

Advanced Laboratory Task Force Final Report  
July 19, 2006

For the past six months the members of the Advanced Laboratory Task Force (ALTF) have been engaged in responding to the charge given to it by the AAPT Executive Committee. In telephone conversations and e-mail exchanges we have discussed a wide range of topics, including the current advanced laboratory curriculum at member institutions; member experiences of developing and teaching the advanced laboratory; and ways AAPT might improve advanced laboratory instruction. The members of the ALTF represent a broad range of institutions, including research universities, large state universities, and small private colleges. Members of the ALTF included both instructional staff and regular academic faculty. This breadth of experience was important to the ALTF mission, because advanced laboratory instruction differs greatly by institution. Local conditions—staff and faculty expertise, equipment resources, financial resources, and departmental commitment—determine to a great extent the quantity and sophistication of advanced laboratory experiments. Much of the content of the undergraduate physics curriculum is the same across a broad range of institutions, but the content and conduct of the advanced laboratory course varies widely and is now, and likely will remain, idiosyncratic. We did not seek recommendations that would benefit advanced laboratory instruction at a certain kind of institution, such as at the hypothetical ideal physics department, but rather we sought to suggest ways AAPT could assist the entire, highly heterogeneous, advanced laboratory community.

The ALTF was asked to prepare a set of sharp, focused recommendations for consideration by the AAPT Executive Committee. Our seven recommendations are given below, along with justification and commentary.

**1. As a regular part of one of its national meetings, likely the summer meeting, the AAPT should sponsor a session or group of sessions and workshops devoted exclusively to the advanced laboratory. Foremost, this should be a predictable annual event, which over time would become an AAPT tradition. The AAPT should commit the necessary resources to establish this tradition over a period of a few years.**

Advanced laboratory faculty and staff form a fragmented group in the physics education profession. Every physics department has one or two faculty members or staff members who carry the burden of developing, maintaining, and teaching the advanced laboratory course, usually with little interest or support from other members of the department. Beyond this isolation within their departments, these individuals often find themselves isolated within the physics education profession as well. There is no “community” of advanced laboratory faculty and staff beyond the informal network of personal contacts made as a consequence of attending occasional workshops, making telephone calls, and exchanging e-mails. The degree of isolation was even evident among those whom AAPT selected to be members of the ALTF: most of the ALTF members had never met or had

any form of prior professional contact before the task force, despite each having a record of some accomplishment in advanced laboratory development.

The isolation and fragmentation is more puzzling and more disturbing when one considers that there is probably no group within the physics education profession that could benefit more from association within a true community, with regular face-to-face meetings. More than any other part of the curriculum, teaching the advanced laboratory requires a knowledge of craft, a kind of knowledge that is rarely written down and is ordinarily learned from someone who has mastered the craft. The advanced laboratory developer and instructor must learn the basic craft of optics, lasers, nuclear physics, solid state physics, vacuum technology, cryogenics, and nuclear magnetic resonance, to name a few common experimental areas, and no developer is likely to have had experience with all of these fields from his or her own research background. The best way to learn the basics of new fields is by learning from someone who knows how things get done in these experimental areas. It should also be noted that there is no area of the curriculum that is affected more directly by the latest technological advances, yet given the isolation of advanced laboratory developers, it can be some time before it is widely known how to exploit these advances in the undergraduate laboratory course.

We believe AAPT should take a leadership role in the improvement of advanced laboratory teaching by creating highly visible opportunities at its national meetings for advanced laboratory instructors to present their latest results, to meet like-minded individuals, and to exchange information. The Lab Focus '93 meeting in Boise is an example of what AAPT can do to bring the right people together, but it is likely that such an elaborate gathering would be too difficult to fund and to organize on a yearly basis, and that is the reason our first recommendation is only that AAPT commit to predictable sessions and workshops devoted to the advanced laboratory at one of the national AAPT meetings. Some ALTF members have found regional AAPT meetings suitable for presentations on the advanced laboratory, but we are in agreement that there is greater potential for bringing advanced laboratory developers together in great numbers at a national meeting. If the advanced laboratory component of the national meeting were given some prominence in the advertising for the meeting, and if these sessions became a yearly tradition, it would be an enormous boost to forming an advanced laboratory community. We don't know how the AAPT develops priorities for its national meetings, but we believe AAPT should consider this possibility as part of its efforts to attract more college and university faculty and staff to its national meetings.

