you were to put the appropriate distances in, you'd hardly be able to see the planets because they'd be so small...The distances are so great you have to think schematically anyway. I'm sort of surprised they haven't done more with...I would have some space missions that was just designed for aesthetics...I would put a system of satellites around Jupiter and around Saturn just to watch, just to build up 3D images of those planets, and just watch the weather patterns. I had the small planet demonstration at SIGGRAPH 93, you were in a flight simulator and pretended to fly around this landscape ...raise your hand you went around orbit...if they had, if I were to do, I would have NASA have downloadable earth planet images that people could have, basically a globe on their

	computer screen, also a globe of Mars because we have enough data there...we have altitude data of Venus...of Jupiter and Saturn you could have a spherical representation of the surface of the weather patterns...and the rings of Saturn. What NASA does, which is a classic thing which engineering people do...is that they work up from the technical source of things, and they don't bridge the gap to the audience. ..NASA images would be some uninteresting...they are organized by satellite or by mission, rather than by the topic. Whereas I'm interested in the topic not the mission, and so is everybody else. If we have the moons of Jupiter and Saturn would certainly be interesting, if they were presented 3D, and speed up the orbit so people would have these little models. For instance I don't know if the moons of those planets revolve in a plane or in arbitrary angles.
Garret Moore	Absolutely 3D. I get so deeply into 3D right now. At physical objects, 3D is the best to go. Qualitative data, 3D may not be better than anything else. 3D affords you multiple perspectives, if you can rotate it, you have a better understanding, you can model things in your mind's eye. I know the potential for understanding were so much bigger.

Interviewee's Name	Question 23. As regards space imagery, what in your view should be static and what should be dynamic?
Christopher Johnson	I think our best example of dynamic is the stock market. It's fun just to watch the ticker going up and down and what it does during the day, it's very dynamic data. [What about in terms of space science? What could be dynamic?] All of it should be. Because it's constantly changing, I don't know how you would gather that data constantly all the time, but to see the rotation...I understand, when I'm working with Flash animation, I understand when I have the coordinates changing over time and have that listed and put those up, I understand what's going on with the equation better, I remember even from geometry that when I'm able to visualize the piece of data and explain what's happening at this point and this point and this point. Or even for programming in Flash, here we are in this situation and if it's this, then this happens, and if it's this, well then this doesn't happen. That explanation as I'm working through the program has really helped me. [Do you think that dynamism should be interactive also? Could you control the dynamism of something?] Definitely. Or even pick out variables in different places. If you could say "A: I'm looking at Mars and I want it on such and such date, but I want to view it from this part of the moon", what would happen? I know James Turrell is using road and crater and excavating it out and creating pools of reflective water and taking advantage of this celestial event that will happen in 2012...it would be great if he could go to whatever resource, and say, "Hey, I'm on this place of the Earth, and I want to see what will happen here", and set that up, that would be very beneficial. In Choco Canyon, they just recently figured out that not only was it figured out on the rotation of the Sun and the seasons, they had spirals, and the rock lined up and cast its shadow at different parts of the year, but they also figure out that it does the same thing with the moon and its cycles, and that their buildings were laid out according to the cycles of the moon, and the cycles of that are every 12 years. It's just amazing what you could do with that information. Architects and artists....Stonehenge, maybe that would unlike the mystery, if they could set that up, gather and gain that information and go back. One of my students was working on a piece with stars, and she got one of those visualization programs...by positioning the stars they found that the Sphynx actually had rain damage, and by the position of it they went to the year they thought it was created and it wasn't facing a certain star, Leo, it was another constellation. They went back to find out when was Leo on the horizon where the Sphynx is facing in that direction, and they found out it was 12,000 years before they thought.
Donna Cox (in person)	
Jackie Morie	

Patrick Lichty (in person)	
Annette Weintraub	
Andurid Kerne	
Dorothy Timourian	When I read the question there, I think in space everything is dynamic, because it's always moving, always changing. But when you get a photograph, that would be static. But when we're talking about a 3D model that would be dynamic, because it's moving, especially if you can manipulate it.
Peggy Frank	
Glen Sparer	
Paul Hertz	You could have an interface where everything is dynamic. A whole range of sounds, or frequencies we don't see, that can be translated into sound, or image processing to shift wavelengths we're using to view something. It changes the perception. To understand the universe is not just silent--not really audible frequencies--but there's a vast range, we don't need to understand it purely in physical light or what we hear. More than a static image. What does a variable star look like. It'd be interesting to hear. The sounds coming from the electro-video sources.
Craig Hansen	
Lisa Jevbratt	By dynamic you mean more feeling of interactivity in navigating around? Again, I still think things that are really complex, if you have interactivity, it puts the focus on the persons themselves. Space is a completely different scale, both in terms of time and in terms of size. Interactivity always puts time into human time, real time--a second is what we think about as a second. In terms of size, things that relate to our body. And I don't think you can understand this type of data thinking about the size of our bodies, and I don't think you can understand the processes that create the universe if you're locked into processes that acts in a human timescale. I think it's better to avoid those. Interactivity is better to avoid in all times when you need to describe systems that aren't acting on a human scale. I would say avoid interactivity, avoid three dimensionality. [Keep it complex and simple?] Complex in terms of allowing the data to be complex, and allowing the ways you look at the data to be complex, don't try to humanize it too much by introducing interactivity and three dimensionality, because they're too much here and now and we and the sense of the space that we have around us everyday.
Geri Wittig	
Nora Raggio	
Bonnie Shulkin	Interaction? I think that it's more practical to have something that's not dependent on the website for the actual learning. Provides the resources that you need, but you don't need to actually be there on the website in the classroom. If you're going to have the kids on the computer, the more dynamic, the more engaging.
Ben Burresss	

Ryan Diduck	I think so. I think if you give people the choice, left or right, they feel that they're really doing it than something that's prepared for them.
Celeste Burrows	
Wendy Coones (in person)	Also sometimes being able to have explanations. You can't time lapse a supernovae if you haven't been able to record one…Donna Cox's colliding galaxies…we know that that's what generally happens…show that working from using a school of fish to using a real school of fish...sardines and show how they never hit each other, to have large flocks of birds...streaming happens, just being able to show people patterns of how things look, this is how nature works. Nature automatically takes care of itself in this way. That is a very dynamic thing. If we were to just show, I get really bored looking pictures of galaxies, and nova-this, and Hubble images all over the place, big and beautiful, a galaxy is a galaxy, a nebula is just a bunch of gas out in space. When you begin to animate things, or show how things move or evolve, it makes it seem more...anthropomorphizing something, you give it life.
Joan Gillerman	
Donna Cox (phone)	
Shawn Lani	They both have their roles, I wouldn't say that static has no role, and full graphics books properly done are wonderfully things…even the font, the physicality is really nice, you have a little shell around you when you're reading a book. There are questions that I think would lead to that sort of thinking. Kids would ask these questions...What's past the edge of space? When we say, the edge of the known universe, they ask, what's past that? What's beyond nothing?...something in a person's mind, how far is it to the moon, how far is this, how far is that...when you talk about the edge of something, that's when the whole...your mind does that little flip.
Noah Wittman	
Wendy Coones (written)	The earth and the sun should be static but the rest of the universe should turn.
James Morgan	The big picture is dynamic. An image should only be relatively static until it can be sampled again.
Patrick Lichty (written)	This is largely dependent upon what imagery is available, the amount of imagery, and the scope of inquiry that the user wishes to explore. For example, if a user wanted to explore x-ray emissions from a rotating pulsar (given the information was available), would I desire the display to be focused on the visible spectrum? Not likely. I would be interested in seeing the various emission strengths for the given object, but this might not mean that the rest of the surrounding objects would not be represented in the radio spectrum.
Myron Krueger	
Garret Moore	

Interviewee's Name	Question 24. How much supplementary information should accompany space science and astronomy images and models?
Christopher Johnson	When I close my eyes, I could see following some planet. And on the planet they show its rotation in 3D space, but also a pop out window that lists the name of it, the temperatures, the makeup of the planet, what's the atmosphere, what's the population. I saw a Star Trek episode where a time traveler had a holographic wrist band where he hit it and projected this holographic display that he was then able to interact with. That's amazing. That could be the future of where we're going. The ultrasound pen has a screen, but has a projector in front, and you can move it over your hand and follow the outline of it. So you could see the bones of my fingers right on the screen. It was like an x-ray of my hand as I held the pen to it. [So would you point this in the sky and learn more about galaxies? Now we're talking about tools.] That would be a great tool. I would like to use a pen rather than a telescope because I don't like having one eye closed to view what's out there. I would have a pen attached to my arm, or more like a fan, and as I move the fan across the sky, it would change that information. [Would that be available on a website, if it's digital or virtual?] It could be available on a website. I see it as an actual tool, though. I know they're coming out with flat-panel screens that you could see through. That's one of the things I would love to have as an artist is a rollable screen that's maybe 3 feet by 4 feet that I could take to the Grand Canyon in a little tube, pull it out, do my drawings on it, or hold it up to the sky and trace the landscape, and go home and connect it into my computer and be able to work with it and manipulate it.
Donna Cox (in person)	
Jackie Morie	
Patrick Lichty (in person)	I would say that needs to unfold. You would have more than a cursory-- maybe a column per page of information-- or maybe you need more. I'm very much about context. Have everything generated by context. I like a little bit of interpretation, but with all things. Interpretation can be as much of a hindrance as a help, you have to balance it. [Do you think, for artists, it's better to have the visual image first, and captions if you want them?] That's really contextually driven. If someone has gone in and read the information about the microphone project and is starting to experiment with these tools, at some point you're not going to need to know everything about...you've gone through the expository information and you already know what you need to know, and then you're in. Maybe you need a link, but the need for broader information diminishes the deeper you go into it. It is important for you to be able to go into that information and get it if you need it. Say you've been away for a year, and you remember how to get into the deeper area, but you've forgotten the broader context, you need to have a link to get back

	up there and see what's going on, otherwise you've just made an Indian rope trick.
Annette Weintraub	
Andurid Kerne	Both are good. Because you can have different intentions when you come there. It depends on who's coming there and why. If someone's coming there, and they're a scientists coming there looking for something specific, they would want text pretty up front. If it's me, I tend to go for integration. I certainly would want things to be visually strong no matter what. So I would put a lot of attention into visual design. The kinds of materials that have to do with this stuff are visually strong, and I would use that, and I would use navigation and metaphor systems around that that take advantage, are symbiotic, of that. Because you're designing an experience, and you want the experience to carry those levels through. You want multi-scale potential, that's why I was talking about zoomability. You want to be able to get overviews, which could in the form of grids and collages where elements, you can get a wide array of elements that are not too big. You want to be able to do the zoom in, and get more context about that, and interactivity can really support that kind of navigation. Traversal process. There are multiple ways I would want to see the relationship between elements and space. A collage system would put things into relationship by putting them next to you. If you could also at the same thing go from that view into a deeper perspective about particular elements, that would allow you to move from one scale to another and allot you to have clearer relationships between those two scales. That's one way I would think bout that. When I talk about zooming, you would want a system that lets you go up and down in levels, but also lets you visualize that set of levels that's there concurrently so you can place yourself in this nested set of elements at the same time you could be right there on a particular, inside of a particular element.
Dorothy Timourian	I think I'd rather look at the picture first, then I read about it, and then I look at it again. I like a lot of information. If it's too complicated, then I just skip some of it. I understand a bit of science because I've been to so many science meetings and lectures. I know a lot of the language. [If you could adjust the level of complexity of the information, how would that be done?] I would put the title, then have the picture, then the data. That's how I would organize it. Under the picture you could have 1-2 lines describing it generally, then an article about it in detail.
Peggy Frank	Actually, culturally, there has been some interest. In context of some of my older students, who have been aware of mythology and the name of Jupiter and why it's connected to the planet, and Mars as a god of war, it's another theme that inspires the youngsters. Otherwise, historically, there's not much connection as far as I'm concerned. Most of my interest is visual as a painter. Just the fabulous color, shape, distance of space with all the stars. Inspiration for abstractions, designs on fabrics, or whatever. It's just one of

