

NRAO User Committee Report 2001

This is an exciting time for NRAO. Existing telescopes -- VLA and VLBA -- are working well, and the prospects for new instruments -- GBT, EVLA, and ALMA -- are very bright indeed. In addition to opening new vistas in resolution and sensitivity, the Observatory is developing plans for wide-ranging archiving of radio data and for smoothed observation and data reduction procedures, all of which will make radio wavelengths more accessible to the general astronomy community. We applaud these efforts.

Following recent tradition, we include extensive comments on various Observatory telescopes and projects below. Some highlights of our recommendations include:

- We strongly endorse the recently-started program of grants for GBT hardware developers. We further endorse the proposed grants program for GBT users in general.
- We are excited that EVLA phase 1 is rapidly becoming reality. It is important to minimize down time between "old" and "new" VLA, and we are happy to hear that it will be possible to run the old and new correlators in parallel during EVLA development.
- We strongly encourage the Observatory to expand dynamic scheduling at the VLA and elsewhere, to make efficient use of the telescope in both good weather and bad.
- We are glad to see that aperture synthesis data reduction in AIPS++ is being tested by some staff scientists in Socorro outside the AIPS++ group. It is clear that continued development and debugging is necessary before aperture synthesis work in AIPS++ will be useful to a general audience. We encourage the Observatory to continue and expand in-house use of AIPS++; until NRAO insiders use AIPS++, outsiders won't touch it.
- Until AIPS++ matures, support for classic AIPS must be maintained.
- The Observatory is making progress in Education and Public Outreach, but more coordination and effort are needed.
- We applaud the Observatory's efforts towards the National Virtual Observatory, along with other proposals to make radio data archives more accessible to the general community. These are long term projects. In the shorter term, the Observatory should move relatively quickly to (1) make the VLA data archive web-accessible and (2) to develop an archive system for the GBT.
- Implement pulsar folding mode on the GBT correlator! Implement pulsar folding mode on the GBT correlator! Implement pulsar folding mode on the GBT correlator!!!!
(Sorry, the committee chair got a little out of hand there.)
- We greatly appreciate the VLA calibrator database and its web interface, and we encourage a merged VLA/VLBA calibrator database.

Finally, we thank the Observatory staff for avoiding the traditional radio band names in favor of frequency- and wavelength-based names during the committee meeting. We hope that this philosophy becomes accepted throughout the Observatory.

VLA

We are generally pleased with the continued support of the VLA and are greatly encouraged that the VLA is the second most cited Observatory in refereed publications. The Pie Town A array observations were a great success this year. The addition of JObserve is of great use to the community.

We are pleased that infrastructure and maintenance items such as painting and railroad ties are being addressed this year.

We view the high frequency capabilities of the VLA to be very important and we endorse the support given to these observing modes. We encourage more support in the form of reorganization of the information on the web, including links to important memos and a checklist for 43 GHz observing schedules, and in help from

experienced staff to novice high frequency observers. We also suggest the propagation of the phase monitoring data along with the astronomical data.

To further support the high frequency capabilities, we encourage more aggressive dynamic scheduling. While we feel that some fixed scheduling should always be available, much more dynamic scheduling would be productive. Gaps in the schedule of 1/2 to 1 hour are acceptable and could be filled with monitoring or snapshot programs.

EVLA

We are excited that the first phase of the EVLA project is nearly underway. The planned expansion of the capabilities of the VLA in terms of sensitivity and performance is extremely exciting for radio astronomy. We greet the appointment of Peter Napier to lead the EVLA project with great enthusiasm, although this move will be a loss to the ALMA project.

We are also very happy to see that planned EVLA activities will not disrupt the operations of the VLA in any major way. We strongly endorse the concept of parallel operation of old and new correlators as the EVLA systems come on line.

