

# **An Early Career Investigator Community Vision for the Future NSF Geophysical Facility: Education, Workforce, and Outreach Needs**

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## **1.0 Introduction**

This white paper has been developed based on a compilation of input from ~45 Early Career Investigators (ECIs) from various institutions who participated in the “*Early Career Investigator Virtual Workshop on a Community Vision for the Future Geophysical Facility*” held April 23-24, 2020 and 59 respondents to a follow-up survey for ECIs distributed via IRIS and UNAVCO list-servs. Our aim is to identify the critical Education, Workforce, and Outreach (EWO) services that need to be positioned within the scope of the NSF Future Geophysical Facility (FGF) to help advance scientific objectives determined by current ECIs.

## **2.0. Professional Development**

Both ***in-person and web-based training*** are essential for the professional development of ECIs and are needed to advance scientific goals. Most workshop and survey participants (~85%) have benefited from professional development opportunities made available through IRIS and UNAVCO. IRIS and UNAVCO provide support for PIs to conduct domestic and international professional development workshops. Workshop materials, such as videos and digital presentations, are readily available on the IRIS and UNAVCO websites after the conclusion of the workshops. In the last three years, UNAVCO held over 60 in-person short courses, and those materials are publicly accessible. Similarly, IRIS organized 83 webinars that are archived for public access. These courses and materials are valuable resources for ECIs. We encourage the continuation of the above services with a focus on leveraging professional development workshops, short courses, and webinars by the FGF. Critically, many of the existing workshops are made possible through volunteering by current members. As demand grows for online activities, more workshop instructors are required, as is greater logistical support.

Much of the ECI professional development training has focused on data processing and analysis, often at the introductory level. We suggest that the FGF ***expand its professional development repertoire*** and include advanced training. ECIs have identified needs for training in high-performance computing, cloud computing, new FGF technologies (i.e. single access portal), as well as, expanded software training with “Hackathons” where appropriate. Training on the design, use, and application of geophysical instruments could be linked to training on data access, motivating specific data quality analysis procedures and common pitfalls. This should be seen as distinct from instrument training geared toward data acquisition, field operations, and data archiving procedures. In addition to training geared toward teaching and research, ECIs greatly value ***professional development training in career management and navigation***, including preparation for careers outside of academia.

ECIs have also benefited from science-oriented workshops and webinars, especially the biennial science workshops now hosted jointly by the current SAGE and GAGE facilities. These workshops introduce ECIs to cutting-edge research in a number of geophysical disciplines while also providing them with opportunities to promote their own research and develop new

collaborations. Therefore, we request that the FGF continue to provide **significant travel and lodging support for ECIs** to participate in such activities.

### 3.0 Internships

Undergraduate and graduate **student internship programs** are critical components of EWO, in particular the USIP, RESESS, and Geo-Launchpad programs at UNAVCO and the IRIS internship program. Specifics of these programs vary, but the essential components include a research immersion experience, presentation at a professional meeting, and development of a cohort/network of geophysics students. ECIs with experience either as research advisors or as past interns themselves were clear about the positive impact of these internships. The value of the internships extends well beyond their direct term; for example, based on a recent report of the IRIS internship program (1998-2018), 89.8% of alumni described the program as influential in shaping their education or career trajectory (internship data provided by Michael Hubenthal of IRIS).

Crucially, IRIS and UNAVCO internships provide a key mechanism for **advancing underrepresented student participation across geoscience disciplines**. The UNAVCO RESESS internship, in particular, is dedicated to increasing the diversity of geoscience students (not limited to geodesy), and is a model we recommend is continued and expanded. In parallel, IRIS has put an emphasis on increasing the diversity of its student cohorts; on average, 50% of all IRIS interns have been women and the number of underrepresented minority interns continues to grow each year and reached 30% in 2020. Additionally, from 1998 to 2018, 106 out of the 229 (46.3%) IRIS alumni have come from non-IRIS institutions (e.g. voting members), where they may have had limited exposure to seismology and lacked access to research opportunities in geophysics. In all, the ECI community was in agreement that the IRIS and UNAVCO internship programs are necessary vehicles for introducing, recruiting, and retaining students in the geosciences.

