Research Infrastructure at Predominantly Undergraduate Institutions

Mark E. Bussell
Department of Chemistry
Western Washington University

Good ideas, enthusiastic faculty and talented students can translate into productive research programs at a predominantly undergraduate institution (PUI) only if there is the necessary infrastructure to foster success in a competitive research environment. Since research is rarely the primary mission of a PUI, the development of suitable infrastructure may be viewed as a luxury. However, those involved in research with undergraduate students understand the central role of this activity in undergraduate education – for students and faculty – and it is important, therefore, to identify the most crucial elements of research infrastructure at a PUI and to build a case for obtaining them.

The term "research infrastructure" has been recently defined in a report prepared by the National Science Board (NSB) to be "the tools, services, and installations that are needed for the Science and Engineering (S&E) research community to function and for the researchers to do their work" [1]. Categories included in the NSB list are hardware, software, technical support and research space. This white paper will focus on these important items, but also a number of others which are of crucial importance if science and engineering faculty are to maintain productive research programs at PUIs.

Students and faculty at PUIs need to have year-round access to high quality research space. While teaching laboratories often become available during summer months when research programs at PUIs are typically most active, research requires sustained progress by students and faculty on a year-round basis so dedicated research space is necessary. The design and organization of science buildings at PUIs has been discussed in detail in a number of recent articles and reports [2-4]. Since research groups at PUIs are usually modest in size (< 5 students), sharing of research spaces should be encouraged for reasons of efficiency, the development of a research community, and the cross-fertilization of ideas. Sharing of research spaces can also have safety benefits by allowing faculty and students to keep close tabs on coworkers in the laboratory. Modern instrumentation and convenient access to information technology are critical to the research endeavor, thus laboratory spaces devoted to research need to have adequate bench and floor space, electrical and plumbing utilities, and telecommunication capabilities.

Laboratory research in science and engineering increasingly requires the use of sophisticated instrumentation such as nuclear magnetic resonance (NMR) spectrometers that is a challenge for PUIs to procure and maintain. Fortunately, there are a number of external grant programs that allow faculty – both individually and collectively – to obtain funding for a wide range of instrumentation. For new faculty establishing research programs, sufficient start-up funding (> $30,000) from his/her institution is essential in allowing the faculty member to purchase basic instrumentation dedicated to his/her research program. Additional institutional funding in the form of matching funds can serve as leverage for both new and established faculty to obtain instrumentation via external grant programs. The National Science Foundation (NSF)

[5], the National Institutes of Health (NIH) [6], and a number of private foundations [7-9] allow instrumentation as budgeted items in individual investigator grants, and with institutional matching funds it is possible to acquire a range of modestly priced instruments. For more costly instrumentation, NSF has programs specifically designed for the acquisition of instruments to be shared by a number of users. Of particular interest, the Major Research Instrumentation (MRI) grant program at NSF no longer requires matching funds for proposals from PUIs. Large instrumentation holdings, while facilitating productive research programs, can become significant drains on faculty time and research funds. To avoid the latter, institutions need to earmark operating funds for instrument maintenance and repairs as well as to support instrument technicians in science and engineering departments.

In cases in which it is not feasible to house instrumentation on-campus, faculty (with the support of their administration) should pursue collaborations with faculty at other institutions as well as with scientists working in industry and at government laboratories. The Department of Energy's Office of Biological and Environmental Research operates a number of national user facilities where students and faculty can have access to a wide range of instrumentation and the technical expertise of laboratory staff [10]. For example, the Environmental Molecular Sciences Laboratory at the Pacific Northwest National Laboratory in Richland, WA has over 100 instruments available for use, ranging from state-of-art high field NMR spectrometers to high resolution electron microscopes, as well as low cost housing for student and faculty users.