We are also very pleased to see that planning of phase 2 of the EVLA project is underway. We continue to endorse and encourage the involvement of the community in these planning activities, including the upcoming planning meeting. (As an aside, we note that meetings in late August are inconvenient for many of us due to teaching commitments.) We endorse continued studies of how EVLA-2 can interact with other planned array projects, particularly LOFAR and SKA. The Observatory should seriously consider how components of the EVLA-2 might be used in the eventual development of the SKA. In particular, non-traditional telescope designs might be considered in place of conventional 25 m dishes.

VLBA

We applaud the many and varied efforts by the Observatory to increase community awareness and use of the VLBA. Unfortunately, we must echo our statement from last year that this is a long-term activity whose impact is unlikely to be apparent after only a few months or even a year or two. The current efforts (data calibration, continued community outreach, sessions at AAS meetings and at the Synthesis Summer School) should certainly be continued and ultimately assessed. We continue to feel that more astronomers would use the array if the perception that VLBI observations are extremely difficult can be reduced through innovative user support activities, like those NRAO has recently implemented.

NRAO staff should continue to observe polarization calibrators with the VLA so that the polarization capabilities of the VLBA can be fully utilized. The results of these observations should continue to be made available online.

As the cumulative list of observed sources grows, it will be necessary to eventually create a database of observed sources. The text listing is suitable now, but some thought should be given to the ultimate creation of a database of observed sources.

We applaud the investigation of magnetic disks as an alternate recording medium for VLBI data. While tapes are still more cost-effective than disks, we look forward to the day when the significant operational overhead due to tapes can be phased out.

We were impressed by Miller Goss's presentation of the pulsar observations undertaken by Walter Brisken as part of his thesis. Although it has been difficult and time-consuming, the finally available capability of the correlator to operate in this original-design mode is an important development. This significant observational enhancement to the VLBA will allow VLBI observations of many pulsars instead of just the brightest few and

lead to new and interesting scientific results.

As AIPS continues to be the primary reduction package for VLBA data, NRAO must continue to maintain the current level of AIPS support. As AIPS++ becomes more widely used, efforts should be made to allow complete reduction of VLBI data within AIPS++ and analysis tools peculiar to VLBI observations should also be made available. Note 200 of the VLBI note series, which outlines requirements for VLBI data reduction in AIPS++ should be consulted as these capabilities are developed.

VLBA science results should continue to be prominently featured in Observatory press releases and used for public outreach. The high-quality and unique science results the array can produce are one of the amazing technical accomplishments of our era. We encourage the inclusion of VLBA images in any archive of NRAO science images.

Response to specific questions:

1) Given the large fraction of VLBA observing time that is scheduled dynamically, the traditional paper schedule is beginning to outlive its usefulness. As a replacement we recommend a Web-based schedule tool that allows users to see their placement in the dynamic queue along with other information. A similar tool should be available for the normally scheduled observations. The current queue listing is helpful, but far more useful would be a listing of the queue updated on a regular basis (daily or weekly) showing project placement and the likelihood of observation in the near term.

We recommend that proposals only be submitted to one location for VLBA proposals including the GBT. If it could be coordinated with the National Astronomy & Ionosphere Center, a single submission address (e.g., propsocao@nrao.edu) for joint VLBA-AO proposals would be preferred.

4c) The reorganization of the VLBA (and NRAO) website has been helpful. Since the overall website must fulfill multiple goals (public outreach, observer information, data resource, etc.) it is critical that the design never be "frozen" so that it can be modified to respond to changing needs. Some effort should be made to ensure that non-VLBI experts can easily obtain enough information about the VLBA to submit sensible proposals. Extra online information for 3mm observing (beyond the Observational Status Summary) should be updated and expanded. The vlbi-exploder archive should be made available online. Finally, some uniformity in file types should be enforced. There is a mix of plain text, pdf, postscript and html files available, which makes accessing the information more difficult. If postscript is offered, PDF should also be available. HTML should be the default format provided for information online and plain text should be converted to this format.

Unified Calibrator Database & User Interface

Currently, NRAO staff maintain two separate databases of calibrators suitable for interferometric observations. The reason two distinct databases exist is partly historic and partly scientific. Since the VLA and VLBA became operational at very different times, two separate databases were created and subsequently used and updated. Scientificly, some sources suitable for the calibration of VLA data are not suitable for VLBI observations.

