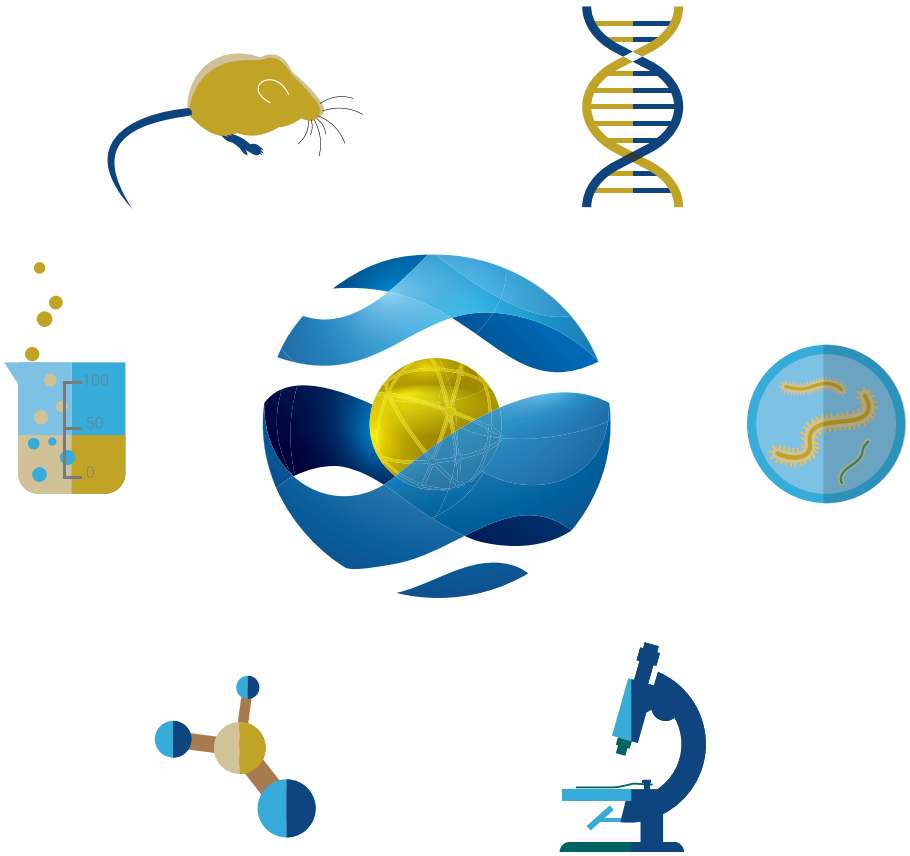

Maximizing Shared Research Resources

Part II: Survey Findings and Analysis

FASEB
Federation of American Societies for Experimental Biology

Acknowledgments

This project was led by the FASEB Shared Research Resources Subcommittee and co-chaired by FASEB Past-President Joseph R. Haywood, PhD, and FASEB Board member Sheenah Mische, PhD. Bethany Drehman, PhD, served as the staff liaison with guidance from Howard Garrison, PhD, and Yvette Seger, PhD. FASEB thanks the leadership and staff of its constituent societies for sharing the survey with their members and colleagues. Similarly, FASEB acknowledges its Board and Science Policy Committee for oversight of this effort.

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The Protein Society (PS)

Society for Developmental Biology (SDB)

American Peptide Society (APEPS)

The Association of Biomolecular Resource Facilities (ABRF)

American Society for Bone and Mineral Research (ASBMR)

The American Society for Clinical Investigation (ASCI)

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Association for Molecular Pathology (AMP)

Society for Redox Biology and Medicine (SFRBM)

Society for Experimental Biology and Medicine (SEBM)

American Aging Association (AGE)

U.S. Human Proteome Organization (US HUPO)

Society of Toxicology (SOT)

FASEB
Federation of American Societies for Experimental Biology

Maximizing Shared Research Resources

Part II: Survey Findings and Analysis

In an earlier project on the sustainability of the biological research enterprise,[1] the Federation of American Societies for Experimental Biology (FASEB) identified promoting the use of shared research resources as an important strategy to maximize the value of research funding. As a result, FASEB established the Shared Research Resources Subcommittee and charged it with "directing FASEB's efforts related to shared instrumentation, core facilities, and other resources that can be jointly utilized by research groups…[and to] evaluate the shared resource landscape, identify current barriers, and explore strategies to promote greater support for and utilization of shared resources."[2] In pursuit of this mission, the Subcommittee initiated a survey[3] to collect the perspectives of resource users and providers located in the United States.