	those things that's a turn on just as any other color and shapes and textures in the natural world would be. So anything visual with a capital "V". I usually dwell on the visual, I'll read more about it, what's that? then look at the caption. simply look at the image. certainly some of the nebulae, it holds my attention, sometimes i'ts fun to know exactly what exactly they've discovered. hand to hand. no technical data. the image, fun to do things with it. fool around with the color, look at the backside, anything visually stimulating. text--good, to have simple and basic statement explanation first, then key words and then if you wish, explore the complexity. my own interest, and youngsters. sometimes all you need is a basic explanation, but some older ones want to pursue more, more to look at. what where, how big, etc. then get into that, pick out where, then go down and see more info about it, size. It'd be nice to have those diff stages so you don't have to plow through a lot of stuff that might bore you, turn you off. build upon it.
Glen Sparer	
Paul Hertz	I don't know if it's necessary, you can do a lot with key words. I think it's more that there's actual bugs in the software. When you have several hundred images, and what's accessible runs up to hundreds of thousands, big files, 10mb files of satellite images. thumbnails will help, but that doesn't always tell you a lot. I find it interesting, what are areas that affected by human habitation, then categories of geological landforms, cities too, missing from this is some way of visual interface that you could zoom in and query which images were available for that portion of the earth.
Craig Hansen	I would definitely see the image first and get excited by that. Oftentimes, I know that there are images that I have looked at that, initially, have not been in/of themselves exciting to me until I read their description. One example was on the Hubble website, of one of the very deep space photos, that showed a gravitational lens distorting the images that were behind a certain body. I had heard about that, but to see this physical phenomena you can witness optically, that was pretty astounding to me. If I hadn't read it on the site, the image itself wouldn't have been of interest to me. It was well-presented in that case. That site is pretty well done, I think. Because initially you get descriptions of what it is you're looking at, and then there are opportunities to go deeper.
Lisa Jevbratt	
Geri Wittig	
Nora Raggio	My sense is that there are those of use who are more sensory, we're more experiential in a way, that sensory information to us is very very important, and the experience, whether it's visual or other types of senses that give us an experience of that space. If that is missing, which is the case in many websites just because in general most websites are very flat, they lack dimension and they lack other types of sensory stimulation, sound or even smell, or perception. One for example, travel would be affected by gravity differently and to experience that would be really fantastic. I don't know, maybe you'd have to send little pills or something through the website. Those

	of use who are very much into that experience. And then there are people who are just texts and data fanatics, don't give them pictures or experiences, just give me the data, whether it's text or databases or things I can sort of manipulate. The experiential can also be manipulating depending on how you enter it, and how you navigate through it. But I think there are other types of people who are data-intensive. It's hard to tell. That would be another consideration in terms of classification. How do you want to navigate this? Some people are more interested in the essence of the theory and the concepts that are verbalized, as well as the raw data, which they can then interpret and manipulate and create their own experience. Some other people want to take the trip experientially.
Bonnie Shulkin	
Ben Burresss	I look at the captions we've written as information that's available if people want to find out more. Ooh beautiful image, but maybe don't understand what's going on in that particular image. Some will be interested and some don't. Hubble images right now just displayed as a beautiful image, caption writing is attempt to add more content, another layer for people that want to go into more depth..
Ryan Diduck	
Celeste Burrows	
Wendy Coones (in person)	I personally am usually a text-first person, but I know from my experience of watching visitors that they're usually image-first. It's an age range thing as well. They like to look first, then see if its' compelling enough to read more. [leave it up to the user if they want captions?] That might be a really good thing...understandable icon somewhere that has an image of a book so you can click on that and read the captions. Or, there's a lot of different learning styles, we try to have things both reading and spoken as many times, an image of a book, and image of an ear, listen to the caption as well.
Joan Gillerman	Not necessarily…I think they complement each other a lot….I can wade through a lot of stuff to get to it..
Donna Cox (phone)	
Shawn Lani	
Noah Wittman	
Wendy Coones (written)	Tiered information. Multi-lingual.
James Morgan	All possible information should be accessible from any image. The user should be able do drill down as far as they please.
Patrick Lichty (written)	I believe that a strategy that allows for a cursory amount of information should be employed, with the ability to expand on this information if the user desires.
Myron Krueger	

Garret Moore	

Interviewee's Name	Question 25. How could artists contribute to space science and astronomy?
Christopher Johnson	The first thing I would say is the design and aesthetic of so many of those animations they show, they don't even know how to deal with type…the approach to type, and the dissemination of the information, again, goes back to the validity, would make it so much more valid as information. I saw one of the SIGGRAPH animations at Cal State Northridge, and the visualization of that was very interesting, but the text that introduces it was just kind of boring and detracted from the strength of the research they were doing and the importance of it. I see it as a collaboration, and the contribution and sharing of those ideas and the communication.
Donna Cox (in person)	
Jackie Morie	What I think artists do so well is open up other directions of seeing, just like 2D is a way of looking at something that might give you more than the original, give you information you might not have gotten flying through the space, you can see patterns and things because you're coming at it from a different direction or a different dimension. The artists are that kind of bellwethers, they can keep you from being too grounded in a linear, rational way of thinking, because we never would have broken the bonds of earth if we hadn't had some of those non-rational leaps. There's so much more to discover out there, we haven't even tapped into it. Now we're out in space and there's so much out there.
Patrick Lichty (in person)	
Annette Weintraub	To visualize, to take information, and not scientific visualization, but to interpret the information visually, to connect it to the way we think about space. If you think about the images of William Blake, his images connected space with spirituality and a way of looking at the universe that was reflective of his time, and I think we can do the same thing. Put it in context either by metaphor or the way we image it to show how we feel about it, the effect it has on us, to interpret it.
Andurid Kerne	One thing you could do is actually have a call for people to do work around that. That would be very interesting. If you gave artists some space and resources to explore that specifically, that could be very exciting. Because it's a powerful combination, it'll just create a different kind of experiential resonance to do that. To let artists work in that way, it'd bring out a kind of reflection and especially if you emphasize the notion of participation and the works have to be participatory instead of something you end up showing people. I think it's important that the end result is something that lets people participate and engage in it.
Dorothy Timourian	The hands-on kind of exhibit really works really well. Like the simulation of the Challenger. My husband runs a program for scientists that go into

	schools and talk to the children and do hands-on projects in science. Everybody was really excited about it. You felt like a child again doing all these wonderful things. I think that kind of thing is tremendous. If NASA could do that for adults at some places would be really terrific. I don't know if they have that in Cape Canaveral or in Texas.
Peggy Frank	art has always humanized things that are hard to understand, visual arts or music or drama. Always dealt with issues, natural world or social issues, that are hard to understand. Another role would be artists interpretation is good PR for space program, NASA. publicize a series of, posters to postage stamps NASA website, people's interpretation, children's, professional artists, sculpture/prints, themes and bits of music, inspired, young/old composers, electronic music. waft of something. Gustav Holtz "the planets". I have a couple of students who like to compose, over the computer. any kind of art or music inspired by the imagery. good PR, humanizes this vast realm so far away from us. most people really do not have much to do with astronomers. bring it down to earth.
Glen Sparer	
Paul Hertz	Certainly important for visualization. David Ems working for JPL in the early days, or Donna Cox for the visualization of large data sets. Which we don't have an adequate visual description.
Craig Hansen	I would say that most artists think a lot or deal a lot with perceptions, the nuances of how people know things and experience things, as well as how people are moved by what they see and experience and what resonance in a person from the world around us. I think astronomy almost more than any other science is one that taps pretty quickly into experiences of awe and wonder, and gratitude for being able to see these kinds of things. I think artists can help present, organize or synthesize things that scientists are learning to not necessarily to improve people's life practically, but to enrich the quality of their life by helping the general public get a more visceral sense, or a more tactile sense, of what's being learned and the excitement of what's out there. Artist as a good resource for that.
Lisa Jevbratt	Always artists working in this context, it's kind of an artistic license to pretend that you're naïve. I don't get this, I don't understand, I'm just going to look at the face value of things. Both saying, this data is probably meaningless, knowing there is meaning in it--or saying, there's much more meaning in here than you guys believe it is. Even if you know and you don't really believe it you can take those positions, you're more free to play with your methods. The scientists can't do it because it's not of their paradigm, but we can do it and benefit from our play of it.
Geri Wittig	I think in terms of art's relationship to science or engineering, it's just the sort of thought process that happens in art, a generalization, there's this general aspect--we approach art with a tendency to think about things in a really unorthodox ways and combining things that are not usually considered you would juxtapose. There's this sort of unorthodox, creative approach that artists take a lot of times that I think impacts those fields in terms of thinking

	about things in a fresh way. A lot of it is purely out of ignorance, and when people don't know they shouldn't think about something in this way, those are times that create pretty interesting results. Sometimes a way to look at it, I think art finds things it wasn't necessarily looking for.
Nora Raggio	
Bonnie Shulkin	
Ben Burresss	
Ryan Diduck	
Celeste Burrows	
Wendy Coones (in person)	What the aspect relationship of people learning space science is, there's something that's contrary to instinct that people really do enjoy being made to feel small. To realize you're a part of the universe, being stardust, and how accidental it is that human beings are on the earth, that we're here at all, that's a fairly novel thing. It's only been a couple of hundred years, and not even that, 100 years perhaps that we've had really fundamental knowledge that it's extremely unlikely we're here...and that the fact that the knowledge we take for granted now, the physical bodies...came from a big huge explosion a couple of billion years ago, is really an awe-inspiring concept, that people get to learn every single day...has always existed, and has been going through all these combinations and....is inert, and not alive, and makes us very happy that we're alive...dirt that happened to be combined in a very unlikely way. This is something that's like a celebration of the fact that we're a people that can ponder through this kind of stuff. Uniquely human, we can appreciate the fact not just that we're here, but what an unlikely scenario it is. Seeing people be able to get that is a really important thing. Relation with art and astronomers come in, what a strong affinity there is for one another, there is a very spiritual side to astronomy as a scientists, because in a way you're looking for what is a modern God. ...why are we looking for this stuff, why does it matter what color a sunset is on Jupiter? It's an interesting and a funny thing. There is a possibility for visitors, audience, or whoever...to be able to have a really great sort of conceptualization of how it is that they as an individual fit into this amazing story that's larger than life, that goes back to the essence of everything. It's like they're one tiny tiny tiny tiny piece in all of that, and that's kind of cool.
Joan Gillerman	Yes I do. Partly because it is so visual and so beautiful,…deep space objects, like the nebulas…if you've been to one of the big observatories, and you've looked through the telescope there, and have the room and dome move and this gigantic instrument looking at a double, pink and blue star. I remember that you get your eyes adapted first with her ed light. not everyone can see the color. ...if you see it as a very sharp beautiful object, just on a very ...it changes your view on the universe, it really does.
Donna Cox (phone)	
Shawn Lani	I don't' know that many, it sure seems to =me that those are the most beautiful images I've ever seen, ever. The thing that catches their eye is the same thing though would have caught my eye if I had been looking…in the end, not that different. They're intrigued by it, they want to know more...they want to capture it, they want to show it, they want to preserve it, they want to talk about it. That's the same thing that artists would say. They'll go through the same process.
Noah Wittman	Artists like scientists help us think and reflect about the world. They could come in