It will not be an easy task to make a success of the first few advanced laboratory sessions at the national meeting, but there is much to build on from the traditions already established at the summer meeting by the Advanced Instructional Laboratory Workshops group and the Apparatus Committee. What is needed is a commitment to making this component of the national meeting more prominent and more valuable in the eyes of those who are developing and teaching advanced labs. Most of these individuals have research programs that require attendance at national and international meetings devoted to their research specialty, and a national AAPT meeting is a luxury they cannot afford for reasons of money or time, or both. It should also be mentioned that the typical

advanced lab instructor is by temperament not inclined to rush to a national meeting to deliver a dogmatic manifesto on “what works” in physics education. The problem for them is usually what doesn’t work in the lab right now and how to fix it; and it’s often not clear that attending an AAPT meeting is going to help them fix it. It will take a bit of planning and promotion to draw this type of person to the advanced laboratory sessions and workshops that the ALTF recommends, but we believe AAPT should commit itself to drawing that kind of person to these sessions nonetheless.

**2. As a way of raising the visibility of AAPT’s commitment to the advanced laboratory, we recommend that a one-time-only special conference be held on the advanced laboratory.**

Such a conference would, of course, be a way to help initiate the tradition described in the first recommendation, but it would also be a beneficial event by itself. It has been suggested to the ALTF that AAPT could propose the advanced laboratory as the topic of a future Gordon Conference in its series on Physics Research and Education. AAPT involvement in a Gordon Conference on the advanced laboratory would be a very visible way to demonstrate AAPT’s increased attention to advanced laboratory instruction. It might be easier to arrange a conference within an established and successful series of meetings, such as the Gordon Conference meetings on Physics Research and Education, than to go to a funding body, such as the NSF or a private foundation, to secure a grant to hold a single meeting. There is also a mechanism in place for a special issue of AJP to be devoted to the topic of the Gordon Conference meeting; this issue could include a much needed resource letter on the advanced laboratory. There is no reason in principle that TPT could not be involved in some way. It might be possible to propose the advanced laboratory as the Gordon Conference topic for summer 2010. (We have learned that the topic of the 2008 conferences has already been chosen.) The proposal might be stronger if it had formal or informal endorsement from the AAPT Executive Committee.

Whatever AAPT decides with regard to a special conference on the advanced laboratory, it should leverage the conference to initiate a sustainable meeting tradition among advanced laboratory instructors. The Lab Focus ’93 meeting was fantastic, and at least two members of the ALTF believe it was critical to their laboratory development efforts in the 90s, not least because it put them in contact with like-minded individuals with whom they developed long-term professional contacts; however, that meeting did not establish a pattern of yearly meetings or workshops to sustain the level of interest that was generated. What is needed is a long-term commitment by AAPT to foster a strong advanced laboratory community, not simply a one-time workshop or conference.

**3. The AAPT should establish an award or prize to reward significant accomplishment in advanced laboratory development and instruction.**

Current AAPT awards are seldom given to those who devote the major portion of their professional careers to the advanced laboratory. Some of the most impressive advanced laboratories that we have in this country have been built and maintained by individuals who do not publish popular books, do not lecture to popular audiences, and are too busy

with laboratory development to serve on professional committees or run for professional office. Some receive little support from their institutions and have not been successful in obtaining support from the NSF or private foundations. Yet they have persevered and made the advanced laboratory experience at their institutions exceptional, in some ways superior to that at the best institutions. If we are to encourage faculty to devote the time that is necessary for developing and maintaining exceptional advanced laboratories, we need to acknowledge this kind of work in a visible way. The AAPT is clearly the right organization to provide this kind of recognition.