In order to remain up-to-date in their research areas, students and faculty at PUIs should have ready access to research journals (preferably in both paper and electronic forms), book collections and searchable electronic databases. Institutional holdings need to be augmented by an interlibrary loan program so that journal articles and books not available on campus can be obtained in a timely manner and at low cost. So that students and faculty can work efficiently, it is highly desirable that they have access to library catalogs and other electronic databases from their offices and/or laboratories. Information technology hardware and software need to be in place for these library-related purposes, but also to allow faculty to maintain close contact with student researchers at their own institutions as well as colleagues and collaborators at other institutions.

To allow science and engineering faculty at PUIs to focus on their most important responsibilities – teaching and research with undergraduates – it is critical that they not be overly distracted by other duties. This is particularly important as it is most often time for research that gets eroded away when another duty must be added to a full schedule. It is not in the best interest of a PUI, therefore, to have faculty devoting time to peripheral functions such as routine instrument maintenance, prepping for laboratory courses, or serving as grant accountants. Shielding faculty from these time-intensive duties requires support staff to fill roles that do not require faculty expertise. Institutions may also want to free up additional faculty time for research with students by having staff teach lower level laboratory sections. For departments lacking adequate support or teaching staff, it may make sense to convert a faculty position to two staff positions so that the remaining faculty can focus more time to developing and sustaining productive research programs.

While the sections above have addressed the components of research infrastructure identified in the NSB report, there are less tangible pieces that are vital to the research enterprise at PUIs. Science and engineering departments are often small at PUIs with the real possibility that some faculty are no longer research active, so a system needs to be in place that keeps productive faculty connected to the research community. It is imperative, for example, that junior faculty are mentored by a research productive faculty member at their institution or, if necessary, by one at another institution. In the latter case, the Council on Undergraduate Research (CUR) has a mentoring program that draws upon their nation-wide database that will match a new faculty member with a research productive one in their specialty to help with proposal writing and other research-related functions [11]. Faculty and, if possible, students need to have access to travel funds so that they can attend national professional meetings. These meetings play a crucial role in professional development as they provide opportunities for faculty and students to present their research findings and to develop and sustain relationships with researchers from a range of institutions. An active seminar program brings a range of scientists to campus so that students and faculty can learn about new areas of research and faculty can build informal connections with researchers. Finally, faculty need to have available a sabbatical leave program and to be encouraged to take advantage of this opportunity.

References

1. "Science and Engineering Infrastructure for the 21st Century: The Role of the National Science Foundation"; National Science Board Home Page. http://www.nsf.gov/nsb/documents/2003/start.htm (accessed June 4, 2003).

2. Narum, J. L. "A Better Home for Undergraduate Science", *Issues in Science and Technology* **1996**, *Fall 1996*.

3. "Then, Now, & In the Next Decade: A Commentary on Strengthening Undergraduate Science, Mathematics, Engineering and Technology Education"; Project Kaleidoscope Home Page. http://www.pkal.org/documents/then-now-and-in-the-next-decade.pdf (Accessed June 5, 2003).

4. "Where it is learned"; Project Kaleidescope Home Page. http://www.pkal.org/template0.cfm?c_id=3 (Accessed June 5, 2003).

5. National Science Foundation: http://www.nsf.gov/ (Accessed June 6, 2003)

6. National Institutes of Health: http://www.nih.gov/ (Accessed June 6, 2003)

7. Camille & Henry Dreyfus Foundation: http://www.dreyfus.org/ (Accessed June 5, 2003)

8. Research Corporation: http://www.rescorp.org/ (Accessed June 5, 2003)

9. American Chemical Society - Petroleum Research Fund: http://chemistry.org/portal/a/c/s/1/acsdisplay.html?DOC=prf\index.html (Accessed June 5, 2003)

10. Department of Energy Office of Biological and Environmental Research User Facilities: http://www.er.doe.gov/production/ober/facilities.html (Accessed June 6, 2003)

11. Council on Undergraduate Research: http://www.cur.org/ (Accessed June 6, 2003)