

WHITE PAPER ON WORKFORCE DEVELOPMENT IN ASTRONOMY FOR THE ASTRO 2010 US DECADAL SURVEY

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William H. Waller (Tufts University and the Massachusetts Space Grant Consortium)
Rolf Danner (Northrup Grumman and AAS Committee on Employment)
Susana Deustua (Space Telescope Science Institute)
Katy Garmany (National Optical Astronomy Observatories)
Travis Metcalf (UCAR and AAS Committee on Employment)
Anil Seth (CfA and AAS Committee on Employment)
Stephanie Shipp (Lunar and Planetary Institute)
Tim Slater (University of Wyoming and AAS Education Board)

Executive Summary:

This brief white paper calls for a broadening of the astronomical profession, so that it serves a greater cross-section of American society and so attains greater relevance and value among the US citizenry. This will require significant reform of undergraduate and graduate Astronomy education programs, so that students can prepare for a greater variety of Astronomy-related careers. We also recommend additional support for mid-career professionals who are looking to make transitions into new types of Astronomy-related employment. In these ways, more people can develop and sustain their identity within the profession of Astronomy, as they contribute to a more astronomically attuned society.

Introduction:

Although Astronomy deals with the entire Universe and all that it contains, the profession itself is relatively small – with less than 10,000 practitioners within the United States. Worldwide, we are little more than one in a million. Despite these low numbers, Astronomy – and astronomers – have an enormous impact on society. Our almost daily discoveries relating to the Solar System, extra-solar planetary systems, stellar and nebular phenomena in the Milky Way galaxy, and exotic wonders throughout the Universe are the stuff of news stories, radio shows, television productions, museum exhibits, planetarium presentations, and casual conversations among friends and strangers alike. Moreover, astronomers serve the needs and interests of much larger professions, most notably in Physics, Aerospace, Instrumentation Engineering, Computer Science, and Education. Even the legal, insurance, and entertainment industries have been known to hire astronomers from time to time. Conversely, people skilled in a wide variety of specialties are vital to the needs and interests of Astronomy (see white paper on “Funding Patterns in Employment”).

To ensure that Astronomy remains a viable and growing profession, it is necessary to prepare future astronomers and to support current astronomers with these larger connections in mind. Towards such ends, we make the following set of recommendations. We build on the reports of the AAS Education Initiative in Astronomy (Edwards and Strom 1996) and the AAS's Examination of Graduate Education in Astronomy (Strom, Edwards, et al. 1996 <http://aas.org/archives/BAAS/v29n5/edrpt.html>). In many ways, these prescient documents lay out what needs to be done. More than a decade later, we can now verify that research funding is no longer growing as it once did, and so the need to “diversify” our efforts in workforce development becomes ever more pressing.

Pre-Collegiate Education:

Education research has shown that by middle school, most students are already making decisions about what profession(s) they intend to pursue (Kerka 2000 <http://www.calpro-online.org/ERIC/docs/pab00018.pdf>). Research also finds that pre-collegiate student performance in mathematics turns out to be one of the greatest predictors of success in college science (Sadler and Tai 2007 <http://www.sciencemag.org/cgi/content/summary/317/5837/457>). How does this impact the Astronomy profession? First, we are subject to these early decisions and levels of mathematical proficiency. To ensure the best outcomes, we should be advocating and supporting early Astronomy education. This can be done by continually petitioning developers of the national and state science education standards to recognize Astronomy as a vital part of any curriculum in the physical and Earth sciences. Currently, Astronomy is poorly represented, with very little topical content recommended beyond the Solar System. Second, we should encourage the alignment of the pre-collegiate Astronomy curricula with the Mathematics curricula. In these ways, pre-collegiate students can learn about their cosmic heritage and the ways of scientific inquiry, while exercising their vital mathematical skills. A greater linkage with Mathematics education further enhances the perception of Astronomy as a mathematically rich science.

The training and professional development of teachers is a critical part of any pre-collegiate education reform program. This is especially true in math and science, where full teaching certification and a college major in the field being taught are key predictors of student achievement (Glenn 2000). We will discuss teacher preparation and professional development as part of the following sections.

Undergraduate Education:

Workforce development begins in earnest at the college level. To date, few institutions of higher learning offer more than the basic major in Astronomy or Astrophysics. Most of these major programs place a strong emphasis on the student mastering a full suite of courses in Mathematics and Physics, as well as a sequence of courses in Astronomy. This approach continues to make sense, especially for those students who wish to pursue

graduate education in Astronomy that leads to a career of astronomical research and/or teaching at the college level.