New faculty are actively discouraged from involving themselves in the advanced laboratory, even though they come to their positions with the latest knowledge of the craft and tricks that make new experiments possible. They are told that too much time is required, and the work doesn't lead to research grants, research publications, or tenure. The pressure on new faculty to focus solely on research has never been greater, and it is therefore not surprising that the advanced laboratory program at some institutions is in decline or is even being curtailed. An AAPT award acknowledging superior accomplishment in the advanced laboratory will not change the expectations for tenure at our institutions, but it just might encourage wider recognition of the fact that some pre-tenure faculty must sacrifice some of their research time in order to modernize and reinvigorate the advanced laboratory curriculum at their institutions. Winning such an award could provide valuable evidence of productivity and professional recognition to a tenure or promotion committee.

It might seem an extravagant notion, but improvement of the advanced laboratory might be best achieved if one award were given to a tenured faculty member or a staff member, and second award were reserved for a pre-tenure faculty member.

Advanced laboratory faculty, through their NSF-sponsored instrumentation grants and departmental budgets, buy a great deal of equipment every year from a relatively small number of manufacturers. If the AAPT decides to establish such an award, it should call on these manufacturers to help endow it.

**4. The AAPT should demonstrate its leadership in improving advanced laboratory instruction by developing the premier web site for advanced laboratory course materials and tricks of the trade. The web site should also serve to maintain communication among the community of advanced laboratory instructors.**

The ALTF believes that one of the best ways for AAPT to sustain a stronger advanced laboratory community would be to sponsor a web site that would serve as a clearinghouse for information and as a vehicle for communication within the advanced laboratory community. The current situation for finding advanced laboratory information on the web is deplorable. A Google search on an advanced laboratory topics yields thousands of sites, with most providing little of real value to an advanced laboratory instructor. There are some good web sites that provide write-ups for experiments implemented at particular institutions, possibly with links to other advanced lab web sites, but there is nothing like a central site for advanced laboratory work. There is an active and successful listserv

called “tap-L” sponsored by the Physics Instructional Resource Association that is used primarily by those interested in developing lecture demonstrations, but there is no comparable resource that we know of for the advanced laboratory. An isolated advanced laboratory instructor in need of help will not find a vibrant community of like-minded instructors on the web.

At the same time that we urge AAPT to develop a vehicle for sustaining an active advanced laboratory community on the web, we also urge caution in selecting a model for how this might be accomplished. The ALTF feels collectively that it does not have the expertise to specify the precise technical manner in which the information and communication functions of a web site should be realized; however, we are all users of web materials and we have a strong sense of what would not work. There was consensus that a mere listing of links to individually maintained advanced laboratory web sites or a static compilation or collection of contributed materials would not make a great improvement in the current situation, although this might be a useful first step. Centralized collection would involve the coordination of too many people, some of whom would have to be paid by AAPT and some of whom would have to be volunteers from the community of advanced laboratory instructors. There was a strong sense that this would likely be too costly, too slow, and too clumsy for the purposes of creating an on-line community of advanced laboratory instructors.

Perhaps the web site model that would work best would be something like Wikipedia, which already has excellent resources for the most general and the most obscure topics in any subject, including physics, without a central authority having directed any specific individual or group to provide the necessary materials. The Wiki model is dynamic, it depends on contributors for its substance and accuracy, and it steadily accretes information in directions that are determined by the interests of its readers. This type of information-gathering model might work out best for an AAPT advanced laboratory web site because it is not realistic to expect that AAPT could supply its own personnel or identify volunteers in the advanced laboratory community to construct and maintain a conventional web site. There is much that the ALTF admits freely to not knowing about how or whether the Wiki approach might work in the advanced laboratory community; but we do know that any web site model must accept the reality that advanced laboratory instructors are busy and few have the time, inclination, or relevant experience to become part-time webmasters of an AAPT sponsored web site.