	and help, for example, frame photos and images, or juxtapose images that make us think or react in a certain way….design an interface. [multipliers?] sure.
Wendy Coones (written)	Obviously visualization. Large moving physical artifice.
James Morgan	Through an alternate perspective artists can contextualize information differently. Working with scientists benefits both artists and scientists we learn from the others methods.
Patrick Lichty (written)	I believe that a strategy that allows for a cursory amount of information should be employed, with the ability to expand on this information if the user desires. I think that many artists have insight into the area of pattern recognition, visual association, conceptual linking, communications, spatial relations and aesthetic/visual ergonomics in experience design for media that scientists may not possess or in different degrees. Perhaps the integration of artists into the space sciences team could increase the ability of that body of researcher to communicate more effectively to the general public.
Myron Krueger	Have a show or something, what artists could do with scientific data. Fly away from earth and fly to the moon, or to the other planets, there had been military funded somebody to do that interface as a way of looking at military battlefields. That's just one example. Here's another thing: apparently on Titan you have a weather cycle, you have precipitation of methane, something frozen on the ground,...atmosphere, and then rains down but it's physics are different. On Jupiter there may be 3 such gasses, 3 such materials, 3 different kinds of rain or snow. Depicting that or trying to communicate what it would be like if you were on a planet and in an alien rainfall, what would the weather phenomena be? We know that there are some worlds that are different form ours, what ....atmosphere, and temperatures are such....different kind of gravity, so strong mission of gravity...on this planet gravity is so strong that there is no jumping, ...alien physics, trying to experience it...wind tunnels and weather models of earth...how to show the graph. Many of the techniques that I implemented and proposed you will now see on weather shows. Now there's Donna Cox a paid job to do that sort of thing at University of Illinois, helping the scientist present their material visually. She was tied to a scientific institution was something I departed from, but basically had taken the same step, it was a role of how you depict phenomena...what it would be like to participate in phenomena. and example of something what you can enlist artists to do. What are there problems that artists might have some insight into how to present or how to experience that may be of some utility....to scientists doing their scientific work. My wind tunnel was so much better than NASA's at the time of their...impossible to use. The attitude of somebody who comes at it from the consumer...me putting my hand in the water, in the lake as a boy, i'd see the patterns that my hand would make on the current as it went by. that fast, that easy. primary goal is on the consumer end, the experience end, not the technical, where did this data come from. The artists doesn't have to do it in a way that necessarily has to be used as a tool....depicting the birth of the universe, how would you make an experience ..quantum theory or space-time dilation, there are lots of things that are not well communicated, gravity-well...mathematicians and scientists about how the universe works...but not part of public intuition. I was thinking that middle school science and even elementary school should be teaching to change people's intuition before they worry about the fact. f you don't start here,...increasingly the scientists are all born abroad. Most of the students are not

	American-born, that's a pitiful record for our education system. How do we get to change the attitude towards science, math...You would not believe they would refuse to tell kids about what math is for. ..algebra is taught with all kinds of definitions...200 pages, not about problem solving. the kids...the definitions really don't matter if you're not a professional mathematician. You really think this is neat, you want to know more. The site I would really be working on that somehow gets across some of hte really incredibly neat stuff that's going on, that might go on, like
Garret Moore	

Interviewee's Name	Question 26. What is the role of art in visualization or interpretation of outer space or the Universe?
Christopher Johnson	I think any kind of collaboration is going to contribute to that. One of the guys I went to high school with, Greg, he actually got into chemistry, but now he's working at Stanford on biology and DNA. He's figured out a way to cut down the process of re-sequencing DNA--it used to take 48 hours. Well, by adding a few chemicals, he shortened the process to almost 2 hours. So he's approached it as a chemist and he's revolutionized how DNA research will be done. As an artist, I mean, Eduardo Kac, thinking about putting the jellyfish DNA for the glow-in-the-dark rabbit, that's one way of approaching it. Or this guy over here, using the DNA and collecting that and just the way he's exhibited it is visually appealing. One of the things I remember as a child is going to the Museum of Science and Industry in Chicago and one of the major things that fascinated me was the slices of people. They actually took people and sliced them, and had them sandwiched between pieces of plexiglass. I spent hours just looking at all the shapes and forms, and I think it was more the colors and the forms and "Oh, this shape is actually the lining of the stomach, this is the leg bone". Seeing it that way was amazing.
Donna Cox (in person)	
Jackie Morie	
Patrick Lichty (in person)	
Annette Weintraub	
Andurid Kerne	
Dorothy Timourian	
Peggy Frank	
Glen Sparer	
Paul Hertz	Astronomers as opposed to cosmologists [or scientists in general?]
Craig Hansen	
Lisa Jevbratt	
Geri Wittig	
Nora Raggio	
Bonnie Shulkin	
Ben Burresss	
Ryan Diduck	
Celeste Burrows	Animations and images…There's a few things: We have some astronomy artwork, there's been a few artists, a well-know astronomer has a mural out here by our stairway, I forget. He's an astronomer but he's talented as an artist. He has artwork that is very true to science...they're showing you

	something you can never see a photograph of. In that sense, the art can represent something that you can never see directly. It's art, it's beautiful. Art and engaging. We have art upstairs that shows where meteorites come from. [Astronomers are visual people.] Yes.
Wendy Coones (in person)	
Joan Gillerman	
Donna Cox (phone)	I think the tools are not there. That artists can help to design the tools so many people can use them. At this point and time, artists' involvement…whole approach of how this data can be accessed by people other than scientists or technologists. Without the role of the artist...creative practices, I believe the data will always remain an esoteric archive only scientists will be able to understand and access...human computer interface...how that data is set up and how it is leveraged, artists should have input, because they speak for a large portion of the population...lay people, but have some very innovative use for the data. Another way...other than visualization experts...the designing of tools, which i just explained. Artists can bring to the table a way of accessing and formatting the data so ppl...better handle on it. Those design concepts to the table. Two critical ways I think artists will contribute...if artists have access to that data, they will re-contextualize data into...questions will be asked that maybe have not been asked by scientists alone. Images will become more integrated into our culture....result of the questions that will be asked.
Shawn Lani	
Noah Wittman	
Wendy Coones (written)	Not advertising!
James Morgan	Fundamental, color choices are made on the interpretation of radio telescope images. Artists are not necessarily more visual than anyone else but there is a certain amount of study involved. If the goal is the transmission of knowledge then art can reach a brain in ways logic, reasoning, and facts cannot.
Patrick Lichty (written)	Visualization and various strategies for pattern association might allow the user to have a better grasp of relations between objects, their location, relative position to earth.
Myron Krueger	
Garret Moore	

Interviewee's Name	Question 27. What do you think the role of scientific data and astronomy could be in Art?
Christopher Johnson	When I think of art, I actually think of the "Raft of Medusa" and Pablo Picasso, but you have the art of film and what they're doing for movies. I mean, those visualizations of storms and water, that's also amazing to think of what can be done in those aspects. If there were ways of taking my image that I just draw and incorporating it with data of a storm, and the amount of rainfall, and that equated to the degradation of my image, transforming or metamorphosing into another one of my images--those are all kinds of ways of dealing with the data with a different approach. That the data is not really used for a scientific purpose but for the purpose of degeneration. If I could take a picture of my face every day for a year, and then have a transparency equated to the temperature--I mean, there's all kinds of ways of looking at that.
Donna Cox (in person)	
Jackie Morie	I think the scientific approach is a wonderful exercise. I think there's lots of those. There is great validity in scientific approach for everybody. Everybody's an artist.[Do you see a site like we're talking about influencing, changing, manipulating people's perception of the universe?] I hope so. I think one of our most unique things as humans is that we have this incredibly malleable brain that we only use a portion of. We are all our lives channeled into certain things that burn specific pathways in our brains, but all those things that challenge us burn different pathways in our brain, and like that bubble I was talking about, they start firing off more and more neurons and different stars and there's just more of everything. We have a greater experience and a much greater life, and it's all fueled by everything. I mean, I'm an artist, and a scientist, and I choose when I want to think about things rationally, and that informs what I think as an artist, and the art stuff informs what I think as a rational scientist. I don't see the two as dissimilar. I think everybody's capable of this. If you can come up with a website that helps set off these sparks in people's brains, you've created new constellations, you've created new universes.
Patrick Lichty (in person)	
Annette Weintraub	I think we're all influenced by the images we see, because they're images we might have imagined and now we know what these things look like, and we can't go back to the way we imagined them. It has a powerful influence. Those images become part of the images we see of the solar system or the earth from space.
Andurid Kerne	That's how it affects people, and it's both ways of course. On one hand it expands our range of possibilities and what we know in many ways. In

	another way, it imposes on us and can be a metaphor and a process. It's about people losing control over their lives just as much as gaining it. It can be dehumanizing as well as humanizing. That's to me why it's important to work with it, it's important to encourage it in that humanizing direction.
Dorothy Timourian	I see it as very inspirational for art, that everything in the world is inspirational to an artist depending on what really inspires them and turns them on. Space is one of the last frontiers we have in the world, we can explore a little more in Antarctica and North Pole, South Pole. I think when Kennedy started the space program it caught everyone's imagination. Today people are still very interested in space. I know when I teach my classes to children, they're just very interested in space, some of the kids know more about space than I do. Here in Livermore there's a lot of people in science and in Livermore Laboratories, so the kids are really interested in science and space projects. I know a girl who grew up wanting to me an astronaut and she didn't get to but she works for AIMS, working in math even though she's not an astronaut.
Peggy Frank	simply as inspiration. Fantastical color and form, simply the awe, knowledge of huge distance and size. Who knows what it might trigger? Social interaction or vastness of desert/ocean, night sky and heavenly bodies. Role of astronomy for art is simply inspiration.
Glen Sparer	
Paul Hertz	The influence in mainstream artists is by and large indirect. There's been much more interest in recent years with the social function of art, rather than representation of scientific imagery. Probably within music you're going to find a much closer alliance, than visual art, because I think historically the production of musical instruments is highly technological. Composition has become a very complex way of creating events that often has mathematical qualities, and sound production now using signal processing tools. There's been a lot of cross-fertilization...
Craig Hansen	
Lisa Jevbratt	I think we get to play with their models. They're providing the models of reality that we're currently saying what we're based in, what our reality is, what our lives are based on. And then we get to play with that. They have to be there to define something for us to pack.
Geri Wittig	
Nora Raggio	
Bonnie Shulkin	
Ben Burresss	
Ryan Diduck	
Celeste Burrows	I know artists can keep themselves busy creating animations demonstrating what happens, like the ones that comes with the textbooks. It's much more impressive compared to reading it… said really much more to me…The drama of it all, that seems to be a stimulus for art, you talk about supernovae and colliding galaxies. That grabs the kids. It might also produce art. Here and there I see nice art on science websites, usually because they're trying to draw something...what it would look like when the moon is formed. It's

	appealing. Usually I'm looking for the scientific information the art is trying to give me.
Wendy Coones (in person)	
Joan Gillerman	It's probably different for different works. I've seen a couple of interesting pieces on AIDS…humanistic aspects on it. To create a discussion is why they're doing it, they're not necessarily interactive. When I'm at an active lava flow, like inches from it, or at a total solar eclipse, there is nothing like the actual experience itself Having said that, I'm always totally preoccupied for documenting it for this other piece I'm going to do. ...challenge how are you going to get this huge idea and sense of environmental bigness in the context of an artwork. What are the things I can do that this is a whole environment, it's not just about this, then that's just a documentation. If you want it to be an interactive environment....then you have a whole bunch of other challenges...idea that I know is fabulous because I've been there, how do you take that perspective and get it out so somebody can understand what it's like. Whatever, a sensual level...It's hard to share that...I will try. But you're dealing with a totally different medium....real experience that's more that 360' with the rotating camera obscura mount....whole sphere, it's experiences that involve other people, in other...what is a sphere?
Donna Cox (phone	
Shawn Lani	I probably wasn't an artist …which is heavily steeped in science. I think I'm more aware of changing patterns, of a large scale. ……so I draw little lines where the sun is setting, sometimes it carves through these carved paned glass…whole wall…little lines and little images.. check the data and what happened last year...something kind of interesting happens. Watching the world change slowly around me has been a habit that's formed form working here.
Noah Wittman	
Wendy Coones (written)	It could guide artists in helping scientists understand the data they have gathered. Understanding this as a continuation of realism in art. Like the birth of perspective drawing.
James Morgan	I think it is important that the two mix.
Patrick Lichty (written)	This is almost like asking, "What is creativity?" I believe that Astronomy and scientific data could have immense application in Art, but the hurdles that need to be overcome are largely associated with making the discursive links between the disciplines, meaning that there are many areas in which the two relate to one another, it's merely making both more aware of the other, and being diligent about determining what those links are.
Myron Krueger	
Garret Moore	