The survey results demonstrated the value shared resources provide to the research community, including cost savings and greater access to advanced technologies and materials. Shared resource facilities—such as cores, stock centers, and user facilities at the National Laboratories—generate further benefits by promoting rigorous and reproducible research, offering specialized expertise, leading technology development, acting as a nexus for collaboration and team science, and providing technical training.

However, shared resource providers face a variety of challenges that limit their ability to consistently offer cutting-edge services to scientists. Through analysis of survey responses, the FASEB Shared Research Resources Subcommittee identified four key areas for improvement: funding and business operations; discoverability and access; ability to meet evolving needs; and facility career track and staff development. Further discussion and analysis can be found in the following sections:

[1] **Federation of American Societies for Experimental Biology.** Sustaining Discovery in Biological and Medical Sciences: A Framework for Discussion. Report. January 2015.

[2] **Federation of American Societies for Experimental Biology.** Charge of the Shared Research Resource Subcommittee. Accessed online August 2, 2017.

[3] See Appendix A for the survey questions and summary results

Section 1: The Case for Shared Resources

Through deployment of shared resources, the research enterprise can realize cost savings while simultaneously expanding access to advanced technologies and materials. Cores, stock centers, and other shared resource facilities also promote rigorous and reproducible research, offer specialized expertise, conduct technology development, act as a nexus for collaboration and team science, and provide technical training.

Cost Efficiency: Shared resources, whether between neighboring laboratories, within departments, or across multiple institutions, can extend the productivity of research investments. Several major resource costs—such as acquisition, service contracts, and physical space to house the resource—are fixed, so cost can decrease as daily use increases through a larger user base. Real savings through facilities were observed by survey participants. The majority of respondents who were able to compare facility versus their own "in-house" costs considered facilities fees to be "significantly lower" (46 percent) or "somewhat lower" (19 percent).[4]

A shared-use approach can offer cost savings by minimizing or preventing unnecessary duplication and error. Established facilities can streamline operations through coordination or consolidation: 39 percent of surveyed facility personnel indicated their unit had undertaken this within the past five years.[5] The technical expertise and training provided by dedicated facility personnel can help researchers avoid errors such as incorrect sample preparation, which invalidate experiments and waste time and funds. Greater sharing of equipment might also allow laboratories to individually maintain fewer instruments, which can be more frequently serviced or replaced without increasing the laboratory's total equipment budget. This approach might particularly benefit the many respondents who rated their routine-use laboratory equipment as "adequate" or "poor."[6]

[4] See Appendix A, Question 24

[5] See Appendix A, Question 21

[6] See Appendix A, Question 18

Greater access: Investigators in all research settings employ a wide array of resources in the course of a scientific study. Sharing resources can increase the number and types available to them. The vast majority of survey respondents utilize multiple shared resource facilities. Eighty percent had used at least three different facilities in the past year, not including commercial providers.[7] Similarly, 78 percent indicated that specialized equipment—which is often provided through shared use facilities—was essential to their work.[8]

Facilities also offer access to advanced instrumentation that individual laboratories often lack the capacity or funds to purchase themselves. When asked to assess the cost-efficiency of facilities, nearly a quarter (23 percent) of participants indicated that this question was not applicable because they were unable to perform those services in their own laboratories.[9] In areas that receive less federal research funding, local shared resource facilities may be of particular importance for providing access. Respondents from Established Program to Stimulate Competitive Research (EPSCoR)-eligible states[10] more frequently reported use of departmental and institutional cores as compared to those in non-EPSCoR states, suggesting greater reliance on local facilities for accessing more costly routine-use as well as advanced equipment.[11]

There is demand to deploy even more shared resource facilities. When asked what specific resource they would most like to use in their research, investigators often described instruments and services that are typically provided through facilities (i.e., electron microscopy, mass spectrometry, and flow cytometry). Several respondents even listed "more facilities" as their most wanted resource.[12]

Quality control and research rigor: Investigators recognize the importance of validating many types of stocks and reagents as well as providing more detailed information about experimental conditions, materials, and protocols in scientific communications.[13] As specialized providers, facilities have the capacity to achieve a high degree of consistency for each procedure, maintain detailed records of extrinsic factors that might affect results, and validate materials.

Similarly, facility personnel are able to attain a high level of excellence and competence in their work by specializing in a technology area or class of research materials. As compared with laboratory staff and trainees, facility staff reported greater confidence in their ability to determine which resources require validation or calibration.[14] They also were more likely to report that their laboratories maintained validation protocols for all frequently used materials and they had

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[7] See Appendix A, Question 22

[8] See Appendix A, Question 15

[9] See Appendix A, Question 24

[10] **National Science Foundation.** Established Program to Stimulate Competitive Research (EPSCoR). Accessed online August 4, 2017.

