Recommendations from the "Broadening Participation in Future Telescopes" Workshop
Workshop held December 17, 2018, Pasadena, California
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This workshop was requested and funded by the Thirty Meter Telescope International Observatory (TIO) to further inform their plan for broadening participation, including increased US community participation, as the new US ELT Program is formed. The goal of the workshop was to launch the design process and generate recommendations for a future effort to design and develop a broadening participation plan for future telescopes. The workshop was led by the Institute for Scientist & Engineer Educators.

Recommendations for shaping a plan to create more diverse and inclusive telescope workforce communities:

1. Define "telescope workforce"
Telescopes require people working in a range of roles to accomplish its scientific mission, including the following major groups (during telescope construction and operations):

- Personnel (scientists, science support, engineers, technical, senior management, admin)
- Instrument teams (scientists, engineers, technologists)
- Scientific users (PIs, researchers, students, postdocs)
- Leadership/governance (science advisory committees, time allocation committees, boards, standing review/oversight committees)

2. Articulate the need for broadening participation in the telescope workforce

- Women, African Americans, American Indians, Alaskan Natives, Native Hawaiians and other Pacific Islanders, and Hispanics are underrepresented in all aspects of the telescope workforce, as well as in the fields that are drawn from (e.g. astronomy, physics, engineering, computer science).

- Utilization of local talent pools in construction and operation of telescopes is needed for many reasons, including the often-high attrition rates of imported talent, and for observatories to become valued members of the local community where they are located.

- To maximize the scientific return of telescopes and engage the national research community, a broader range of universities need access to telescope time, archival data, and open collaborations.

- Broadening participation requires more than bringing more underrepresented groups into the field. There is a large body of knowledge about why people leave science and engineering during college, graduate education, and career positions. For example, there are many studies linking career persistence to a "science identity" shaped by experience in the workplace, and many practical strategies emerging from that research can be applied to workforce and inclusion programs. In addition, some groups disproportionately experience biases, discrimination, and other marginalizing behaviors. Well-documented gender biases have been identified in hiring, salary, start-up funds for laboratories, credit for authorship of papers, letters of recommendation, invitations to give talks at prestigious university colloquia, and telescope time allocation. The prevalence of discrimination, bullying, and harassment in science/engineering workplaces and field sites is also well-documented.

3. Establish high level goals for broadening participation in the telescope workforce
There are three goal areas for broadening participation that can be further refined to guide the development of a program(s) for broadening participation in future telescopes:

- Increasing participation of underrepresented groups and under-served communities in all aspects of the telescope, in construction through operations
- Increase the diversity of institutions accessing and using the telescope and data
- Creating an inclusive workplace environment that supports the success of people from all backgrounds

4. Identify measurable outcomes of workforce development and inclusion
Outcomes from successful workforce development and inclusion efforts can be measured in a variety of ways, including: career progress of individuals, changes in demographic composition, and organizational change. Below are examples that apply to some of the major areas of telescope workforce: personnel, science users, instrument teams, and leadership.

Individual outcomes	● Completion of career-relevant degree ● Employment in targeted career area ● Retention and advancement in career or organization ● Ability to apply skills learned (e.g. mentoring, inclusive teamwork, technical)
Changes in demographic composition	● Increased degree completion rates of groups with high attrition ● Increased hires of people from underrepresented groups in targeted jobs ● Changes in demographic composition of organization, team, science users, boards, advisory committees ● Diverse institutions (research, smaller, Minority Serving Institutions, etc.) leading observing programs or using archival telescope data
Organizational change	● Adoption of value statement related to diversity and inclusion ● Implementation of hiring, promotion, telescope time allocation, or committee formation practices that broaden participation ● Positive changes to workplace climate ● Development of resources to enable access to under-served groups ● Increased number of mentors participating in mentor training

5. Identify indicators of progress in achieving outcomes
The outcomes noted above may take time to achieve. In some cases, shorter term indicators will help in evaluating progress. Outlining career progressions into major telescope workforce areas is an example of a strategy for identifying short-term indicators. For example, there are multiple pathways into instrumentation careers, and specific milestones (e.g. types of skills, publications, team membership) that are indicators of career progress. Creating a career progression with specific milestones can also be used as a tool and disseminated to others.

6. Dedicate resources, expertise and leadership to workforce development and inclusion
Workforce development has outcomes, partners, effective strategies, and activities that are significantly different from education and public outreach, communication, and human resources.

Workforce development overlaps with inclusion efforts, which often involve the professional development of people currently in the workforce and plays a role that is distinct from but complementary to human resources. To be effective, workforce development and inclusion need dedicated resources and expertise, and leadership reporting to the Director level.

7. Integrate design of workforce development & inclusion into telescope design process
TIO and the US ELT Program have a rare opportunity to integrate the design of workforce development and inclusion from the telescope design and pre-construction phase and will have the best chance of success if resources, expertise, and leadership are dedicated now. Workforce development takes years of investment and making changes to workplace practices and culture is a long process. Several immediate actions were identified during the workshop:

- L**aunch a design and development project during the pre-construction phase:** Workshop participants initiated a process and are interested in continuing to contribute to design and development.
- **Begin implementing some preliminary student training activities:** There are existing activities that could provide an opportunity for piloting and establishing practices and a supportive culture within the ELT community, and begin bringing new institutions into the ELT community.
- **Establish a value statement around workforce development & inclusion:** This would serve to build a common understanding and be a foundation to build from.

8. Include design and development project in future funding proposals: A short narrative to be included in future proposals was sent directly to TIO.

Workshop participants
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