Interviewee's Name	Question 28. Do you know of other artists working with scientific data and/or astronomy data?
Christopher Johnson	Off the top of my head, definitely Eduardo Kac and James Turrell actually deals with it quite a bit. I think Steve Schkolne would really benefit from working with that. I know there's a lot of graphic artists that would be able to get in and use the data for information graphics, and I can't think of any specific names right now. I can send those to you later.
Donna Cox (in person)	
Jackie Morie	Donna Cox comes to mind. Joseph Cornell comes to mind, because he built universes and transcended universes. If he'd come up with some of those measurements we were talking about, I think that would've been interesting. I keep a file of people who connect art and science. There's a couple of artists that paint with grass. When you set something on grass it's not able to complete it's photosynthesis so it loses it's green. So they place things on these large patches of grass to create these images. And the photographs of the grass look like photographs, they have very smooth tonalities. Their work informed biologists in creating different kinds of grass genetically. So that was Ken Knowlton and this woman's in Maryland, I can't think of her name. She worked at Bell Labs with Ken Norton and came up with that idea, as the artist, that different letters create a different tonal value. She wrote Beeflix with Ken Knowlton, which was an animation language in 1970. There's the people making nano-sized sculptures using non-lasers, or whatever. I feel people use what we consider pure science as part of their art making.
Patrick Lichty (in person)	someone more like Stelarc might even be...because he's taking a lot of this information and turning back into a visceral component of the body. Eduardo Kac...both of these artists are problematic for me in terms of visualization. I think they're more into the idea of realization instead of visualization, and in terms of engagement with a larger public, some of their resources that Stelarc and Eduardo have are outside the realm of feasibility to most people. I think realization nowadays is much more accessible to people. I think that Donna Cox is doing amazing, amazing things in the Big Bang project. That's fairly traditionalist representation of data, but in doing simulations like that, giving the look and feel of something is extremely important. I'm not going to be critical of our more hard scientific colleagues. What artists can do in this.. in the hard research ideas, I've been very involved in the development of reusable near-Earth man-vehicles. I've had, with a company TGV rockets, they said, we have this data and these designs, but if we do a mockup it'll look sterile. What we need is for you to breathe life into it. I think the idea of creating a pattern, giving something a visceral life, that's the tarot card of the Magician, that's the artists point, area in this. We may have some background

	in this, and I think that's helpful if they do, we have strengths. We can look at patterns, visualizations, conceptual relations and cultural...we have different areas of expertise. People like Donna are taking this data and turning it into an engaging form of media, something people can actually consider as statistically relevant. Something from a simulationist point, makes sense from a cosmological point, but also a thing of beauty, and is appealing, and engages with the viewer. It inspires desire within the viewer. That idea of inspiring desire within the viewer as intellectually challenging is beautiful. Challenge, appeal, desire. I think they're important--like the yin and yang of things--sorry if I'm sounding New Age-y. When dealing with expression, though, I think that these "touchy-feely" things are very important, even though a more Apollonian person like myself in the harder humanities--cognitive science and such--would care to admit. Some of my color sculptures, for instance, deals with very vibrant color schemes. I'm dealing with color, with form. They're engaging from a visual standpoint. Make that animation very engaging. I think engagement, from a visual, intellectual, standpoint. It's a big challenge, I realize that. We live in such a fast-food didactic society. I believe that people are hungry for something worthwhile to do with themselves rather than surfing through 500 sites of crap. I think the children, young adults, rather than watching Star Trek, need to feel that they can go out and really be engaging with this data and getting exciting about earth science and astrophysics. There's an astro-cartography room in the movie, Star Trek Generations. They're standing in the middle of this platform, and this huge spherical display of where they were at versus where they were going, and they'd point out where the matrix was coming from, and all this information would pop up, and they could see where the matrix was going through down the path, they could see all these things. That was fun! Out in emerging technologies there's a display called the Twister, a 360 degree stereoscopic LCD display that you could get into, and it's all around you. It's a very crude explication of something that could be really amazing like this. Things like this are at the edge of what we're capable of now. I think we can do things like this. We have a fairly short attention span, but with a depth of content, and building of community, and a way that would allow people to do their own research. One thing I really like is the SETI@home program. That's a really novel way for people to get involved. You're doing something. I think too many programs like this because you wind up with a depletion of symbols, it dilutes the excitement into too many things, like now and the record companies, rather than the Beatles and Rolling Stones. Instead of boulders you have a lot of powder. There should be some focus in some of these things. This is one of the problems with my work. I am too dispersed and interested in too many things. In one way, I consider it a survival tool for this day and age because I'm independent. But on the other hand, it's merely a matter of treading water, being in as many places as I can, it's not a matter of ego, it's a matter of me trying to survive. It's the fact that I don't think we have enough focus and reflection. Through NASA sites or tools in which we

	can have a deeper engagement, we can actually reflect on the ways that we learn from these things in a greater cultural context of where astronomy comes from. Actually learning some of the principles, terminology...it could be a good educational tool, adults, anyone interested in learning this, people that can get more people into the space sciences. I still think people should get suggestions once in a while. Not a bombardment of things. Amongst themselves in the disciplines, but also back and forth...if people had really cogent questions or commentary for astronomers, they could talk to astronomers about their work.
Annette Weintraub	I'm sure there a lot of people working on the eb with databases. I'm just drawing a blank now.
Andurid Kerne	Well, there Natalie Jeremijenko's "Ride the Loma Prieta Pony", that's a nice piece with the bucking bronco ride, the more seismic activity there is the more it tries to throw the rider. [Is this art effecting science, or science affecting art?] Both, the arrows go both ways. Jennifer Healy has this piece that has to do with startled response that's kind of interesting. About measuring when people are startled and using that to trigger video.
Dorothy Timourian	I can't give you any names, but not long ago, this year, I saw a painting of space at SF MOMA, which was an exhibition of different artists' work. So every so often I see other people doing space paintings. There's DeWitt is an artist that did some artwork that was burns on paper done from the Sun, he had a lot of explanation for that. He had a lot of data from the sun experiments that he did. I looked up in one of my exhibit catalogs from SF MOMA, and there's an artist Spien did drawings from within the nucleus in 1976. Artists from time to time do use scientific data and things related to science and space.
Peggy Frank	no, not of any right now. I know there's a whole group of artist, photo-like paintings, standing on the surface of mars into space. I'd rather see a fabulous abstraction based on feelings. Students use this all the time. Jus that it is such a fabulous thing to think about and imagine. because you can't actually go there, see it, you imagine them. children are more open to the unknown and the mystery of things that aren't quite so practical.
Glen Sparer	I saw this interesting piece by Ken Goldberg called "Mori", and he took data from the Hayward earthquake fault, we are all living on this fault. "Mori" of course means death, or presence of death in Japanese, and it was a hectic sound, visual and interactive installation. You would go up this black ramp, it was almost like being in a cave, and the only light was this tiny little thin neon tube that ran across the ramp, and you go into this circular area, you hear the earthquake and shaking as you're going up, and the feeling of walls, you could feel it vibrating. You go up, there is this hole in floor as if you were looking down into a womb, and there were round iron rods around inside this hole, and looking up was a computer monitor, and you see this kind of heartbeat that's going up and down, and it was connected to the Hayward faults. Every time you saw the heartbeat go up -- he did it with a sound designer-- so the whole thing would shaking, vibrating, sometimes you would

	hear the sound of like a San Francisco trolley, and the sound of voices, but every time the wave would go up with the earthquake, your heart would race. Because the earthquake was happening right then, but it didn't kill you, it wouldn't make it to the peak, and it would go back down again, and then your pulse would slow. It's on Ken Goldberg's website, it's called "Mori", but I actually saw it at this big exhibit of new media artwork at the Art Institute in San Francisco last year. At the same time the "001" thing was going on at the San Francisco Museum of Modern Art.
Paul Hertz	A number of artists working with biotechnology. Natalie Jeremijenko. The ubiquitous Eduardo C…Australian artist's name, creating tissue around bio cells to create sculptures. Areas of robotics and A-life has….often, it's interesting how artists creatively misinterpret what scientific beliefs are. A lot of what artists consider complexity is really dynamic systems...music and art world, following John Cage, physics as inspiration, or at least, recreate in his art the functions nature uses in creating the world. Inter-determinacy of physics to .... not really close to the statistical methods of physics. Still working as an artists, equations wrong but the music is interesting. Artists are trying to do something else. Makes better art, rather than going strictly with the rules.
Craig Hansen	A few. There's a sculptor, Ned Kahn, he's a pretty well-known name in the exhibit community, he used to work at the Exploratorium. He has a number of interactives, they border on being interactive sculptures at Chabot Science Center. He deals a lot with the forces of nature and change. There is a group in East Bay, who are bridging the boundaries of science, history, and social and environmental use. They are interested in tracing the history of different places in the East Bay through images, either old photographs, up to current satellite images, helping people see how areas have evolved from their natural state to the state that they're in now. They are definitely, they produce scientifically accurate and valuable maps and things like that, but also do some things that are more visually poetic that draw connections from one image to another to tell the story of how one are went from being a marsh to being a mission, and end up being a shopping mall. It gives you perspective on what you see around you and what has come before.
Lisa Jevbratt	There's a lot of artists right now working with--people right now can access all sorts of data with the internet--people working on the internet tend to work on this kind of data. C5 for example, also artists that were in the Whitney Biannual for the art this year. John Klima was using this sort of satellite geographical data. In whole the internet art community that works a lot both with visualization and large data sets. I think this guy I'm going to teach with at UC Santa Barbara, Marco Pelan, I've been looking at his web stuff, I think he does a lot of data, things about space I think. Sonya Rappoport up in Berkeley, she was talking to me about some project doing with some relation to space communication data. It's not the type of project I work on, but one that was kind of nice in dealing with the human is the project on the heart. This was more about sending information out there, than reading information

	in. Sending information out through the heart. If you're really going to work with the human, as opposed to clicking, you can work with teh physical, complexity of the human. Accept the complexity, and not coming down to the simplified version of two interfaces trying to work with each other. He does 3-dimensional visualization stuff, John Klima, and Ben Fry. We're going to have a conference at the University of Colorado, Boulder, in a few weeks with me, John Klima, Mary Flannigan, artists working with visualization strategies. I think there's a lot of that going on.
Geri Wittig	A lot of people are doing mapping projects and working with ideas of mapping and GPS, we're just at the beginnings of people trying to move into biotech and engineering. There is someone that has gotten a lot of notoriety, but I don't like him, I think he's just doing this for sensationalism, so I don't want to talk about him. There are people doing what he's trying to do, but in a real way, in terms of luminescent animals, to get luminescent cells from deep sea creatures and bringing that into other life forms. That's a pretty interesting field that I have a lot of concern about in terms of being someone who's an animal rights person and a vegetarian, knowing how the art world can be really ego-driven and people might do things for not very valuable reasons. There are people that are wanting to go into space in terms of shuttle type things, and I don't know how far it is in pragmatics. I know there is a European project that they were asking people if they were interested, a MIR-like space station. I don't even know if it exists or if they're just training people. I think artists are starting to look at those things in terms of getting up into space onto structures that already exist. It's just so exorbitantly expensive I don't really know how far away all that is.
Nora Raggio	There's a variety of artists who are using data as part of their works: Eduardo Kac is definitely one of them. Lisa Jevbratt, her whole work is based on data and the interpretation of that data, and sort of relationships between that data and some way of pictorializing, of manifesting that data in an interesting way. The whole C5 collaboration, they're using data all the time. There's a group that's a combination of people from MIT and Tokyo where you can enter, say genomic data, and they'll create some sort of organism for you based on the information you give them and the algorithms that they use. There are people in Israel, I forget who specifically, but they're working with bacterial data and creating images from the understanding of that bacterial information. The guy at Berkeley, Ken Goldberg, he uses data from the Internet to work on specific art pieces. Those are just a few. There's been a mushrooming of people that are using a vast amount of data to do this. There's even a project where people talking about space go and categorize craters, so they're basically using people from the Net as slave labor. Definitely they're using data. I would also recommend that you talk to someone who is very much in touch with this information, he's a mathematician and computer scientist, and he works for Park, which is now spun off of Xerox, his name is Marshall Burns. He is very much in tune with people who are doing this kind of work, other mathematicians who sometimes do artwork. Say from Australia, Natalie