With the recent expansion of the VLA calibrator list to include high frequency calibrators and the expansion of the number of calibrators cataloged for VLBI observations through surveys, it is now appropriate to merge the two databases.

By merging the two databases, significant staff time (used for list maintenance, monitoring and updating) is likely to be saved over the longer term and users will not have to search both databases for suitable calibrators.

We urge the NRAO to merge the two calibrator lists and expand and enhance the user interface to the database following the rough outline presented by Greg Taylor at the User's committee meeting.

Care should be taken to ensure that users may easily search, characterize and choose calibrators for their observations. Adequate source information, perhaps including source maps, UV plots, historic flux levels or other information should be provided for at least the most important calibrators.

Staff expertise should be used to categorize or rank the calibrators in such a way that a user can make a suitable calibrator choice with the information provided.

The calibrator database should be available online along with adequate documentation on its structure and a "How to" description of how to pick suitable calibrators. The current VLA calibrator interface is very usable and user-friendly. Its best features should certainly be retained in any merged system. We note that other observatories (OVRO, BIMA, IRAM etc.) in addition to current NRAO online resources all contain excellent "pieces" to the overall puzzle of an excellent user interface. NRAO should seek to use existing interfaces and systems available both internally and externally to reduce the development time for the merged database interface.

It may also make the most sense to out source the creation of any interface tool, which would minimize the impact on scientific staff resources, while taking advantage of the experience in the commercial sector for user interface creation.

The overarching theme in developing this merged database system is to "Keep it Simple". Provide all that is needed, but not more and stay away from overly complicated interface design.

GBT

We are excited by the excellent performance that the GBT has shown to date, although disappointed that hardware difficulties have slowed commissioning. We look forward to the scheduling of user programs in coming months. We wholeheartedly endorse the financial support of user-built instrumentation, though we note that the April 2001 deadline was not well known through the community, and there was very little time between announcement of the program and the deadline for proposals.

We are glad to hear that the spectral line and cross-product modes of the GBT correlator have been implemented (though not yet fully tested with the telescope). Reiterating a statement in last year's report, we note that pulsar observers are expected to be major users of the GBT, and we urge the rapid completion of the correlator's pulsar-folding mode. While alternative pulsar backends are available, they have significantly smaller bandwidths and fewer spectral channels than will be available with the GBT correlator.

An improved turret drive system, allowing a change of receivers without moving the telescope in stow position, should be given a high priority. Motion of the turret should also be fully integrated into the monitor and control system, rather than requiring separate, manual operation by the operators. At Arecibo, the turret can rotate any feed into position within seconds, completely automatically. While such high-speed changes are not critical at the GBT, fast feed changes will significantly improve the efficiency of some projects, and are important for multi-frequency observations of time-variable sources and for multi-frequency VLBI.

We continue to encourage research and development of phased array feeds.

A significant use of the GBT will be to fill in the "zero spacing" in VLA maps. It is important that this capability be fully developed (i.e., the relevant software written, perhaps in AIPS++, and a brief cookbook written.)

ALMA

We applaud the considerable progress made toward making ALMA a reality in the past year. The inclusion of the Japanese and the clarification of the partnership with the Europeans appear to have considerably strengthened

the prospects for the rapid progress of the project. We are also pleased that the inclusion of the Japanese partners has not been at the expense of 1/3 of the support from the NSF, but a smaller fraction, the result being that the inclusion of another partner will expand the scope of the project, not merely reduce costs for the American side.

We hope that ideas being tried out at the GBT, particularly financial support of outside groups to develop instrumentation, can be applied to ALMA as well. We feel strongly that existing millimeter University groups need to be included in the ALMA development process. We are pleased that some ALMA memos have been generated from outside of the NRAO, and hope that the fraction of university-based input will continue to grow. We would like to know of any plans of collaboration between the ALMA and CARMA projects, since the science and technology of these two efforts are so closely related.

