Strategic Plan for NOAO Education and Public Outreach

The National Optical Astronomy Observatory is a federally funded research and development center (FFRDC). NOAO's programs and facilities are funded by the National Science Foundation. Because of these two factors, our Education and Public Outreach (EPO) strategic plan is responsive to NSF, and to the expectations of an FFRDC including the broader federal STEM strategic plan.

NOAO adopts NSF core values for development of its EPO program (*Empowering the Nation through Discovery and Innovation NSF Strategic plan For Fiscal Years 2011-2016):*

> Visionary—imagining the future, working at the frontier, realizing the full potential of the research and education community, embracing risk, advancing promising ideas wherever and whenever they arise, and encouraging creativity and initiative;
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> Dedicated to Excellence—investing optimally the resources entrusted to us, realizing the full potential of our people and managing a capable and motivated organization that provides an inclusive and positive work environment, and rewarding accomplishment;
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> Learning and Growing—continually improving our ability to identify opportunities, promoting learning and growth for the S&E community and the agency, and sharing our best insights with others;
>
> Broadly Inclusive—seeking and including contributions from all sources while reaching out, especially to groups that are underrepresented, serving scientists, engineers, educators, students, and the public across the nation, and exploring opportunities for partnerships, both nationally and internationally
>
> Accountable—operating with integrity and transparency, and maintaining quality in administration, management, and oversight.

With these core values in mind, NOAO EPO's mission is to inform, educate, and engage the public and professional communities through a series of well-developed education and outreach programs and support activities. **The overarching strategy for EPO is to accomplish this mission in ways that support, reflect, and build upon the core research mission of NOAO.** At the highest level, NOAO EPO seeks to accomplish its goals by addressing core deliverables as agreed upon with the NOAO Director. These are:

- Dark sky preservation near observatory sites
- Educational outreach and programs in Region de Coquimbo and Arizona
- Outreach to Tohono O'odham Nation
- Engagement with the American professional astronomical research and education community; support of AAS meetings
- Media and Public Information efforts
- Other educational efforts after the above are fulfilled.

Implications to NOAO EPO Program: Key program areas will focus on dark skies education, local outreach in Arizona and the Region of Coquimbo, outreach to the Tohono O'odham Nation.

NOAO uses the **Federal STEM Strategic Plan** to guide and inform the development of the programs used to achieve its high level deliverables. Our overall approach to these deliverables is congruent with the goals of the Federal Education STEM 5-year Strategic Plan. The Federal STEM 5-year Strategic Plan sets out ambitious national goals to drive Federal investment in five priority STEM education investment areas:

- Improve STEM Instruction: Prepare 100,000 excellent new K-12 STEM teachers by 2020, and support the existing STEM teacher workforce;

  Implications to NOAO EPO programs: This is a clear message on the importance of pre-service teacher education and ongoing professional development for teachers. This may also include research experiences for potential and novice STEM teachers as well as workshops for exiting STEM teachers. NOAO's darks skies programs and Teaching with Telescopes (Galileoscope) programs in Chile and the U.S. focus on teacher and informal educator professional development. Past programs such as Hands-On Optics and Astronomy from the Ground Up devoted a large part of its resources to professional development of informal educators and teachers. The current STAR Teachers program that NOAO participates in is devoted to giving pre-service and novice teachers an authentic research experience. Finally our support of teachers conducting astronomical research is also aligned with this investment area.

- Increase and Sustain Youth and Public Engagement in STEM: Support a 50 percent increase in the number of U.S. youth who have an authentic STEM experience each year prior to completing high school;

  Implications to NOAO EPO programs: This encourages us to aid science fairs, science camps and festivals, afterschool programs, and star party/observing experiences, etc. in support of authentic STEM experiences. We support this area at NOAO through our local outreach work in Chile and the U.S. in providing authentic astronomical experiences for students. Our Galileoscope program provides students the opportunity to build and understand their own telescope and to conduct authentic astronomical observations. Our Globe at Night program encourages K-12 students to conduct their own

assessment of light pollution in their area and to post the results for analysis. Other authentic STEM experiences are given through our extensive star parties and our work with TLRBSE and Spitzer program teachers who have high students conducting astronomical research. Our Colors of Nature program is designed around authentic STEM experiences for art-interested girls and combines optics, biology, materials science, and art.

- Enhance STEM Experience of Undergraduate Students: Graduate one million additional students with degrees in STEM fields over the next 10 years;

  Implications to NOAO EPO Program: We want to encourage and mentor undergraduate students who are pursuing degrees in STEM fields. This may include undergraduate research, undergraduate mentor programs, and of course REU and related programs. An undergraduate mentoring program that conducts outreach can enhance our effectiveness in most of the other priority areas. The NOAO REU program is widely respected as an effective way to encourage and retain students majoring in astronomy and related fields. The undergraduate mentoring program is designed to improve retention of STEM students and has a strong record of success.