	Jeremijenko also works with a lot of data and uses it to make art.
Bonnie Shulkin	
Ben Burresss	
Ryan Diduck	
Celeste Burrows	
Wendy Coones (in person)	I can, but not right now. I have most of my information is at my desk at work. Just offhand…not that many. One very large segment of artists that are working with the space sciences that are not really recognized in the contemporary fine art community because the artwork isn't that good. Painters that's painting science fiction landscapes.. they're very accurate and precise, a very particular style, they're all over the place. Landscape on Demos at sunset with the sun a little speck in the background...artists that are working on all of the different TV shows, having to create a vision. It's sort of like being space travelers...what's scientifically known about the place. That's a whole genre that they're not going to be written up in Art in America, they're doing things that people have been doing for years and years and years.
Joan Gillerman	Joel Hagen, I don't know exactly…worked with JPL before…paintings, probably electronic…up at California State University Arts program…Space arts. I haven't talked to him in years, but I'm sure he's still doing that. We have another installation by the way at the Tech Museum of Innovation...interviewed a lot of...innovation and technology. Covered areas of cloning, genetic engineering, biotechnology...nano technology...quality of life ethics involved with all of these new...Dr. Sylvia Earl, USGS Allen Lynn, medical doctors, urban planners. I really don't, it doesn't mean I couldn't come up with some if I didn't think about it. I think in general they're more interested in interpretations of things...interpretations of science and science data. I know a lot of artists that might use a little snippet of a little something that's been done in science...a whole piece around something biological process, it doesn't wind up being scientific at all...a social comment on science, that happens a lot. .. It's very important not to be condescending. There are ways to communicate without being condescending and being understood...people can get engaged...that's a part of play, which is an important aspect of things.
Donna Cox (phone)	We collaborate with the Hayden planetarium in NYC, former students…one of the top artists there is Carter Emmert, …I would consider him to be an extremely good artist…traditional background.. used to work for NAS…..several other artists working there on projects for the planetarium dome...treating it very artistically and sending it out to the public thought he shows that they do. The other artists coming back from the biannual electronic arts show that's in Perth, Australia--there were several other artists there. I don't know their names, I just met them. That are working with large data and bringing it into a gallery setting...explorations of that data.
Shawn Lani	One gallery in there is called …Landscapes, done by my friend Ed Cohen…Most of that work was developed playing with materials…art bubbling up through sand…alien landscapes.. wind blowing around…all

	these formations are found in the solar systems on some planets ...they're reminiscent, they’re great points to start from.. it's not trying to show something specific, its' visually reminiscent of something that's real. ...it kind of behaves a little bit like a comet. You can talk about comets, and broaden their discussion out into something that might not have interested them before...You could argue some painters in the vaguer sense. There was a guy who did a book called Van Dyke.. fluid motion...took pictures of vortices and instabilities....beautiful images.. convection cells or wrinkling in waves formation....ships and oil spills...he saw the commonality between this are a of study and used his contacts in the scientific world...it's almost like you put them together aesthetically. ...That was a really neat book.
Noah Wittman	I can't think of anyone right now.
Wendy Coones (written)	No.
James Morgan	Steve Wilson runs a course on artists and emerging technologies at SFSU.
Patrick Lichty (written)	Some, but not directly.
Myron Krueger	
Garret Moore	

Interviewee's Name	Question 29. Could you cite some relevant works in the Arts which involve scientific data and/or astronomy data?
Christopher Johnson	
Donna Cox (in person)	
Jackie Morie	
Patrick Lichty (in person)	
Annette Weintraub	
Andurid Kerne	Well, there's this work Techla [Schiphorst] and I've started doing. That's measuring and modeling and representing body state and using it as a basis for communication, that's really about taking personal data reflects body and emotions and visualizing it and representing it. It's been called the Whisper project so far, but there may be some derivative names or branching in terms of that. That project is certainly about the representation of scientific data, or body data, personal data--the scientific ness of it or the personal ness of it, is about creating a perspective that's based equally on both of those dimensions of what the data is.
Dorothy Timourian	
Peggy Frank	
Glen Sparer	
Paul Hertz	
Craig Hansen	
Lisa Jevbratt	
Geri Wittig	
Nora Raggio	
Bonnie Shulkin	
Ben Burresss	
Ryan Diduck	
Celeste Burrows	
Wendy Coones (in person)	
Joan Gillerman	
Donna Cox (phone)	
Shawn Lani	
Noah Wittman	
Wendy Coones (written)	Stelarc. Biology, anthropology collage documentary. Something with weather. That Mac program where you could make a solar system.

James Morgan	Not off the top of my head. I would look at rhizome.org or Steve's book information arts.
Patrick Lichty (written)	I only know of the Deep Sky Project.
Myron Krueger	
Garret Moore	He did the 3D exhibit at Smithsonian for the solar system. Don Davis. He's been working since in his 20s, with USGS, JPL, NASA, visualizations, one of the artists on series of Cosmos…Adolf Schaller. Bringing these together rather than pulling them apart. Our tradition scientifically is to take things apart, sciences are very fragmented and cloistered, collaborative potential not recognized yet. Joe Firmage, to make discoveries on combining each of our views for a greater understanding. Have the particle physicist talk to the astrophysicist.

Interviewee's Name	Question 30. Do you have any recommendations to NASA on how to make space science and astronomy data and imagery interesting/accessible/useful to artists?
Christopher Johnson	I think that accessibility and being able to communicate and collaborate is the best use of that for artists. I think having those opportunities and maybe even grants or workshops, or within the website, discussion boards, and a registry of artists that would be interested in using the data or working with other artists on that. And making it clear that it doesn't matter how much expertise you have. If space intrigues you at all, register, and then we'll go from there. If as a kid you looked up at the stars and were intrigued, there's something there for you now. We can still help you discover those intricacies and the development of that, and put you into contact with other people that might be interested in those.
Donna Cox (in person)	
Jackie Morie	I would like NASA to think as much outside the box, outside of earth and into the universe, as possible. Think of the website as an inspiration, a catalyst, and not just a repository of information. Think of it as something that goes out and creates new stars, instead of just coalescing all the stars into whatever. Make it an energetic, creative thing that goes out. It'd be great that if NASA as they're doing it think about the words from the Jesuit philosopher Tillhard de Chadin, who in 1926, came up with the concept of the neuro-sphere. Now, this has been latched on to by people, and there's lots of neuro-sphere websites and neuro-sphere web rings out there. In 1926 he came up with this idea, he was looking up at the biosphere, which was a very new idea about earth being surrounded by this halo of life off the surface. He envisioned that the earth was growing and connecting in ways it has never done before in the area of thought, and that we'd create this network of thought that would link everything on the planet. He called that the neuro-sphere. This is 1926, there's not computers for a long time. He envisioned it to the point it would start enfolding on itself, like fissures in the brain, and that new connections would be made, and we're at that point with the Internet in a very fledgling way. I started reading Chardin when I was 18, and this was way before computers. I think Chardin's dream is coming true in ways you can't imagine. And this site can have a big influence in that continuing connectivity in the neuro-sphere.
Patrick Lichty (in person)	I think on one hand, we've been talking about this a great deal, an expansion of the sensorial. Looking at it from the perspective of an intuitive form of ergonomics, an intuitive form of information architecture. We've seen it here at SIGGRAPH we have so many people working with multiple ways of visualization, multiple ways of using sensorial to analyze data so we could ascertain these patterns. The German research group in emerging

	technologies that was doing vortex flow analyses of these beautiful, 3D vector representation. They are gorgeous. I think that NVO could be an incredible tool for engagement with the public, I think this is a really unique opportunity for NASA to really get them excited again, out of the Star Trek rut. The idea that, okay, we're not going to be flying around in the starship Enterprise anymore. It might not be 2300, but 2400 or 2800. We're not even doing 2001, but if we get more interest in the space program--and I hope it doesn't have to be based on another Cold War space competition-- it's one of the last greatest adventures. By the way, I want us to get back to the moon. We keep talking about Mars, going to Mars...we need a moon base! We could do all sorts of incredible research on the moon. And Mars will probably be just as desolate as the moon, it's just further away, a greater technological challenge.
Annette Weintraub	I think of a way of reaching out to artists so we understand more about these images when we use them. Our understanding is more complete and less superficial, because these images are becoming more and more a part of our daily life, but I don't think they're always used well. They're used very often in a kind of superficial way. I think the only other thing is the incorporating of 3D, film, or film-like, of more experiential ways of looking at this information.
Andurid Kerne	I would emphasize a couple of things. One is this notion of experience and process, it's not just about informing people, but about engaging them, giving a space to their imaginations, this notion of participation, of unexpected possibilities and integrating that with formal learning. I think this notion of having some commissioned works that which artists specifically focus on conveying this sense of exploring this information space, but also really completely broaden and deepen what you have. I twill open the range of experiences that people can have, and people who will be drawn into that process and will really--that could really help supply a fundamental elements of connecting space science with the public good actually. Because you want imagination to be on the same level as data and information. In this conceptual view of space, space should have imagination in a forefront position, that kind of reflective imagination needs to be a multi-vocal imagination, not just one message, but it needs to encompass more points of view. That's what would make it part of and accessible to human experience.
Dorothy Timourian	I think it's a great idea. I think that they could make it some 3D things that you could manipulate on the website. If you could take a ride through space in some way, that would really capture imagination. I think that having a lot of great pictures about space and new discoveries, new universes that are being discovered is really interesting. I know I've read about that not too long ago, and I haven't seen too much more of that. I'd be a user of this site. My grandkids too. It can be divided into elementary age students, for junior and senior high, and college age and up. There could be variations on the site so that there could be some understanding for the younger children. If they just

	did elementary school age, first and second scholars are so interested they would understand stuff for fifth graders. A little bit for everyone. Besides the website, I think NASA should still continue to print their photographs in photograph books and books on the universe and space, and scientific magazines too. Still publishing books with really fine pictures in them is really very helpful. Don't go only virtual. And libraries too, to get all this materials. So children that don't have access to computers or people can have access to these materials at the libraries. It's great to be able to check them out and have them quite awhile. To be able to buy books too and look at them while sitting in a comfortable chair. I can work at a computer but it can't be too long for me. I need something more comfortable. So you don't have to read them from the screen, keeping your head in the same place.
Peggy Frank	I would say, visual with a capital V, as many pictures as you can put in. not overly complex at first. Lots of visual cues. Give people the ability to explore things into more depth, not there immediately. Easy way to get into more detail. Someway to publicize the website, some place other than the computer. schools, science education centers, Chabot Space Center, magazines. "The Mysteries of Outer Space at your Fingertips". Fabulous pictures. categories: stars, nebulae, new findings. I've never been aware that there is this available to the public, and I've never used it. Download some of the fabulous pictures so you can use it. Certainly for education, should be things for the schools. for other artists, fliers to university art depts. some fabulous catchy flier/poster. "like this image? NASA's new website". Available for inspiration. they could sponsor exhibitions, competitions necessary? exhibitions inspired by, display at neat places--Smithsonian, NASA in Houston, school children, young artists, professional artists, as long as there are places or a virtual exhibition! Have it online. astronomers, from the photographs, or 3D images. some of the artists might...a series of exhibitions, different age groups. really link art to what's going on in astronomy. it's a turn on. anytime chance to exhibit inspires people to think. Anything to do with outer space evokes natural awe...I'm very glad it's being done right now. NASA can have a "call to artists", collecting artwork.
Glen Sparer	Let's go to Mars! There's so many places to go to. I heard this interesting radio show on NPR about zero-point gravity, it's something going on in the 1950's and then suddenly vanished from the scene. Some scientists now are doing research on it. If it does happen, it will revolutionize everything. In terms of energy, it would be a new form of energy, for one. It would change our consciousnesses completely as to how we've been doing things so far. Most of the way the discovery of the atom did. I'd be very interested in a site on zero-point gravity. I think the things I've mentioned so far mainly. Space and time as an element, space travel and discovery should actually be the way the site be navigated. How can we change space, change time through the interface? Actually having the experience, not simply reading about it is really,