The NRAO needs to continue to communicate often with the radio astronomy community when letters of support are needed, as was done this past spring for ALMA. We are not always aware of this need, and appreciated the "heads up" that was sent out.

Grants

We are extremely enthusiastic about the new NRAO grants program. This is part of a package of enhanced support for US users of NRAO facilities, which also includes complete page charges for publications of results from NRAO telescopes and up to \$1000 of travel support for observations and data reduction, including archival data, at NRAO facilities. All of this is very good news for the US radio astronomy community.

Many of us, particularly those based in universities, experience "double jeopardy", first in getting financial support for our research from the NSF through their intensely competitive grants program, and then in getting telescope time through NRAO's competitive proposal process. We recognize that many of our colleagues have succumbed to the temptation of "single jeopardy" NASA support which comes automatically with telescope time awards on HST, Chandra, and other space-based optical, infrared, X-ray, and gamma-ray observatories. This imbalance in funding opportunities over the last decade has had the effect of channeling graduate students out of ground-based radio astronomy. We applaud the initiative to start a small grants program to support research using new radio telescopes such as the GBT and the EVLA. This will have a strong positive impact on the user community, and particularly on the younger generation.

Our priorities for the allocation of the funds available for grants in support of research with NRAO telescopes favor students. Support for a graduate student doing a Ph. D. project is one very high priority (typically \$20K/year for two years), summer support for undergraduate and first and second year graduate students (typically \$3K to \$5K) is also a high priority. Other appropriate uses for these funds to help the user community include support for post-docs and partial salary support for professors, e.g. summer salary or sabbatical leave support for temporary residence at NRAO sites. All these possibilities were discussed at the meeting, and they all were welcomed by the users. We recognize that the grants program will evolve as experience is gained in the most effective use of the funds available, and we hope that some initial grants can be offered over the coming year.

One general suggestion which we make is to keep the funding application and selection process as simple and brief as possible. The scientific justification for the project is already presented in the observing proposal. Thus an additional one or two page budget with explanation should be all that is needed from the applicant. Since observing proposals are already subjected to an intense review and ranking process prior to telescope scheduling, it should be possible to use these reviews to make the funding decisions also.

E2E, COBRA, Data Processing, Archiving

A sketchy plan for "end-to-end" data processing (E2E) was presented at the meeting. While we greatly appreciate many of the goals of the E2E program, at the same time we are concerned that a loosely-defined, do-everything-at-once program will end up being a much bigger drain on resources, and much more complex to implement, than the Observatory expects. Some highlights related to E2E include:

- The Observatory's involvement in a potential National Virtual Observatory and its efforts to obtain funding for a common radio archive (COBRA). We strongly support the development of a user-friendly, publicly-accessible, web-based archive system, with data products available in final form (e.g., images), or with on-line processing tools available to quickly convert raw data (visibilities or whatever) into images, with minimal user input. Given the nature of radio data, this will be an extremely ambitious undertaking, but the rewards will also be immense.

With talk of such a grandiose archive project, it may be tempting to avoid dealing with other, shorter-term archive needs. Independent of COBRA, NVO, etc., we urge that

- The VLA archive should be made available on-line. While archival VLA data are accessible, there is a multi-day delay while the request is approved by the NRAO administration, the data are put on tape, and the tapes are shipped to the Observer. Putting the archive on line will entail some effort moving data from tape to disk, but this will have to be done sooner or later, anyway.
 - An archive needs to be developed for the GBT, quickly. Apparently there is no plan for archiving GBT data, other than writing data files to tape from time to time. Given the immensely complex nature of GBT data -- for example, correlator measurements are kept in one set of files, while information about where the telescope was pointed during an observation are kept in a completely independent set of files -- the lack of a well-organized archive could quickly lead to chaos.
- Integrated datataking and analysis with the VLA. A smoother process, from preparation of the observe files and calibrator lists, through the data taking, calibration, mapping, and deconvolution to final visualization, would be helpful to everyone from novices (who otherwise might avoid the VLA altogether) to experienced users (who would be able to observe more efficiently.) Such a process would naturally lead to more consistent final data products, simplifying the production of a user-friendly data archive.