However, the undergraduate years are also appropriate to introduce the student to other Astronomy-related career paths. These include careers in pre-collegiate and informal science education, science journalism, instrumentation development, chemistry, geology, computer science, database management, and scientific visualization. At Tufts University, for example, seminar courses in “Astronomy and the Media,” “Space Science Education,” “Space Science and Technology,” and “Cosmochemistry and Astrobiology” have been piloted (see <http://go.tufts.edu/galacticecosystems>). Partially supported by NASA, these courses helped to attract and retain undergraduate science/engineering majors in the general field of Astronomy – either as majors or as minors. However, these sorts of courses are not germane to the standard Astronomy/Astrophysics major, and so they are vulnerable to the largesse of the departmental chair and the more pressing roster of course requirements that the student must fulfill.

To ensure a solid undergraduate education for Astronomy/Astrophysics majors while introducing them to a greater variety of Astronomy-related career paths requires a careful balancing act. Elective seminar courses help, given sufficient and sustained support (which we strongly recommend). So do internships and fellowships. Currently, NASA and the NSF provide summer opportunities for students to carry out projects in Astronomy-related research. These should be expanded to include other activities ... including internships at museums, scientific publishers, media outlets, and developers of scientific instrumentation. One could call these funded programs “Career Experiences in Science for Undergraduates” or (CESU), with Astronomy-related venues included as in the popular “Research Experiences for Undergraduates” (REU) program.

Lastly, the recruitment and preparation of undergraduate science students for career paths in pre-collegiate Science Education (including Astronomy Education) should be encouraged. As of 2002, less than 40 percent of all Earth science teachers in the United States had degrees in any of the topics which they were teaching (Weiss 2002). This critical shortfall in essential training is best remedied at the undergraduate level, where students are choosing their major and minor fields of study. The UTeach program has achieved significant success in these regards, with 14 universities across the nation currently recruiting and fostering new cadres of properly trained K-12 science educators (see <http://www.uteach-institute.org/>). These institutions received support from the ExxonMobil Foundation and the Bill and Melissa Gates Foundation. Further expansion of the program will likely require additional support.

Graduate Education:

Graduate school is a time for students to become qualified for their intended professional careers. Towards these ends, we reiterate the recommendations made by the AAS’s Examination of Graduate Education in Astronomy (Strom, Edwards, et al. 1996) by calling for flexible Masters degree programs in Astronomy-related fields. Many of these

programs will be inherently interdisciplinary (e.g. Astronomy Education, Scientific Instrumentation, Astronomical Software, etc.) and hence subject to turf wars between different departments or even different schools/colleges within a university. To this issue, we recommend that funding agencies explicitly encourage collaborations along with some sort of rubric that helps the collaborators to decide which department should host the program. For example, a student (or practicing teacher) could earn a Masters degree in Science Education with a specialization in Astronomy, or just the opposite, depending on his/her priorities. The funding support should go beyond stipends for the graduate students, and should include direct support for the professors implementing the graduate courses and programs. Otherwise, the hosting institutions will likely balk at the prospect of taking on this additional expense until a sufficient “market” of paying students is proven. Ultimately, joint professorial appointments in Astronomy and complementary departments should be fostered.

Post-doctoral Support:

Much of the post-doctoral research activity in Astronomy follows the flow of space missions and ground-based projects in Astronomy. Additional postdoctoral fellowships are awarded by NASA through the NRC/NAS Resident Research Associates Program and by the NSF through its Astronomy and Astrophysics Postdoctoral Fellowship program (that combines both research and education activities). We recommend that such combined experiences are beneficial to the future careers of many Astronomy postdocs and should be encouraged at the mission level and elsewhere. Meanwhile, we applaud the NSF’s decision to require that NSF research programs involving postdoctoral fellows should lay out a clear plan for mentoring these postdocs.

Mid-Career Support:

Most support for mid-career professionals in Astronomy reverts to the research proposals that they submit to NASA, the NSF, or other funding agencies. However, for most astronomers in small colleges and in non-tenured positions in larger universities, this is not enough. As research dollars become increasingly difficult to secure, these professionals are often left without sufficient resources to develop professionally – or even to stay in the field. To ensure that they can continue to develop – perhaps by transitioning into other Astronomy-related career paths – we recommend that funding agencies develop “senior fellowships” which can support their efforts. NASA, through the NRC/NAS, offers such fellowships at the NASA Centers. We recommend that their model be expanded to allow mid-career professionals to pursue new opportunities at a variety of other venues (including research institutions, museums, school districts, and minority education centers), that they may be able to further grow professionally and contribute to the larger cause of a scientifically advanced, enlightened, and engaged society.

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