	really important. Artists always wonder how they can have access to data. There could be way to stream that data to them. Perhaps NASA could set up an outlet from their website, somewhere some artist can come in and feed that data into an art exhibit. So it'd be a live feed from a natural resource, these things are happening all around us, and give accreditation to NASA, so people coming to the exhibit would say, "Wow, NASA is really doing interesting things" and they'd go back to NASA, and give them tax dollars, saying "NASA should really have more money to do these interesting things". I think a lot of people don't really know what NASA is doing. So the website would ground a lot of the work and serve as communicating to an audience. This is what we're doing. You'd have to be able to break it down into very specific categories so people understand it. You have to think about who the audience is. You have to think about making it accessible to them. It needs to be broad, but it also needs to be specific. The hierarchy of the information has to be really accessible, look into that and study it. And easy to navigate, of course.
Paul Hertz	Representation of astronomical imagery. That's what we're discussing. Some understanding of both the scale of the info and the wealth of the information. Certainly very few people understand astronomical distances, so being able to comprehend those is rather difficult, perhaps a way of doing that on the computer. The most successful things have been models of the planets shrunk down to cover a five mile radius, educational purposes. Try to reveal how vast the distances are in some way. As an artist, I think the possibility of there being a compelling beauty in images and sound you present is an important element. There are times in that that there's a bit of scientific fabrication. If you're presenting the compelling side, you need to get down to the nature of the scientific data also. What you have to begin with is just numbers, not even imagery, translated into an adequate visualization. Any site that's going to be honest about it, how scientific data is an interpretation of other things. It's possible to use sound and imagery and movement through 3D space, yet each one of those has implications of a kind of falsification. At the same time, they are really giving us information. Information that is given to us through instruments, that wouldn't even register on our senses. [How about cultural differences?] There are all kinds of cultural differences. What people see in the sky differs all around the world. Whether or not that matters to you for telling time, in certain professions, if you're a fisherman, you'll be aware of tides, you may be aware of where the stars are, they're much less important than they used to be. A lot of people who live in cities haven't even seen a good night sky. I guess I can also say from the times I was living out in the Canary Islands, there are places where people are more attuned to looking up at the sky....guide to the season, if you're a farmer the seasons matter to you. An issue of familiarity, traditional culture, stories about the sky. Our stories are more along the lines of science fiction and speculation. A fund of common knowledge, a lot of industrial cultures, or you see movies. Space

	opera showing up. What's true and what isn't true in those movies?
Craig Hansen	Some practical things are to be able to, if they're presenting a collection of images, I think it's important that there be thumbnails to look at pretty quickly. Unfortunately with most of the NASA sites, perhaps due to the sheer volume of stuff, they'll include every single photograph, every single frame of every roll taken on every space shuttle mission, which is great actually, to have that volume of stuff, the descriptions are usually so hard to penetrate for the average person unless you really sit with them and read through them and figure out what all the numbers mean. You have to do a lot of back and forth searching before you find what you're looking for. If there was a way to organize their library of images, to be navigated a little more visually as well as systematically, as well as when the film was taken...[intuitively?] Yes. Netscape used to have an image search function that can be researching for a picture of the moon, and a bunch of pictures of the moon would pop up, and it would say, one of the choices underneath would say, "Other images like this". They must have had a program that broke down the basic symmetrical image that is high contrast and has a round shape, and it would spit out everything it had that was close to that. That's somewhat useful. In my case, since I'm looking for pictures of San Francisco Bay, I've been forced to sprawl through 15 pages of lists of photos, to see if any of them mention San Francisco and clicking on that, and then waiting for it to come up, and then seeing that it's only one little corner of the south part of the bay. If initially there's a very small thumbnail that gives me a glimpse if it's close to what I'm looking for. I tend to be able to find factual information faster than I'm able to find a particular image. If you're talking about artists it's the same problem. An artist needs not only simple to find a certain content, but a certain expression of that content. It's often the situation that you don't know exactly what you're looking for until you find it. So it can be helpful to be able to gloss over a lot of images quickly to get a sense of what's out there, and then focus in from there. Instead of looking at a long list of numbers on the roll of film from a certain flight, it doesn't tell me anything about what the image is. "Image of the Day" or "Image of the week", I guess it's kind of intriguing. But it ends up taking a great deal of space on the page, and I'd rather come to the homepage and be given some clear simple and few choices to get where I'm going. I'd rather take more steps through pages that had fewer options than be confronted by a page that has 50 different things on it, that's organized in 5 different ways, as often happens on these sites. I think an attention to having a really strong sense of design, not including things that aren't really necessary to get what people are after. To remove any kind of advertisements, anything that has to do with awards the website has won, to remove extraneous things like that, and just focus on very simple pages that give you a clear. It's sort of like you're literally driving down the freeway you can only grasp so much information and make a decision and even though sitting at a computer is not that same sort of pressure, most computer web pages overload people with too many choices.

Lisa Jevbratt	Make things, allow things to be complicated, don't be humanistic, overly concerned with the human. We're not doing this because we want to find out how fast we can click on something, or how our own bodies feel. We see this because we're interested in something else. Really avoid all types of representations of data that are focused on the individual. Focus on the large scale system, and believe that people are smart. People wouldn't go out on mountains--well, I guess there's always both to understand yourself--but in general, when you make science popular, it seems you tend to lose the outside and you tend to focus on the individual experience. Focus on the system and the other scales. Come up with ways for people to engage and understand other scales, as opposed to bringing these other scales into the human. Keep it complicated and open, allow different expressions to happen. Have a lot of text available as it is. Simple.
Geri Wittig	I would say that what is paramount is that they have somebody who is a really, really talented designer, information architect, these are people that are extremely skilled at creating really graphically understandable sites. If they're trying to reach such a broad spectrum, an information architect and a designer who know how to reach those people would be paramount. To find that team would be the most important thing. Designers, information architect, editorial people, people that understand the language of what they're trying to get across and know how to make it accessible. You need those rare people that are within their field that are natural teachers, that know how to communicate the esoteric aspects of their field. Those would be really really important people to have. Of course you've got all the backend stuff. I'm sure they must be up on all of the latest and greatest in web technology. Another important thing is that they stay up on that because it's changing all the time. Everybody's trying to figure out what's the best way to do this in terms of information, because there's so much information that they have to manage, their backend is going to be really important to think about how it's going to grow and expand in the future and how they're going to manage it. We have to think five years out in terms of database driven technology. I'm a fan of NASA, I think they should get their funding. From that artist's perspective of pure research, I think what they do is valuable, and whenever there's all that discussion about if it's worth, I think it's hugely worth it. Space exploration is just one of those things we just have to do.
Nora Raggio	The first thing I would like to specify is I think it should have a diversity of perspectives, that's really,really important. By diversity of perspectives, I think that NASA has a fairly wide view and has collaborated, for example, with a lot of European space programs, etc. But I would like people from different parts of the world to really be involved. Diversity of perspectives not only from geographical areas, but in terms of disciplines, and in terms of beliefs too. I think that scientific data is fantastic but it is also good to correlate with other

	disciplines, putting it in a cultural context, and in an artistic context. Having that diversity of perspective even though it is primarily a scientific endeavor. Putting that in a context that is interesting to a wider population would be great. Space is something that most of us forget about it, we're so fixed here on planet Earth, that we forget the amazement that some of the ancients had because they lived without a roof, they had to look at the stars and the universe and they lived with that awe, and they had a sense of how the earth was traveling through the universe. First, a diversity of opinion from a variety of parameters that I mentioned. Second, is something that would really bring back the awe of space. Something that maybe a really good marketer could do, because I think it's such a wonderful concept that we need to explore and live with it and be in awe of it and really be excited about it. In a sense, we might be a way in the species the way early Cretans, where they were just in their little islands, and they were just going out there to navigate and see other shores, and I think we're maybe at that point, where both the macro and the micro space needs to be explored with more gusto. More than competition I'd like a super-collaborative awe of the universe. And the universe linked with the micro, because the universe was very micro at one point, so understanding those stretches of dimension will give us a different perspective, will change the way we look at one another and the way we behave to one another.
Bonnie Shulkin	Website intended for artists? General public, encompass all of NASA? I don't know if astronomers are included in that definition. It's pretty ambitious! I would like to have an index of activities, the better sorted they were the better useful, activities good for short demonstrations, an hour-long presentation in the classroom, month long units. The more information you had on each activity, what ages it would required, formal or informal, materials required and costs, that kind of thing. I think it's interesting, it sounds incredibly ambitious, it's overwhelming.
Ben Burresss	If we're still talking about scaling the level of information, I can see it being useful in 2 ways: one, just what we're talking about, allowing people to select what level of information is presented to them. Someone using this knowledge base, a researcher might use the basic level to do some skimming, then find more detailed information they're looking for. If you're designing this for information levels, keep the audience in mind, but the researcher and ease of use...extracting the more detailed information. Above and beyond simply providing the information in different languages, presenting in ways that make more sense in a particular culture. I think right now we do quite a diverse audience, especially with the school groups that come up here. The school groups that come up as school trips, the teacher selects a class from the subjects we teach here, and they get a show, and access to the exhibits. So I think we serve the audience we have pretty well, doesn't mean we can't improve over time. An example, last March was the second annual Sun-Earth day so we ran a whole bunch of activities here. Solar max in the theatre, the