In any event, AAPT should get advice from experts if it decides to sponsor a web site for the purpose of sustaining an advanced laboratory community. The pitfalls in setting up web sites are numerous: duplication of effort; poor tailoring of the site to the intended audience; too great an impediment for audience contributions; failure to provide for easy communication among members of the intended audience; lack of an effective rating system. Under any web site model, it would be essential to identify someone with advanced laboratory experience who would be willing to serve as webmaster or moderator for the first year or two and also to line up a core group of “early adopters” within the advanced laboratory community who could immediately contribute existing

lab materials to the web site in the required format. Early coordination of a core of committed individuals would be critical to the success of a web site.

Whatever is done by way of new web sites, list-servers, bulletin boards, workshops, and meeting sessions should build on existing efforts wherever possible, and not dilute current efforts with simply more web sites, more list-servers, more bulletin boards, more workshops, and more meeting sessions.

Perhaps the greatest benefit of an AAPT-sponsored advanced laboratory web site would be identifying those instructors around the country who actually considers themselves to be a part of the advanced laboratory community. If the members of this community were more widely known, there might be far greater cooperation among members of that community, and a real reduction in the sense of isolation and fragmentation.

**5. The AAPT should establish a visiting lab developer program, similar to a visiting lecturer program, whereby those who have been successful in laboratory innovation can travel to those institutions that seek to strengthen their advanced laboratory programs.**

Almost every institution has a list of experiments that it would like to add to its advanced laboratory course, but a lack of local expertise makes it difficult to initiate the steps necessary for adding the experiment and actually getting it to work successfully in an advanced lab course. The AAPT should take a more active role in the dissemination of the results of innovative laboratory development projects at “good practices” institutions, particularly those that have received support from the NSF CCLI program. The CCLI program currently requires grant-seekers to provide a plan for dissemination of the results of a project, but does not allow for grant funds to be used to carry out the dissemination plan. As a consequence, many of the most successful laboratory innovations sponsored by the CCLI program have a limited effect on the wider community because dissemination, apart from a single publication or a single presentation at a national meeting, does not take place. As emphasized in our first recommendation, laboratory development is far more craft than textbook science, and learning from the master of a craft is the most efficient means for transferring new experiments. The AAPT could improve advanced laboratory instruction by working to fill the gap that is widely acknowledged to exist in the current NSF instrumentation grant programs.

Members of the ALTF have compared such a visiting developer program to the old tradition of “barnstorming” at an earlier, more communitarian, time in our nation’s history. If there were travel funds available from AAPT for a department to invite a person from a “good practices” institution to assist in setting up new laboratory instrumentation, this would help institutions without in-house expertise to copy some of the splendid examples of advanced laboratory work that the NSF has so generously sponsored. Perhaps the NSF would agree to support an AAPT-sponsored initiative of this sort. Even without NSF support, there might be many ways that the AAPT could help coordinate the direct transfer of innovative laboratory practices to institutions with specific needs.

**6. The AAPT should take on a stronger advisory role to the NSF instrumentation grant programs in physics.**

The ALTF is not privy to the extent of formal or informal dialogue between AAPT and the NSF; however extensive that dialogue may have been in the past, the ALTF believes it would be beneficial to the advanced laboratory community if there existed a more open and official mechanism within AAPT for communicating suggestions and criticisms of AAPT members to the NSF concerning initiatives such as the current CCLI program and for informing AAPT members of new NSF initiatives. Just as many of the research subspecialties within physics have advisory panels that provide advice to the NSF in making its funding decisions, we believe the AAPT should play a more active and visible role in making sure everyone in the advanced laboratory community is well informed of and well served by the instrumentation grant opportunities provided by the NSF.