[11] See Appendix A, Question 22

[12] See Appendix A, Question 17

[13] **Federation of American Societies for Experimental Biology.** Enhancing Research Reproducibility: Recommendations from the Federation of American Societies for Experimental Biology. Report. January 14, 2016.

[14] See Appendix A, Question 49

received training for all equipment they operate.[15] Applying their subject matter knowledge, facility personnel can assist investigators with experimental design and data analysis, troubleshoot protocols, and adapt methods for new applications.

Technological development: Many shared resource facilities engage in technology development. For some, such as those supported through the National Institutes of Health (NIH) P41 mechanism, advancing research technologies is their primary objective. These facilities often work with investigators to develop custom protocols and overcome technical limitations. Discoveries made through these collaborative efforts have the potential to advance methods and even supplant them with more powerful technologies.

Nexus for collaboration and team science: Many shared resource facilities were established to provide multiple laboratories access to a specialized technology or service. Thus, facilities are typically used for many different research projects, often spanning multiple fields. By working with investigators from different departments, schools, and even institutions, facility personnel are well positioned to identify opportunities for collaboration and serve as a point of introduction. Shared resource facilities can also establish integrated workflows with other cores, providing a structured path to bring additional areas of expertise to a project.

Education and training: Through their subject matter knowledge, facility personnel play an important role in training students and keeping users abreast of technological developments. Among facility directors and staff, 82 percent reported that they offer assistance with experimental design, 74 percent provide education and training services, and 40 percent offer other consultative services.[16] Although facility personnel did not rank "teaching" quite as highly as other skills for running a facility, 86 percent rated it as "highly" or "moderately" important.[17]

While facility directors and staff primarily share their knowledge to assist investigators and accelerate research progress, many have found that educational activities are a valuable tool to attract new users. When asked which outreach strategies are effective, 60 percent of facility personnel selected "holding workshops or technical seminars" and 41 percent selected "involvement in graduate training programs or courses."[18]

[15] See Appendix A, Question 51

[16] See Appendix A, Question 20

[17] See Appendix A, Question 48

[18] See Appendix A, Question 29

Section 2: Strengthening Shared Resources

Unmet needs and shortfalls in support for shared resources have been well documented across the biological research enterprise.[19], [20], [21] Improving their deployment and use has the potential to generate greater cost efficiency, broaden access, and speed scientific progress. Given the size of their collective user base, the scientific community would particularly benefit from efforts to strengthen shared resource facilities—including institutional cores, stock centers, and user facilities. This section examines four key areas for improvement and offers recommendations. Additional issues and ideas were raised by survey respondents and can be found in the full survey results.[22]

Funding and Business Operations

Stable and predictable budgets enable facilities to operate efficiently and maintain high standards. In turn, this reduces the cost of conducting cutting-edge research and provides greater reliability for users. However, many facility personnel reported that they struggle to provide consistent, high-quality services at a stable rate.[23] Overall facility support and funding for specific types of expenditures was highly variable, suggesting a lack of commonly accepted and robust business models for facilities.

The percentage of income derived from each funding source varied greatly among institutional and departmental cores.[24] Likewise, high variability was evident in how specific line items

[19] **National Academy of Sciences, National Academy of Engineering, and Institute of Medicine.** Advanced Research Instrumentation and Facilities. Washington, DC: The National Academies Press. 2006.

[20] **Slaughter C.** A Bright but Demanding Future for Core Facilities. *J Biomol Tech*. 2005;16(2):167–169.

[21] **Federation of American Societies for Experimental Biology.** Research Equipment and Resource Requirements of NIH-Supported Investigators: An Assessment of Current Conditions and Recommendations for Future Funding and Programs. Report. August 2000.

[22] See Appendix A

[23] See Appendix A, Questions 36, 41, and 44

[24] There were too few responses from individuals working at the other types of facilities to assess funding patterns, but great variability was observed within these categories.

were covered. When asked to what degree their institutions support non-billable operational overhead, service contracts, and capital equipment costs, nearly all (26 of 27) possible response combinations were reported.[25] Federal sponsors also exhibit inconsistency in their support of major expenditures. For example, the National Science Foundation (NSF) allows service contracts to be included as a direct cost for their Major Research Instrumentation Program (MRI) awards,[26] while the comparable NIH S10 awards do not permit their inclusion.[27] Variability was also observed in which type of federal grants (instrumentation, research, or center) the awarding agencies primarily used to directly support facilities.[28]

This heterogeneity in support can create financial instability for individual shared resource providers. Across all facility types, nearly a third (31 percent) of respondents indicated that their facilities' annual incomes were "moderately variable" or "highly variable." Of particular concern, regional facilities faced disproportionately higher rates of instability, with half of these respondents selecting "highly variable."[29] The varied fiscal landscape also makes it challenging for individual sponsors or institutions to design programs that optimally deploy and maintain shared resources. With many gaps and overlapping efforts, any change risks harming one subset of facilities or unduly benefiting another group.

