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Pushing Glass: Engaging Young People in Astronomy Through Amateur Mirror Making Classes

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Abstract. One of the activities utilized by amateur astronomers to excite the general public about astronomy is mirror making. This activity requires few basic skills other than patience and perseverance, and the proper instruction. This poster reports on the results of a study of mirror making classes conducted by nine amateur astronomy groups in the Northeast and Mid-Atlantic U.S., including class organizers' reflections on their successes and challenges in recruiting and retaining young men and women through the completion of a workable telescope mirror.

1. Amateur Telescope Making

Amateur astronomers continue to play a very important role in the popularization of modern astronomy. A 2002 online study by Storksdieck et al. found that 63% of amateur astronomers who responded engage in educational outreach. Through sidewalk astronomy, presentations to school and private groups, and star parties, these enthusiasts stimulate and nurture public interest in astronomy, especially among school-aged children who require mentoring and encouragement. This is especially important when considering the well-documented drop in girls' interest in science during middle school (e.g., Rosser, 1990). In a study of attendees to the 1993 and 1994 Stellafane amateur telescope makers conventions and 1994 Riverside Telescope Makers Conference, it was found that the majority of male amateur astronomers became interested between ages 6–12 through individual experiences (mainly books), whereas female amateurs tended to become interested in their 20's through the direct intervention of a family member (Larsen, 1995). This finding complements numerous studies which suggest that girls' waning interest in science is exasperated by lower participation in science activities and fewer opportunities to work directly with scientific equipment (e.g., Rosser, 1990). For this reason, the AAAS (1990) strongly recommends that all children should have hands-on experience with tools beginning in elementary school.

Tools and astronomy find a natural convergence in amateur telescope making (ATM). The first known amateur telescope making course was led by amateur astronomer, explorer, and architect Russell Porter in Springfield, VT on

August 17, 1920. Fifteen men and one woman (mainly employees at the local Jones and Lamson Machine Company) learned how to grind their own primary mirrors and construct reflecting telescopes. Porter's tradition of hand-making high quality, cost-effective telescopes continues to this day, through the work of the Springfield Telescope Makers (STM) which Porter later founded, and myriad other amateur groups throughout the world. Mirror making consists of four stages: grinding a flat piece of glass to a roughly spherical shape of a particular depth; fine grinding the glass to perfect smoothness; polishing; and figuring the mirror from a spherical to a parabolic curvature. Afterward the glass is coated with a reflective surface, usually by sending out the mirror to a commercial vendor. Fortunately, the tools required for each of these stages are few and inexpensive (except for the optical testing which must routinely occur to make sure the mirror reaches the proper optical characteristics), and most mistakes can be corrected with sufficient time and effort. The quality of the finished product is routinely superior to most commercial telescope mirrors. Therefore, mirror making is an appropriate activity for children as young as elementary school (with supervision) and can be utilized to interest children in astronomy and observing.

The authors of this poster surveyed nine amateur mirror and telescope making classes offered in the Northeast and Mid-Atlantic regions in an attempt to find best practices and positive trends, as well as difficulties encountered by these groups in terms of recruiting and retaining young mirror makers.

2. The Study

Nine ongoing amateur mirror and telescope making programs were contacted and their relative success with recruiting and retaining youth mirror makers during the past 7–8 years ascertained. One, connected with the Astronomical Society of Greater Hartford (CT), was rated highly successful. Five—STM (VT), National Capitol Astronomers (NCA) (WA DC), Delmarva Stargazers (DE), Amateur Telescope Makers of Boston (ATMoB), and the Society of Telescopy, Astronomy, and Radio (STAR) (NJ)—were rated moderately successful. Three programs—Aldrich Astronomical Society (AAS) (MA), United Astronomy Clubs of New Jersey (UACNJ) (NJ), and Lehigh Valley Amateur Astronomical Society (LVAAS) (PA) reported no success with having youths complete mirrors and only the LVAAS reported having several youths contact the organization but not follow through.

2.1. ASGH Mirror Workshop

Dick Parker's mirror workshop was easily established as being in a class of its own. Beginning in 2000, Parker began hosting an annual series of ten-week Saturday morning (9 AM–noon) workshops held from January through mid-March in his home workshop in north-central Connecticut. He reports 69 individual participants, roughly 11–15 per year, with some attending for multiple years, and some working on multiple mirrors. All but three completed their mirrors. Thirteen youths participated and all completed at least one mirror. One young man made two mirrors which he made into telescopes and entered into the telescope judging at the Stellafane convention. During the past year, two of the

three youths involved were girls. Parker reports that all but one of the youths participated in the workshop due to what he termed "parental stimulation." The remaining young man asked his father to make the initial contact with Parker. There is no cost for the classes, but participants are expected to procure their own materials (glass blank, grinding "tool," grit and polishing agent) prior to the workshop and are given the necessary information. Parker is able to provide materials for cost for those who are unable to do so. The site is easily accessible from a large geographic region, and participants have come from CT, RI, MA, ME, and NY.