Of course, relatively automated observing and the desire for relatively uniform data sets must never preclude observers from doing novel or non-standard observations for good technical or scientific reasons. A hallmark of radio astronomy has been hands-on manipulation of data and instruments by observers, and that must not be allowed to go away.

- Coordination of computer software and hardware standards throughout the Observatory should increase efficiency.

One suggestion from the Committee regarding the E2E effort is that a prioritized list of short term goals should be prepared and circulated. We would like to see the operations of this new NRAO division kept as accessible and as user-friendly as possible. Working closely with users at every stage will help make the products of this initiative more quickly accepted and widely used. (Surprisingly, many members of the committee had not previously heard of the COBRA proposal, despite the fact that it would be a major undertaking of the Observatory. Efforts such as the COBRA proposal should be more widely publicized within the user community.)

AIPS/AIPS++

While we are encouraged by continued progress with AIPS++, especially for processing single dish data, NRAO must realize that AIPS++ will never be widely adopted by the user community until it is the program of choice for NRAO staff for processing array data. We laud the "testers program" now in place at the AOC. The current testers have clearly made significant progress (although it is sobering to hear how many bugs have turned up). The tester program should be expanded such that all NRAO staff scientists cycle through the program and play a major role in debugging the system. Once AIPS++ reaches a level of usability such that the testers adopt it rather

than returning to regular AIPS as soon as possible, users will begin to try AIPS++ itself. As a committee contribution toward "good citizenship" committee members have vowed to actually try AIPS++ during the upcoming year.

The committee has been an advocate for rapid distribution of AIPS++. However, there must be a balance between resources allocated toward debugging and toward getting the program out. Distributing a buggy program can cause considerable harm.

We appreciated the comments made by testers and other AOC users of AIPS++. Indeed from the users viewpoint, such comments are more valuable than presentations by members of the AIPS++ group. Next year, we would welcome a presentation from AOC AIPS++ users to a closed session of the committee.

Needless to say, regular AIPS must be maintained at its current level and augmented as necessary. The staff involved in this continue doing a commendable job. In particular, the AIPS installer has been well received by the users.

Proposal Submission

It was reported that for the Feb 2001 deadline, 125 VLA proposals, 57 VLBA proposals, and 11 Global proposals were received, and all but six were submitted electronically. The committee was then asked whether there was any objection to accepting only electronic submissions.

In the eyes of the committee, it appears that electronic submission is already widely adopted, with few exceptions. The only questions at this point are 1) is it acceptable to explicitly forbid paper submission, and 2) should electronic submission be done via a web form, TeX formatted files that are emailed, or some other process. The latter question is more related to the End to End Initiative (e2e) and will be discussed more there.

As for electronic-only submission, at this point, our attitude is one of "If it isn't broke, don't fix it...". While we are aware that handling of paper submissions is more time consuming, the extremely low volume of paper submissions does not warrant their exclusion. We note that one reason some feel compelled to submit paper proposals -- the use of color figures -- could be alleviated to some extent by the Observatory agreeing to print and distribute proposals in color when requested.

RFI

The past year has been something of a roller coaster ride with the on-again, off-again possibility that a major source of radio frequency interference (RFI), the Iridium constellation, would be de-orbited. Even in the absence of Iridium, though, passive services like radio astronomy are facing increasingly complex environments. This problem is particularly severe for radio astronomers given the general faintness of the radio Universe and the increasing demand for larger frequency coverage and broader bandwidths.