	Native American connection, a Native American storyteller, to tell stories, he had one about the sun. We do try to reach across the spectrum, not just science and art, but cultural perspective. Solar icons from the cultures. a poster briefly explaining the information behind each solar image. I think we're all, we want to embrace that. We're just starting up here, over time, that's the direction we're moving in. we're not just trying to just present the facts, the scientific perspective from scientists or that particular mode. Just trying to think: We have a vision statement.... Monterey, the security guard told us their vision statement. We actually, astronomy is the umbrella here, it pervades most of what we do here. We don't try to exclude any other science, we try to include all the sciences. The Human Body, a small exhibit downstairs, to go along with the movie we're going to start showing here at the end of the month. New visualizations of the human body really relying heavily on modern imaging technologies, showing things we've never been able to show before....a neuron firing, you can see the electrical impulse go through the neuron. We showed Mysteries of Egypt, we're still showing that. We have a whole life sciences/biology classroom for the kids, we're trying to develop our environmental lab, and enviro-lab garden, computers and technology. Camps here in the student we do Lego mind-storms, build a Lego robot and program it. We're not limited at all to astronomy. [NVO and relation to Chabot?] I could see using it in our computer lab classes. Eventually we're building out a new observatory out there then we'll have a solar telescope up there, our intent is to use them also on our website as a remote...on of the projects that's been desired for a long time, is a remote observatory, log in from their classroom. Certainly those two telescopes would be able to contribute in the outward direction, I can see all sorts of uses to other observatories imagery. We do it already using today's or near-real time images of the sun from SOHO or ground-based observatories contributing images. in exhibits, in classrooms. I can just see a mind-boggling expansion of that depending...interactivity there could be. allowing students to not only receive the information, but request on real-time basis, expansion of "ask an astronomer" function, actually operate a telescope or make a measurement. Or like the globe project where meteorological information is acquired by students... We tried to do that one. one in Ecuador, a scientists on the south pole. each class would make their measurements, put the raw measurements on the websites where other classes can obtain it, then guess where the other classes where based on latitude, longitude, and boiling point of water, altitude...That would be very cool to do in the future. Along the way you use some math and you learn the connection between the sun and earth, geographical coordinates, shadow dimensions. That kind of a thing is very hard to coordinate...but very effective. I'm attracted to the idea of everything in one place, and of course scalable. It's a massive project to coordinate the information in such a way that you can take slices of it based on your particular perspective. Different cultural groups would be a tough one. Not just changing the type of information available, ...Basic ways to deliver information that would be useful in any setting. Back

	to basic visualization. Obviously the language and text would be different. If you're using this as part of a curriculum, how the students would approach the information. If I set a class in front an immersive environment of the star catalog...I would give a problem to solve with it, learn a few things along the way. That's more on the user end. If we're talking about just the knowledge base...That's where something like the SETI screensaver that crunches SETI data on people's computers. In a similar way, you have somebody's desktop crunching data and contributing, putting in a ...of this knowledge base, things could be contributed form the distributed network of all the users, teachers, even students sharing with each other how they've come to understand such and such things. In a way it already exists in the internet. [A sharing thing going on...] Almost becomes a wisdom base. It might be an entire camp onto itself, or an actual class. Also we have a lot of teachers come up here and take workshops, this might be a good subject for a workshop as well. Have participants here at Chabot contribute, at least for the students, spark them in a direction they might not have considered before.
Ryan Diduck	I'd like to see NASA work with the science centers around the country, they've been appealing to the target audience for decades. We don't' completely know what's right, we have a feel of what's the right amount of information….what's the right thing for audiences, because we deal with it everyday. We've been acting as the medium between the public and NASA for years now. [collaborate between planetarium and NVO?] I would hope so. I would really like to see that. I think with the technology that's coming to light now in the planetarium field, high definition all dome imagery, there's a medium now for all the high-res NASA's using, can be used to present to public in a more immersive environment...it's more realistic if the image is all around you vs. a 20" monitor. The Einstein Planetarium in Washington opened up the next level of all planetarium, detail and clarity of imagery. Germany, using lasers to the project imagery. When that becomes popular and more affordable then the sky's the limit. [Is there an edge?] I don't think so. Scientists don't know if it's open or closed universe. We suspect...romantic idea of universe as closed, fly out and come back to where you started form without turning anywhere, I kind of like that, kind of never-ending. I don't think there is an edge. Not the way people think. There is no limit. Strongest recommendation is to make the environment in which the viewer will be looking at the images as realistic as possible, i think it'd make it more real for them. 2D or 3D, whatever, to make it as realistic as possible.
Celeste Burrows	One thing that if a teacher has a computer in a sixth grade classroom. By sixth grade there's a few children that's interested in astronomy. I don't know if anyone knows what to tell the child to do…Don't know where to go. Maybe it requires a lot of training the teachers in the classrooms....There's stuff out there, if the child doesn't have a parent, grandparent, teacher to walk through their own ,...i don't know if they know where to start...that they can participate

	in an activity that ....Educational tools that connect the classrooms better with what's going on in science. Specific school classes involved with something NASA is doing...kids would send up their experiments. I did something like that at the Exploratorium once, kids were up int he flying observatory-- the Kyper observatory, it's come down...an airplane with a telescope in it, it flies all night long and it's pointed at something. There were kids in it, it was flying in such a high elevation, they designed some science experiments...they were communicating, a link between the school and the scientists. I'm sure that's very enriching...schools and kids involved in NASA projects, I don't know how you find out about it. More interactive, more collaboration, almost like picking up the phone like calling in, dial NASA, just a way to make a contact with an astronomer. Project Astro there's so many amateurs in astronomy field, they're more available and passionate, they organized a connection between the amateur to the school...the nice thing is that some amateurs know only telescopes and stars...it didn't matter what your specialty was, the kids loved it. It's a great program and it's still going on. But there has to be someone there running it, managing it. Ask an Astronomer a question website, You'd probably have to interview teachers in the schools. Kids are often interested ...they go to movies, science fiction, the mission to Mars, they don't know what's true and what's not true...Kids do pay attention. They want to know if it's really true, what happens if you take your helmet off in space. A way to pick up kid's curiosity. I know when they go back up there's no follow up, but while they were here they were really interested...There are a lot of educational workshops, NASA does a lot of them, I don't know what the limiting factor for teachers are...or maybe the school standards don't include astronomy in the curriculum. What would it take? What kind of tools? The kids really like video simulations where they can navigate through things, go visit a planet, stop on a moon. I've seen a little bit of software where you can do a bit of that. I guess if it's easy enough to use that if the teacher didn't understand it, the kids could do it. ...Thursday's classroom used to have lesson plans for the teachers, that's a NASA program that's not really updated. You're planning a mission to Mars, you decide what your science goal is. Then you have a choice of landing sites, you can zoom in and look around, then you decide which one is the best for you to go to pursue your science goal. There's a few other things on NASA's website, I don't know if the kids can find those things themselves, i think the teachers would have to know what that's all about. Well, using images and data for classes we teach. We're not offering a large variety of classes to the general public. Most of our offerings are for school kids and teachers...more and more into9 specialized classes research results on different topics, some kind of archive or databank of that sort of information.
Wendy Coones (in person)	One thing I think is that…not as much to do with content of the site as it has to do with the public perception of NASA, some people consider it word from God, that it's absolutely is true …a lot of people are very suspect of it. They

	know there are ties between the military and NASA...try and look around for dust in the universe when there are people starving in Africa still. Important is for NASA to try and qualify themselves in some way, and be able to really explain with this project what the purpose of putting the information out there is. It is possible that it can be misinterpreted as some bizarre spy mission...influence of pseudo-science on people don't know the difference. So when they go to some of the sites I automatically chalk off, there's a lot of the general public that don't know to do that. Not that they wouldn't want their name on the NASA site? But maybe specify that there's a difference between NASA astronomy and BNASA man-space program, and this is a participation with other learning institutions, be very upfront about some of the partnerships. I'm kind of talking in circles here, but people do know that some of the projects that are being worked on with specific telescopes ...have absolutely nothing to do with furthering human knowledge...strange government programs that are secret. So NASA needs to be aware of the fact that they need to be as upfront as they can about what the purpose...[science museums and NVO?] I would say, as far as linking to it, or linking back. if NVO has science center that would be linked on, go visits science center...data that is being collected at those science centers, being fed into NVO, exhibit that's been made, you can go and see. Part of it would depend on the relation. Part of it could be a two-way link. Science center websites...find out more information about the NVO, and also have--again, that gets into the question of authority. I would hope that people that would go the Chabot website, whatever we create links to are going to be real science. No links to aliens.com website. People would be able to use us as a funnel for good information, and also vice versa. People that go to NVO website, ...they could find some places that are reputable. It just depends on what the link is for. One of the things that comes up again and again, at least for what I've seen working with astronomy for 2 years now, just beginning to understand some of the rudimentary things, an astronomer and a background in astronomy...to draw upon that's not necessarily a given for every person...there's a lot of background knowledge that needs to be accessible. Some of that is really interesting, some if it is in the form of history. To be able to walk through the history of astronomy is to walk through the understanding of how we know some of the stuff we know. I would encourage NVO to not just look at what's happening currently, what kinds of data is known...also have information on the historical data. Some fascinating...hand drawings of the canals on Mars by Lowell, who made a hypothesis that the canyons that are found to exist on Mars where were the little Martians traveled around on gondolas. ...even though it was wrong. I've just found that people are quite intrigued by the history of scientific knowledge. ...feed that through as well. There are some really wonderful stories as well. Dovan culture...in Africa, and they have some naked eye observations that only very recently were substantiated, that people said were impossible. Native Americans...they found the wobble of the earth. There is some very sophisticated knowledge out there that's been found by indigenous cultures...lyrical stories that are not

	necessarily accurate or inaccurate, they're just the mythology. include a lot of that in, but to qualify it, this is the story of the ...ancient Chinese culture. To give it a human nuance, perception. not just this is Star number ....[layers?] I think some of that too is going to have to be done and decided upon by artists working on it, or interpreters working on it, because it will have to be chosen to be done. It's going to somebody will have to set aside and say, "I wan tot make a map of the sky where whenever you click on a....in all of the different known cultures, and maybe even tell the story of those constellations"...The Big Dipper is not always the Big Dipper. ...spend time doing, to gather up all of the information. That needs to be compelling. To a certain extent, sometimes who decides what is most interesting, I don't know if scientists are the best people to make that decision...high knowledge already. Science museums are in touch with the general public. It may be too that just putting out a query on the website...open for discussion, here are 5 different possibilities of where we might do the next project. To be able to do some kind of an evaluation of what to focus ...what layer to do next. Really nice if it came from the audience, artists do that kind of stuff already. They find a compelling thing to look into, to research, they go and do that. This is where my background both as artist and educator comes from, I really like making things people I know are going to have questions about. Creating intriguing and engaging projects. If ,.,..usually I ask people first. Is that something compelling to you as well? ...There's no point in making something that no one else is interested in getting the answer to as well.
Joan Gillerman	That's a big question. I don't know whether they're doing this…many live web cams out there? I know they're compositing things at JPL. I have this friend, business associate, who maps underwater volcanoes, …describing like they map in space…I'd love to see a live image of a close-up of the craters of the moon...I can access whenever I want to see it. ...nice option to zoom in...huge scales that's another question...how do you relate to light years...enormous things visually when my friend described the underground volcano...you wouldn't see much unless you knew what you were looking for...I would like to see that on there as a live thing. They've abandoned some of the space travel...I used to be getting the Space Planetary Society ...for a long time. That's the important part, it's humankind, it's not like the US versus the Russians ...politics to some extent is getting in the way of really wonderful....research like that...even if it's a money thing...it'd be nice if it was very global when this happens. Same thing going underwater...they stopped the program...they lost somebody. They got sort of gun-shy. You can do all this stuff with robotics, that's another option for sure...I'd rather have solid things up there and see them, then dispense with it all together. I would agree, if my eyes were good enough to see what you can see with a telescope, I'd rather not bother with the telescope. I don't' have a problem with that. It's like an entry into that world, a closer up...I look at the sky all the time. This doesn't always happen, ...lava flow...we've used up all our tape, okay, now we can go

	home. It's relative. Going to an observatory and looking through those big telescopes can blow people away. If there's some way of getting that to them of what this is like, I think that would change a lot of people perspectives...people are really myopic...you go what's the priorities here? What's right what's not right. It's important to keep that perspective all the time.
Donna Cox (phone)	I touched upon many of these ideas, I'll just summarize them here. I really believe the collaborative component is essential…for people that are not just scientists. The tools need to be set up in ways that are more friendly than the scientific websites and how they operate. The idea of expanding from just a web browser to a portal to where info that is multimedia and that is textual and library info, that it could be brought in simultaneously to be able to relate to the work that one is doing with the instrumentation and the data....the language barrier...not technologists. That has to be really worked on. It is one of the big problems in collaborative groups getting together, there is literally language barriers between individual groups. I think common sense really has to be a part of this, not so politically driven, ..the more people that get access to this data brings in diversity as an educational tool, it democratizes the data so it can be perceived and interpreted by more people than those that sit in their ivory tower. This democratization require the tools be at the level of expertise that would gear itself toward the non-scientist as well as the scientist. One thing I would like to do is be a part of the tool-building process...let's say we had links that would bring a history of art's interest in science, the obvious ...LEONARDO...astrophysical, astronomical...wonderful thing to have that as a resource that would either complement or augment NVO. I think their awareness as art in contribution in this area is very important. That an interactive artistic work that would engage and bring together ...with the new tools would be very interesting...
Shawn Lani	It is a really huge opportunity to share and open up everything that they do, it's a conduit out. I have a friend who makes a living going through old libraries going into their basements and going through…dusty old books, until he finds a whole bunch of interesting things, and then he writes books about.... a Paul Collins there...a spokesperson.. there's somebody there sorting through this stuff and presenting it...for any history, to have that spokesperson and to be able to share that to such a wide audience. If I was NASA I'd do that as much as I could. ...If you had 10 bad things....in terms of web development...as soon as you bring peoples in early on...the more of that you get into it, wow.
Noah Wittman	It's so hard to think about this project because it's so broad and ambitious in scope. I think the idea of starting off with a portal that tries to address the needs of many audiences and shunt them off to…general audience and whatnot. Experimenting and so. In terms of specifics, I think the 3D visualizations is pretty interesting. I've always been curious about trying to take the data from different, trying to illustrate where our star has been and