2.2. Moderately Successful Workshops

The Demarva Mid-Atlantic three-day residential mirror making workshop has been held at the Mallard Lodge in Smyrna, DE since 2001. Participation is limited to 15, and a jump start is given on all mirrors, as the initial curves are pre-ground to a specific radius. All materials are provided onsite and the cost is covered by a participation fee. Participants have come from as far away as Canada. Don Surles reports that an unspecified number of youths have attended and all completed a mirror. All have been supervised by his or her father (not surprising for an overnight workshop) and in one case both the father and child worked on their own mirrors.

The NCA mirror making workshop meets each Friday night at the Chevy Chase Community Center. Materials are provided at cost. Projects are ongoing and the instruction informal, with an average of 3–8 participants on a given week. According to Guy Brandenburg, over the past five years ten mirror projects were begun by youths. Three have been completed, two are nearly completed, three are ongoing, and two are apparently abandoned. Five of these projects were done in conjunction with a parent. Interestingly, two of the projects were done by home-schooled families (two siblings and one or two parents). One of these last projects has been completed. At least three of these projects involved a young lady, with one 8-inch telescope created by a father-daughter pair dubbed the Amber Spyglass after the classic book by Philip Pullman.

The STM mirror making classes are held at the club property on Breezy Hill in Springfield, VT, except when weather precludes access to the site. Classes are run 10 AM–4 PM on the Saturday nearest new moon from October through March (on the same date as the STM's monthly club meeting) and are limited to approximately sixteen participants. There is frequently a waiting list for spots. All materials are provided at cost. Participants typically come from across New England and New York, and many take more than one season to complete their projects. Between 2000–2008 twenty-one youths began mirror projects. Four completed their projects (with two, a boy and a girl, working on their second mirrors). One mirror was completed by the child's father, three are near completion (and were possibly completed at home), and two young participants moved away and were unable to complete their projects. The remaining projects remain uncompleted. All but one of the youths attended the class with a parent, but only five parents actively worked with their child on the project. There appears to be gender parity among the young participants. One of the most successful, Samantha Tabor, a middle-school student, is working on her second

mirror, and the telescope she made with her first mirror was the Mechanical and Optical Youth winner at the 2007 Stellafane convention.

The ATMoB mirrormaking workshops are held on Thursday nights in the clubhouse in Westford, MA. According to David Siegrist, a number of youths have begun projects, but few have completed a mirror. An exception is a high school student who completed a mirror and later parlayed her experience into a job in the RIT optics lab while in college. Two high school students are currently working on mirrors. Gordon Waite of the STAR group in New Jersey reports that they have had a small weekly mirror making class for the past five years. Two youths completed multiple mirrors while two more began but did not complete mirrors.

3. Conclusions

Although the evidence is anecdotal and the sample size small, this study suggests some future directions of study and possible best practices for successful amateur mirrormaking workshops. Easy access to materials is certainly important, and an easily accessible location perhaps equally so. Weekly programs appear to be successful, as do programs with a limited time commitment (a "season" similar to a sports season or a series of science workshops offered during a semester or school term). One of the frustrations voiced by the leaders of the STM workshop is a 25% completion rate on all attempted mirrors, despite a target twice that. The limited number of workshops in a season, necessity of cancelling some sessions due to the inaccessibility of the site during inclement weather, and large amount of time between each session (a month) demand that the participants do significant work at home, which they are apparently unable or unwilling to do in many cases. Fran Edwards of the Aldrich Astronomical Society voiced similar concerns, writing that the long time required for a youth to finish a mirror without working at home would pose a serious impediment, and "would generally require considerable long term support from family." This preliminary survey supports the suggestion that as in many extracurricular activities, parental involvement is key. These results also suggest (albeit anecdotally) that mirror making classes can be successful in introducing girls to hands-on scientific and technical work involving tools, and promote a continued interest in science past the middle school slump.

One final amateur mirror making workshop should be recognized. In 1995–96, physician and well-known amateur telescope maker Dr. Mario Motta teamed up with the AAVSO to create a year-long mirror and telescope making workshop for talented 5th and 6th graders at Lynnfield Middle School (MA). Pairs of students successfully created a total of eight Newtonian-Dobsonian telescopes for use by their school (Motta, 2006). The success of this project suggests that future partnerships between school systems and amateur mirrormaking programs could create further opportunities for young men and women to become interested in astronomy in general, and optics in particular.

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