Against this backdrop we were heartened to hear of a number of positive steps occurring in the Observatory:

- The NSF MRI award to Rick Fisher was a welcome announcement. Given the NSF's substantial investment in ground-based radio astronomy facilities, this award represents an excellent insurance policy toward maintaining these facilities at the leading edge of astronomy. We were however, sobered to hear the excellent presentation on the challenging RFI environment at Green Bank given by Rick Fisher.
- We applaud the Observatory's membership in the International Dark-sky Association. The IDA has had a number of successes in maintaining or improving dark skies, and we hope the Observatory's membership will assist them in maintaining dark skies at all wavelengths.
- We are glad to hear that a senior engineer/manager position is being advertised to coordinate all spectrum management work in Green Bank and that adequate financial resources are finally becoming available.

Mark McKinnon had been performing many of these tasks. We thank him for his work in this area and hope that an equally capable replacement can be found quickly. We are also glad to hear that this position's responsibilities will include mitigation of locally-generated RFI.

- We are glad to hear that Darrel Emerson is serving on CORF. We think that it is important that the Observatory continue much of the work started by Dick Thompson. It is also important for the Observatory to maintain a presence on or in front of the relevant domestic and international organizations and/or make presentations regarding RFI to those bodies they cannot participate in as a member. Coordination with other observatories regarding RFI is of the utmost importance. It should be remembered that without usable portions of the radio spectrum, radio astronomy will become a thing of the past.

With the continued expansion of radio instrument sensitivities into the higher frequency areas, special attention should be paid to potential sources of RFI in these regions. This is especially true for potential short-range radio signals from automobile collision avoidance systems and other developing technologies. The Observatory should begin now to worry about preservation of the radio sky at the higher frequencies. The recent agreements at the WRC in Istanbul are an excellent start on the long-term job of preserving the higher frequencies for scientific use.

Working with the IDA and/or American Astronomical Society's Committee on Light Pollution, Interference, and Space Debris, we recommend that the Observatory produce an outreach or public relations product describing RFI and its impact on astronomy.

Particularly useful would be material that faculty members could work into their courses and a sheet of "talking points" (similar to what the IDA already produces for the optical night sky).

While it may be self-evident, we recommend that the EVLA produce significantly less RFI than the VLA does currently.

Education and Public Outreach (EPO)

We are pleased with progress made in a number of EPO areas in the last year:

- the new blue brochures for each telescope are attractive, professional, and informative
- the increased presence at AAS meetings provides important outreach to the community
- the new Green Bank visitor's center will be an extremely useful facility, and we applaud NRAO on its ambitious design and on obtaining funding.
- the continued frequent press releases are important for increasing visibility with the public. We learned during the meeting that the VLA generates the most publications per year of any telescope except HST, and these results need to be publicized!
- as always, hands-on programs for teachers at the Green Bank site are a spectacular example of educational outreach.

We were disappointed, however, to receive no written report on EPO prior to the meeting. We received no response to the many detailed suggestions we made last year. We realize that this is partly because a search is going on to hire a new EPO staff person, and we hope this person can take charge of Observatory-wide EPO soon.

We are also very pleased to see the emphasis on EPO in the Long Range Plan, where it is one of four major goals for the next few years. The new VLA Visitor Center and Education Program is desperately needed, and we look forward to seeing a more detailed plan for this in the coming year. Recommendation: As part of the long range plan, be sure to include an EPO component in the planning and budgeting stages for each major new instrument (EVLA, ALMA, etc.), similar to the EPO component of every NASA mission.

Finally, we're glad to hear of your plans for a meeting in September 2001 to plan an Observatory-wide detailed strategy for EPO, and encourage you to solicit comment from the user community (via AAS email exploder, etc.)

while making these plans. Below is a prioritized list of the EPO initiatives we feel are important in the short term and the long term. Comments on another EPO-related issue, the NRAO web site, are given in an appendix.