Many stakeholders have recognized the value of facilities and undertaken a variety of approaches to increase their financial sustainability. Some shared resource providers have responded with efforts to diversify their income streams. However, many facility directors and staff noted that institutional and federal policies constrained their ability to offer services to outside users.[30] A number of institutions have standardized or centralized one or more non-technical functions for facilities, such as billing systems, to help reduce operational costs.[31] Several federal agencies are assessing and revising resource programs to address grantee concerns. For example, NIH has made multiple adjustments to the thresholds for S10 awards, closing a gap and allowing a wider range of instruments to be acquired through this program. While these actions are impactful, without well understood expectations for all stakeholder groups, optimal allocation of resource support will remain elusive.

Strategies to improve funding and business operations of shared resource facilities can be found in the recommendations document.[32]

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[25] See Appendix A, Question 39

[26] **National Science Foundation.** Major Research Instrumentation Program (MRI) Solicitation, 15-504. Posted October 16, 2014.

[27] **National Institutes of Health.** Solicitation Shared Instrumentation Grant (SIG) Program (S10) Program Announcement number PAR-17-074. Posted December 12, 2016.

[28] See Appendix A, Question 34

[29] See Appendix A, Question 32

[30] See Appendix A, Questions 36, 41, 44, and 54

[31] See Appendix A, Question 40

[32] See Maximizing Shared Research Resources, Part I: Recommendations from the Federation of American Societies for Experimental Biology

Discoverability and Access

Making shared resources financially sustainable is the first step. Investigators must also be able to easily discover and then utilize them. Unfortunately, access is a challenge for many researchers; just under half of survey respondents reported that within the past five years they wanted to utilize a facility but were unable to do so.[33] Reasons ranged from not being able to identify a facility that met their needs to the cost of use, insufficient capacity, and restrictions on who can utilize it.

Currently, when investigators search for a facility, they primarily rely on word-of-mouth (95 percent). A majority also would refer to an institutional list of facilities (57 percent) or conduct an online search (52 percent), but very few would use a database of facilities or commercial service providers (21 and 17 percent, respectively).[34] Thus, many investigators are only being exposed to institutional options or ones their collaborators and colleagues already use. While this approach may not be problematic for researchers seeking commonly available, basic service facilities (i.e., sequencing cores), it is extremely limiting when seeking facilities that provide more advanced or unique services and instrumentation.

By ensuring their investigators can find and access the resources they need, institutions can enhance research productivity, raise the institutions' profile and make their investigators more competitive. However, survey responses suggested that a number of institutions are not employing simple and low-cost actions to facilitate use. Participants indicated limited availability of institutional resource-related programs[35] and only 40 percent of facility personnel reported that their institution conducts outreach to faculty and researchers about available facilities.[36] Furthermore, 9 percent of respondents stated that their institutions do not even maintain a list of core facilities and another 8 percent (primarily trainees and laboratory staff) were unaware if such a list existed.[37] The quality of institutional assistance also matters. Among respondents who indicated awareness or availability of an institutional list of core facilities, one-third (33 percent) found it difficult to find or use; these same respondents were also less likely to refer to it when seeking a new facility than those who reported the availability of a user-friendly list.[38]

Discoverability must extend beyond institutional resources to ones located in other states or countries. In addition to word-of-mouth, the majority of respondents stated that they would use online searches to find a facility.[39] Facility personnel most frequently reported "maintaining an

[33] See Appendix A, Question 28

[34] See Appendix A, Question 25

[35] See Appendix A, Question 38

[36] See Appendix A, Question 40

[37] See Appendix A, Question 26

[38] See Appendix A, Questions 25 and 26

[39] See Appendix A, Question 25

online presence" as an effective form of outreach.[40] Few researchers turn to databases, such as the ABRF Core Marketplace, and, not surprisingly, few facilities find registering with databases to be an effective strategy.[41] This is likely a negative feedback loop, with facilities not registering in databases because researchers do not use them, and researchers not using them because too few facilities have registered for databases to be useful. Successfully filling this informational gap could significantly boost utilization.