**7. The AAPT should seek ways to improve the contribution of its principal publications, AJP and TPT, to the work of advanced laboratory instructors and developers.**

TPT and AJP are the principal means by which AAPT communicates its core values in print to AAPT members and to the outside world. The ALTF, which included two members who have served as editor of the Apparatus and Demonstration Notes section of AJP, could not formulate specific recommendations regarding these journals but it did find itself asking questions such as the following. Are these journals doing what they can to encourage excellence in the advanced physics laboratory? Why is it that so much of the excellent advanced laboratory work that we all know is taking place at institutions around the country is never reported in the pages of AJP or TPT? Is there something AJP in particular could do to increase the number of articles that have relevance to those working to improve undergraduate laboratory instruction?

We realize the AAPT Executive Committee asked the ALTF to answer questions, not generate them; however, in the case of AJP and TPT we found ourselves unable to make concrete recommendations for changes. Yet we found ourselves uneasy with questions such as those already given. At the next reviews of AJP and TPT we believe it would be worthwhile for the Executive Committee to reconsider the structure of both journals in light of how they serve to strengthen advanced laboratory instruction. Are some advanced laboratory developers and instructors not taking the time to write up their work for AJP partly out of fear that their manuscript will be consigned to the Apparatus and Demonstration Notes section rather than appearing as a regular paper? To one's peers or to a tenure-review committee, should such a note be considered on a par with a mere letter to the AJP editor? And why are there no theoretical notes in AJP? Are manuscripts involving theory intrinsically more worthy of regular paper status? Again, we offer more questions and no answers, but we believe somewhere in these questions is the sentiment that AAPT values textbook physics and abstract pedagogy more than it values experimental technique. Perhaps as part of its initiative to increase support for advanced

laboratory instruction, AAPT can use its influential publications to elevate the status of advanced laboratory instructors and contributions within the physics education profession.

Final comments, but not recommendations.

Throughout this report the phrase “advanced laboratory community” has been avoided where possible because it was not clear to the ALTF that such a community indeed exists. The ALTF members as a group know a great number of talented advanced laboratory instructors throughout country, many of whom have almost sole responsibility for their department’s advanced laboratory curriculum. But these instructors do not constitute a community or even part of one; indeed, many of these instructors feel that their work is marginalized within their departments as well as within their profession and that their work is not really part of the mainstream of the physics education profession. Perhaps the greatest good the AAPT can do as result of the ALTF’s work is simply to seek to elevate the status of these individuals within the physics teaching profession and to promote a greater sense of community among them. The advanced laboratory instructors can get good laboratory development work done on their own, with or without help from NSF, APS, or AAPT. Advanced laboratory people are always “can do” people who get the job done for its own sake. But the AAPT can assist them greatly by recognizing their unique contributions to physics education and by fostering a community of such people within the mainstream of the physics teaching profession.

The ALTF spent time on some of the bigger questions that advanced laboratory instructors are often forced to ask. Do the traditional goals for an advanced laboratory course make sense today? Are students well served by the kinds of advanced laboratory courses we offer? The ALTF decided not to tackle these questions in its report, as the issues these questions raise seemed outside the charge given to the ALTF; however, we believe these are important questions that some group should engage. ALTF members noted that a much has changed over the years they have been teaching. We are seeing fewer students with significant hobby or work experiences that have taught them about hands-on construction, troubleshooting, and repair. It is true that students now have more experience with calculators, computers, and video games, but these skills are not replacements for the craft skills acquired from traditional hobbies such as amateur radio or automotive repair, or traditional part-time jobs involving carpentry, plumbing, electronic construction, or machine-shop work. And we have seen a shift in what students are doing after the undergraduate physics program: more seem to be choosing graduate programs outside of physics or jobs in the business and financial sectors. Graduates who leave physics may benefit more from an advanced laboratory course with greater emphasis on writing formal lab reports and making oral presentations, general communication skills that are important in any occupation. Suggestions such as this one for changing the relative weighting of the various components of the advanced laboratory course were considered in the discussions of the ALTF, but we decided that an extensive discussion of teaching methodology was outside the scope of our charge and should be carried out by some other group within AAPT.

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