PRIORITIZED LIST OF EPO INITIATIVES

(Users Committee Member C. De Pree will attend the September 13-14 EPO Meeting in Green Bank, WV)
Critical/Short Term Needs (in order of importance)

- Hire a full time EPO Coordinator at the AD level (if possible) to direct EPO at all NRAO sites. This area is in need of committed, long term leadership to organize the substantial but undirected efforts of the individual sites
- Unveil a Public Image Archive, well organized, accessible, and professional-looking. Call it something like RadioSky.edu (to complement RadioSky.com, the amateur radio astronomy site)
 - A possible starting point: Radio/Optical Messier catalog (see specific comments on image archive)
 - This site needs a unified presentation and professional look (possibly matched in terms of design to brochures)
 - Short Captions should be provided, and the name(s) of the observer(s)
- Web Page Improvements-see detailed comments in appendix
 - Early split (Professional/Public) on the first page
 - Better organization of materials for astronomers
 - Public pages should be re-organized (see specific comments on WWW)
- Update exhibits at the current VLA visitor center, as a transition to a new visitor center in the long term. Also, start staffing the visitors center full time (perhaps this same person could fill WWW orders for NRAO T-shirts, hats and the like).
- Have NRAO astronomers make Powerpoint presentations available on the web for astronomers giving EPO talks

Long Term Needs

- Outreach to College/Post-graduate students
 - The Post-Doc program seems to be in good shape. This is an important form of "outreach" to the community, and post-docs should be kept as diverse as possible in terms of their observational background
 - The Pre-Doc program has always been more informal, and could perhaps be "formalized". The NRAO might be able to investigate a competitive Pre-Doc program that would support graduate students in their first two years of study, and one requirement of the scholarship could be residence/study at an NRAO site for two summers. If the NRAO summer school meets every other year, these scholars would attend that summer school as part of their training.
 - The NRAO summer internships for undergraduates has been incredibly successful and has generated many future radio astronomers. Perhaps someone within the organization could do statistics on the "success rate" of summer school students and a listing of publications that have come from summer projects
 - The formalization of the student observations with the VLA should be publicized in the newsletter and on the WWW site
- Radio Astronomy Brochures (available via mail and in PDF format on line)
 - RFI Brochure should be made available. Could be borrowed from the IDSA site or generated internally
 - "White Papers" (see Users Committee 2000 report). These could be written by research astronomers, and then edited and given a common "look" by NRAO staff. Could include a brief biography of the astronomer
- Individual Site Initiatives for EPO
 - VLA visitors center similar to GBT is badly needed. Small radio telescope for visitors to operate is a great idea. Would allow a comprehensive program to reach all NM school children.
 - Exhibits could be developed with the intention to duplicate them at various NRAO sites and have one spare display on traveling tour to small planetariums around the country

- Programs for K-12 teachers. All sites should offer services to these ages. GB seems to have the most organized efforts on this front. Should be expanded to other sites.

Appendix: A Critique of the NRAO Website

Overall, the NRAO website contains good information for the general public to consume. However, the largest fault of the website is that it lacks good organization of the content. For members of the general public, it is not clear what information can be retrieved from the site or where to look. As a user, one wants to access valuable information quickly. Currently, the NRAO site does not support this goal for the general public.

Search Capabilities:

The NRAO has good coverage on the Internet based on search engine results for "radio astronomy". When surveying four popular search engines for "radio astronomy", the NRAO website was listed within the top two selections on three of the sites and was 6th in the remaining site. The NRAO has much less coverage on the Internet based on search results for "astronomy" 3 of the 4 sites did not list the NRAO at all. On the remaining site, NRAO was 3rd on the list. Recommendation: the NRAO should enlist itself with the major search engines based on a wider set of search criteria to include "astronomy".

Naming:

The site name, www.nrao.edu, is not an easy site name to remember, especially for those unfamiliar with radio astronomy organizations. It is recommended that site names mean something to the user. For instance, other astronomy website names that are hard to forget include "radiosky.com" and "signalone.com". Recommendation: the NRAO may want to consider developing a separate website for public outreach and assign a name that is easy to remember and more meaningful to the general public.