	where it will go in the future. Time lapse. I do like the idea of opening, of perhaps creating some kind of artists residency program to design skins....media artists and designers, to experiment around and have fun with it, and see what takes off. It's not just one single approach, it's the power in the multiplicity of approaches that you'll take, that's the beauty of database is that you can change your views of things in different ways, and that's a great thing about the web with unlimited storage and access.. you can provide the multiple views...There's the bandwidth and the audience. I'm not sure it has to be artists or scientists as much as someone that's created to the end audience...if the purpose is to be useful or practical. I think artists are good at provocation, so that's the other end. If you're just looking for utility, you want to go out and find what people need. Artists come from the end, I think, they come to shake people's world up a little bit, not thinking about their day to day needs. Offering an extraordinary look.
Wendy Coones (written)	Build us a spaceship or let us go. (Or at least to space camp).
James Morgan	Yes, it is not about the images you might make with your data, but about letting others access the data and work with it.
Patrick Lichty (written)	For thousands of years, astronomical bodies and the night skies have been inspirational subjects. Perhaps some of the luster of space has dimmed slightly with the reality that the future will not be fulfilled in the images of Kubrick's 2001 or Star Trek. However, although humanity will not be moving en masse into space, there can still be great interest in our species' greatest adventure. The issue in my estimation is that of engagement. How does this inspire me? How does the universe relate to me (the artist)? What does contemporary scientific information say to the artist, and what does it say about the situation humanity is in regards to itself and in contrast with the larger universe? To address these questions, my ideal site would offer unique visualization tools (associative methods, distortion mapping of spatial maps and easy location of database information [Important-- possibly allow read-only open access to NASA data through SQL/XML?] In addition, perhaps the site could offer community areas for groups to discuss such topics, and even host discussions with well-known artists who might have interest in these issues. In addition possibly that efforts to engage with artists in order to "kick start" this creative process could be initiated in hopes that a larger community of artists using this information might be created.
Myron Krueger	All of the astronomical stuff, like the orbits of the satellites. Targets for if you have this telescope, here's what you should look at tonight. It is in the interest to NASA that everyone who buys a telescope succeed. Basically a tourist map of tonight, what should I look at and be guaranteed success. If i think about NASA's website, part of it yes, they just want to make their products available not just to other scientists, to everybody who might benefit. part of their

	product is they're the brand for space, it's in their interest to maintain that brand and expand on it...scientific information will vote for NASA budgets. and will be NASA scientists. They have to entice the individual and support the teacher with the information that teachers need, and to support the needs of kids taking courses, if I were teaching I might or might not involved...too difficult or too uninteresting. It would be in their interest to have things people could do in those courses, so they can do something related to space. They have a burden to ..multiple communities...self-interest to support any glimmer of curiosity that anybody ever has, and NASA would become the answer...tailored search engine, focus on space-related stuff...you wouldn't get stuff about architectural space or the space between your teeth....extraneous stuff that I'm given. yes it's great to find something of interest, but i have to look at a bunch of junk. If somebody did a good search engine for space-related information, that would be a contribution. .small planet, a very good interface to the world. We're told we live on a sphere, we only see the sphere in a certain way, northern hemisphere up and spins it on its axis. That interface is good as a very long potential educational benefit. Should be pursued for that purpose, not just for earth data but other planetary bodies and moons we have the data for. That would be a very simple thing to have a 2D, jpeg, of a sphere, so that you get a 3D, turn the sphere, weird projection thing, you could have a model of the sphere, with the data texture mapped on it, so you could turn it even on a PC, that's something they ought to have, maybe somebody does. The project we're doing now for blind people, interface that maps for blind people, system generates speech to tell them what they touched. We know have done it for the history of the world. maps of the world for every thousand years, year by year. there is data going back to 500 BC, now you can have a globe, a temporal view of the world, so you can fly through time as well as through space. you could also have imposed on that is logical information from the past. when you look at the expansion of Russia every ten years, Moscow principality, expanding...same thing with Mongol Genghis Khan, expanding through middle Turkey, Hungary, up into Russia and Finland, visually it's quite dramatic, you see it move. I've never seen that data animated before. One of the claims...that they would be better at geography than sighted people. finger position go to the website and send back the information about where they are, generate the speech, but not have to send th image, it now can be done over low bandwidth, very fast response rate. These information resources, i think this site can be supported by high school kids. ...custom maps for blind kids around the country. ...Iowa learn. The history of plants and animals, where did they start, that the tomato started down in Peru, then went to Italy, only much later came to America, there were no animals to pull a plow in America...the llama in the Andes, no real beast of burden like an ox, that really kept North and South America from developing further. then I want to show the evolution and expansion of humans out of Africa...out of recorded history into pre-history...time travel sort of a kid's science fiction fantasy become a mechanism for learning.

Garret Moore	First, they need to have some stratification in their taxonomy. Top level for people with no science, that is fairly simple information, but you have the ability to drill down into deeper aspects of the research. Say you have one screen, and several buttons for deeper levels, you can look at the beautiful images and basic simple articles, and press the next button and get more information, then take those by subject and go even deeper by level, and get access to scientific papers, all on different levels. If you try to do it all on a 2D plane, it'll be too much for some, too little for others. You have to find a way of stratifying this data, it would express this data as needed. Interface that's fairly intuitive, you can conform the data and type of searches you'd be doing, very specific or broad searches, visual or raw data oriented. That way you apply to everyone. The lies in the interface and the way the data is expressed. Very simple child level information, you can conform your interface, like a search engine that would intelligently be able to respond to the different searches that you want. Or intelligent search with an AI type of thing, from a single interface. You could also have different quadrants for different resources. You would turn that off, but you might want to know a certain amount of info, without the others, not necessarily what you're looking at. Or you might not care where it came from, just what it is. Filtering, intelligent delivery service. A lot of my research I'm looking for specific things. There's a lot of information that doesn't come across in a picture...theoretical models, some observed...you want to be able to turn those levels off. Just the information you want. Conformable, visual desktop you can conform the visual or data delivery to a specific form as possible. Detailed information, very superficial and broad information. Vitalistic and mechanistic view of the universe, a war that happened early in our history, 1700s, people that were spiritual and qualitative aspects, and mechanists that only saw measurements and quantifiable. The final answer will be bringing these together. Art is the mechanism with which I can bring both types of information and hybrid them into a more complete character of true information.

Appendix F. Roster of Artists working with Art & Technology

(*cited by the interviewees*)

Artist's name	Areas of work and interest	Main works and projects	Contact information and web site
Eduardo Kac	Transgenic art, genetic engineering, interactivity, telepresence art, telecommunications art, media poetry and language art.	GFP Bunny Genesis Time capsule Teleporting An Unknown State Rara Avis	More information on his works, resume and selected publications can be found at: ***http://www.ekac.org/*** E-mail address: ***ekac@artic.edu*** Phone (312) 345-3567 Fax (312) 345-3565.
Natalie Jeremijenko	Information design, tangible information, politics of information, real-time monitoring; ubiquitous computing; human computer interaction design; science un-fiction; technological justice, socio-technical interactions	Bangbang Media Network SuicideBox Onetree Voice boxes	More information on her works, resume and selected publications can be found at: ***http://cat.nyu.edu/natalie/projectdatabase/*** ***http://cat.nyu.edu/natalie/*** Phone: 212 998 3382 Fax: 212 995 4122
James Turrell	Cosmological phenomena Artificial and natural light	Projection Piece Wedge work Perceptual Cell Roden Crater is a natural cinder volcano situated on the southwestern edge of the Painted Desert in northern Arizona. Since 1972, with grants from Dia Art Foundation, the Guggenheim Foundation, and the National Endowment for the Arts, James Turrell has been planning to transform the crater into a large-scale artwork, that relates, through the medium of light, to the universe of the surrounding sky, land, and culture. More information on this work can be found at ***http://www.rodencrater.org***	More information on his works and resume can be found at: ***http://www.pbs.org/art21/artists/turrell/***
Donna Cox	Computer graphics, information design, education, and scientific visualization	Virtual Director Cosmic Voyage Venus & Milo	More information on her works, resume and selected publications can be found at: ***http://archive.ncsa.uiuc.edu/People/cox/***

			E-mail address: ***cox@ncsa.uiuc.edu*** Phone: 217.244.2005 University of Illinois at Urbana-Champaign 4051 Beckman Institute 405 North Mathews Urbana, Illinois 61801
Ken Goldberg	Robotics, Telematic connections, Collaborative Telerobotics, internet insatallations	TeleActor Telegarden	More information on his works, resume and selected publications can be found at: ***http://www.ieor.berkeley.edu/~goldberg/*** E-mail address: ***goldberg@ieor.berkeley.edu***
Stelarc	The concept of the body and its relationship with technology through human-machine interfaces incorporating medical imaging, prosthetics, robotics, VR systems and the Internet.	HexaPod ExtraEar PingBody Fractal Flesh Third Hand	More information on his works and resume can be found at: ***http://www.stelarc.va.com.au/*** E-mail address: ***stelarc@va.com.au***
Lisa Jevbratt	Database Interface, Visualization Software	Troika Out of the Ordinary 1:1	More information on her works, resume and selected publications can be found at: ***http://cadre.sjsu.edu/jevbratt/*** E-mail address: ***jevbratt@jevbratt.com***
Sonya Rappoport	Interactive installations, social and gender issues	Redeeming the Gene Arbor Erecta The transgenic Bagel Make me a Man	More information on her works, resume and selected publications can be found at: ***http://users.lmi.net/sonyarap*** E-mail address: ***sonyarap@lmi.net*** Phone: (510) 658-4741 6 Hillcrest Court Berkeley CA 94705
Marko Peljhan	Communication through radio and satellite technologies	"Insular technologies" (International Networking System for Universal Long distance Advanced Radio) More information on this work can be found at: ***http://www.insular.net***	projekt atol - pact systems ane ziherlove 2 si-1000 ljubljana – slovenia E-mail address: ***makrolab@mail.ljudmila.org*** ph-fx: +386-1-2572-639

John Klima	Java based genetic search algorithms, 3d mapping of global political, health, and demographic information.	Speedo-MAT EARTH, Discrete Terrains POLITICAL LANDSCAPE, EMOTIONAL TERRAIN .	More information on his works, resume and selected publications can be found at: ***http://www.cityarts.com/lmno/*** and at ***http://www.firstpulseprojects.net/john_klima.html*** E-mail address: ***klima@cityarts.com***
Mary Flanagan	Internet work, gender and technology, cyberculture, interactive media, and sound design.	Double Search Phage Virus (a computer virus created by the artist which explores the architecture of the computer it invades)	More information on her works, resume and selected publications can be found at: ***www.maryflanagan.com*** E-mail address: ***mary@maryflanagan.com***
Ken Knowlton	Computer-assisted mosaics, internet art	His current artworks are mosaics, particularly those made of seashells.	More information on his works and resume can be found at: ***http://www.artists-nh.com/knowlton.htm*** E-mail address: ***kcknowlton@aol.com***