- Better Serve Groups Historically Under-represented in STEM Fields: Increase the number of students from groups that have been underrepresented in STEM fields that graduate with STEM degrees in the next 10 years and improve women's participation in areas of STEM where they are significantly underrepresented;

  Implications to NOAO EPO program: This encourages us to put our program emphases on groups historically underrepresented in STEM fields, including women in the physical sciences and engineering fields. Nearly all NOAO programs have been designed to serve groups historically under-represented in STEM fields. Our Colors of Nature program serves upper elementary and middle school girls who are underrepresented in careers in he physical sciences, mathematics, and engineering. Our PAARE program provides valuable research and mentoring opportunities for students from Historically Black Colleges. Our active recruitment and support of college students from the Tohono O'odham Nation in our REU program is another example.

- Design Graduate Education for Tomorrow's STEM Workforce: Provide graduate-trained STEM professionals with basic and applied research expertise, options to acquire specialized skills in areas of national importance, mission-critical workforce needs for the CoSTEM agencies, and ancillary skills needed for success in a broad range of careers.

  Implications to NOAO EPO Programs: NOAO encourages this through the support of graduate research at NOAO telescopes and sites. The EPO department has ceded this area to the larger observatory efforts in this area.

(Reference: The bullets above are from the Federal Science, Technology, Engineering, and Mathematics (STEM) Education 5-Year Strategic Plan: A Report From The Committee On STEM Education National Science And Technology Council)

NSF Criteria for Projects and Programs
As an FFRDC, we pursue projects and approaches that are consistent with The NSF Intellectual Merit and Broader Impacts Criteria. In particular, this latter requirement drives our projects and approaches towards innovation in the service of underrepresented groups.

For Intellectual Merit, our projects must advance knowledge and understanding within its own field or across different fields. Similarly, our programs and activities must suggest and explore creative, original, or potentially transformative concepts

NOAO Implications: As appropriate, we will pursue creative approaches and cutting edge or bleeding edge projects that advance the field. To create transformative projects we will need to partner with the top organizations in the field and probably attract outside funding through competitive proposals. Some projects that have particularly strong intellectual merit include the International Year of Astronomy 2009 (innovative ways to reach large numbers of people), the Galileoscope project (invention of a high-quality inexpensive user-friendly student-assembled telescope), Colors of Nature (new approaches to encouraging art-interested girls to develop science identities), and Globe at Night (one of the first successful citizen science projects).

For the Broader Impacts Criterion we must pursue projects and approaches that give positive answers to these questions:

- How well does the activity advance discovery and understanding while promoting teaching, training and learning?
- How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)?
- To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks and partnerships?
- Will the results be disseminated broadly to enhance scientific and technological understanding?
- What may be the benefits of the proposed activity to society?

Implications to NOAO: Where possible, our target audiences will be underrepresented groups. We will strive to enhance the infrastructure of the astronomy education system through partnerships. We will be active in disseminating our results, especially through national workshops, national presentations, and through publishing. Service activities will be encouraged if they help enhance the infrastructure or reinforce partnerships.

Summary

The NSF values and STEM strategic goals in combination with the NOAO deliverables lead us to decide on which projects will be pursued. The above criteria also lead us towards an ambitious strategy to pursue (as resources and opportunities allow) innovative and possibly expansive national projects rather than safe and limited projects. Transformative ideas and initiatives come with substantial risk and are not always % successful. One element of transformative education projects is to achieve a greater reach in ever more efficient ways. Efficiency is only one area of innovation, but it is an important one. Other projects are designed to be transformative through research in advancing the current knowledge and practice of science education. Our plan moves us to focus on multiple key areas (local outreach, dark skies education, or teacher research/development) to achieve our goals.

We are keenly aware of the two major areas that impact our ability to succeed: factors internal to our organization and factors external to our organization. For the former, we are aware of the strengths and weaknesses of our department and the observatory as a whole. We are also aware of the interests of members of our department and of upper management (e.g., our deliverables described earlier).

For factors that are external to the observatory, we note the environmental threats and opportunities. Threats include (for example) decreases in the science literacy of the population as a whole, the shortage of trained teachers in physical science, and the lack of authentic experiences in science for teachers and students. Opportunities include our department's expertise in astronomy, the experience of some department members as teachers and museum educators, our access to astronomy and engineering facilities, and our ability to integrate engineering and mathematics into our efforts. The last item is particularly valuable in light of the Next Generation Science Standards.

We also note that the last of the two external factors is society's expectations of the observatory. We view this largely in the context of our funding agency, NSF, and their expectations for an FFRDC.