NRAO Home Page:

The home page has a very pleasing appearance with low clutter and clearly identified alternatives to select. However, as a member of the general public, where should one go? What information is available on this site that is relevant to the general public? Where is the introductory material on radio astronomy? It is clear that the home page is servicing a wide-range of audiences. It appears that the site is servicing at least five users groups including: professional astronomers, students looking for a job, NRAO staff, educators, and the general public. It is acceptable and often necessary for a website to service several audiences but good websites provide clear instruction and meaningful tag names to guide each user audience to the correct pieces of information. (Note: This first requires the NRAO to clearly understand what types of information each user group wants to obtain from the site.) For instance, the names of the selection options are not meaningful to the general user. Education: What is Education? Does that imply that you should select this if you want to get educated or because you are an educator? Library: Library of what? Will I find pretty astronomy pictures here? In addition, the selections are not grouped based on user group. As a general user, there is no need to access "Engineering" (it is not clear what Engineering is for) but "Engineering" is listed between Education and Library - two selection that a member of the general public will most likely make. Recommendation: The NRAO should first clearly identify the user groups it is targeting with its website. The NRAO should ask each user group what types of information they want to see on the site. Once those audiences have been identified and relevant information defined, the Home Page should then be designed to target each user group and to provide a clear information flow leading each group to the information relevant to them. The NRAO does this more effectively on the Very Large Baseline Array site as the various user groups are listed by name on the home page (www.aoc.nrao.edu/vlba). The goal is to get people to the information they are seeking as quickly as possible. The fewer clicks the better.

Beyond the Home Page:

As a general user, "About NRAO" is most likely the first area selected. The content is good but it gets quickly confusing again by the additional information provided via the new selections. Only 6 of the 10 selections clearly apply to the general public. One has to search through the other selections to see if there is anything of interest behind those selections. The same experience is reached when accessing "Education". There is information there that applies to the general public as well as to educators. Good websites never mix information

for one user group with information designed for another group. This is a suggestion for a design of the page that is relevant to the General Public, as follows:

NRAO description

Intro to Radio Astronomy (currently under "About NRAO")
Early Radio Astronomy (currently under "Education")
Radio Astronomy Fundamentals (currently under "Education")
Value of Astronomy (currently under "About NRAO")
Visitors Center (currently under "About NRAO")
Radio Image Gallery (currently under "Education")
Image Gallery (currently under "About NRAO")

Note: Why are the two image galleries different? In addition, place a link to the image galleries on the Home Page as this, in is the biggest draw for the general public. Recommendation: redesign the site based on the needs of the user. Ask the general public what types of information they would like to see and build the content and the site around that. Perhaps NRAO should consider getting a consulting firm to do their website for the general public.

Navigation:

Navigation on the site is not bad but it could use some improvement. The user must often use the "back" button to return to a previous page. It is better website format to always have a table of contents visible so the user can easily navigate between sections of the website. The Association for Radio Astronomy in Education website, <http://www.arae.co.uk>, provides an example of great navigation.

Image Gallery:

Build an image gallery with more astronomical objects, descriptions, links to websites in optical wavelength, then explain why Radio astronomical images should be integrated to optical images (e.g. What the constellation looks like) even if there is nothing to see in optical wavelengths (e.g Hubble/AAT/VLA images of the same object, see <http://spaceimages.northwestern.edu>). It does not make sense to have the M87 image by itself separated from galactic and extragalactic categories for VLA and VLBA images. VLA is the HST of optical astronomy. Digitized VLA images should be very useful and easily accessible for the general public. Check <http://www.aao.gov.au> under images. Check also <http://www.eso.org/outreach/info-events/ut1fl/astroim-bebular.html> for clarity and the organization of astronomical images. Suggestion: Add a radio Messier catalog or radio counterpart to some of HST images. It would have the following benefits:

- limited scope
- emphasis on the relationship to optical images (show side by side)
- certainly reasonably good observations exist of these objects
- could be proof of concept for layout, etc. NRAO should pay for page charges only if authors provide their radio astronomical images for public consumption (exceptions can be made for a delay in submitting radio images).

Miscellaneous:

Use more animation in the VLA website (how the VLA site looks like from different angles). Should consider receiving proposals for public outreach from astronomers who have received observing time from GB (similar to what HST does).

Users Committee 2001

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