We urge the FGF to **continue to strengthen these internship programs**, integrate them across disciplines, expand them beyond seismology and geodesy (e.g., magnetotellurics), and streamline the application process with a single application. We also propose that these programs incorporate a time-frame for interns from all of the internship programs to interact and learn about a range of geophysical disciplines beyond their specific programs.

### 4.0 Teaching Materials

ECIs value and benefit from **instructional materials** designed for undergraduate courses. In our survey, 85% of respondents have used teaching materials provided by IRIS and UNAVCO (~50% consider these essential), from short explanatory videos and earthquake teachable moments available from IRIS, to full lesson plans and multi-lesson modules (e.g., GETSI from UNAVCO).

We encourage the FGF to establish a presence in primary education by **developing and promoting teaching modules** that can be easily distributed to educators in collaboration with existing sources of K-12 science lessons (e.g., [mysteryscience.com](http://mysteryscience.com)). In addition to ensuring that lessons are consistent with the state-of-the-science, this will introduce students and teachers to the FGF and foster the next generation of geoscientists.

### 5.0 Public Outreach

ECIs agree that public outreach for geophysics is vital to expanding knowledge of geohazards and natural resources that may impact people's lives. For example, ShakeAlert, the earthquake early-warning system for the Western US, has a successful outreach initiative that educates the public about earthquake hazards. Both IRIS and UNAVCO maintain an active social media presence, a critical component of public outreach and a key element of engaging the geophysics community. IRIS also sponsors community lectures and interactive displays for

museums and public outreach. We encourage ***continued support for social media engagement, creation of informational graphics and posters, and development of teaching materials*** that may be used by the ECI community for public outreach and K-12 lectures (such as interactive displays and physical analog models). Ideally, resources should be available in multiple languages, including Spanish. We also envision a ***speaker series***, similar to the IRIS/SSA Distinguished Lectureship (a seismology speaker series intended for general audiences), that supports a broad and diverse set of geophysicists presenting locally (e.g., at their local science museum).

## 6.0 Broader Impacts Support

Numerous ECIs have taken advantage of support services for developing Broader Impacts and Educational components of proposals through IRIS and UNAVCO. For example, ECIs have funded IRIS and UNAVCO internship participants, hosted educational workshops that were supported via IRIS and UNAVCO, and engaged in public outreach in countries where they are pursuing their research projects. We expect the need for ***Broader Impacts and Educational support for proposals*** to continue and request that these services remain a part of the FGF.

## 7.0 Geophysical Resources Hub

A FGF will ideally serve as a hub for geophysical resources, including both EWO materials and geophysical data. Making this hub easily accessible and navigable will help advance the scientific goals of the FGF and improve accessibility for researchers, students, and the public. This hub would consist of ***high quality metadata, a well-designed user-friendly website, and support for digital tools***. We encourage the FGF to invest in the database and web development efforts necessary to achieve a robust, lightweight, and streamlined user experience on both desktop and mobile devices. This should include organization of all teaching materials categorized into types of materials (e.g., informational posters, presentations, and handouts), as well as, by appropriate experience level (i.e., grade school, high school, college, advanced). The FGF would incorporate these old and new resources into one well-organized web platform that is easily accessible to all.

## 8.0 Community Governance

It is essential that the FGF be responsive to the changing EWO needs of its users. We support a ***community governance model*** that pairs facility guidance with community input via an oversight-empowered standing committee made of community member stakeholders, including ECIs. This system ensures detailed, two-way feedback between the FGF and the community, assists the FGF in responding more nimbly to changes or expansions in community science emphases, and enhances community investment in (and usage of) FGF services.

## 9.0 Preparing for Future Science

The professional development and public outreach opportunities afforded to ECIs will play a critical role in driving scientific progress. We encourage the FGF to remain invested in EWO activities, alongside infrastructure, such as data services and geophysical instrumentation. We recommend that these investments be made in a way that further improves the diversity of backgrounds represented in the geophysical sciences.