Even after finding the right facility for their project, potential users face additional hurdles. The most common reason for being unable to utilize a facility was facility fees.[42] Inability to afford fees was also the second highest ranked option for investigators not using a facility again.[43] Likewise, three of the top four reasons investigators gave for significantly unmet resource needs were related to costs.[44] In written comments, respondents often called for fee subsidies, vouchers, or other discounts; fee reductions were described as the most pressing need by unfunded researchers preparing a grant application and by investigators located at less research-intensive institutions.[45]

After costs, the major reason investigators could not access a facility was unavailability.[46] Thirty-one percent of investigators ascribed their unmet resource needs to "too much demand for a shared resource"[47]—a basic capacity issue. Others were prevented from using a facility due to restrictions on who could access it; [48] such limitations often stem from the interpretation and implementation of a combination of grant requirements, federal policies on facility financial practices, and institutional policies.[49] Although some facility directors have been able to offer their services to researchers outside their unit or institution, others described a series of failed efforts to do so.[50]

Strategies to increase the discoverability and access of shared resources can be found in the recommendations document.[51]

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[40] See Appendix A, Question 29

[41] See Appendix A, Questions 25 and 29

[42] See Appendix A, Question 28

[43] See Appendix A, Question 23

[44] See Appendix A, Question 16

[45] See Appendix A, Questions 30, 41, and 44

[46] See Appendix A, Question 28

[47] See Appendix A, Question 16

[48] See Appendix A, Question 28

[49] For example, some grant mechanisms require—or strongly encourage—grantees to ensure that at least a certain percentage of users are funded by the same sponsor.

[50] See Appendix A, Questions 36, 41, and 44

[51] See Maximizing Shared Research Resources, Part I: Recommendations from the Federation of American Societies for Experimental Biology

Ability to Meet Evolving Needs

For a facility to maintain its value to users, it must evolve to meet changing needs. Directors bear great responsibility for keeping their facility current and relevant. To do so, they must replace or upgrade equipment, develop staff expertise, implement new protocols and workflows, and regularly communicate with users to identify emergent needs.[52] All of these actions require money, whether for acquisition costs or to provide personnel with protected time to carry out important, but non-billable, activities. Unfortunately, many facility directors report a struggle to obtain this support, limiting their ability to provide users with cutting-edge services.[53]

Although greater funding would certainly help, this problem is multi-faceted. Procurement systems can make it difficult for an individual provider to purchase or replace much-needed instruments. Most facilities (including institutional cores) are prohibited from funding equipment acquisition through "an internal operating surplus;"[54] thus, acquisition must be supported through an external sponsor or the institution. However, the number of federal instrumentation grants awarded each year is small and inadequate, according to survey participants.[55] The NIH S10 program comprises only 0.3 percent of NIH's research funding,[56] and the NSF MRI program allows only three proposals per institution each year.[57] While acquisition can be funded through other grant mechanisms, federal investments in shared resources are lower than the rate recommended by survey participants.[58] In the absence of external support, facilities are

[52] Survey respondents, particularly users, also considered these actions to be an important aspect of facility accessibility (see Appendix A, Question 30).

[53] See Appendix A, Questions 36, 41, 44, and 54

[54] **NIH Office of Extramural Research.** Frequently Asked Questions: Core Facilities. Last revised April 18, 2013. Accessed online August 4, 2017.

[55] See Appendix A, Question 44 (and, to a lesser extent, Question 36)

[56] Annual research funding data was obtained from the NIH Data Book, and S10 funding data from NIH RePORTER

[57] **National Science Foundation.** Major Research Instrumentation Program (MRI) Solicitation, 15-504. Posted October 16, 2014.

[58] Most respondents thought that NIH should provide funding for resource specific grants (see Appendix A, Question 42). The median amount recommended was 15 percent of NIH research funding (see Appendix A, Question 43). Because some grant mechanisms are not solely used for shared resources, it is difficult to quantify exactly how much NIH research funding is allocated for this purpose. Counting the mechanisms most commonly used to directly support facilities (P30, P40, P41, P50, P60, U54, and S10), a rough estimate for FY 2016 places it around eight percent—about half of the median recommendation.

Facility Consolidation vs. Integration vs. Coordination

The NIH program for core consolidation, supported through the American Recovery and Reinvestment Act of 2009 (ARRA), demonstrated the many benefits of similar facilities combining their efforts. Participating facilities not only achieved greater cost-efficiency, but also reported faster service for users, improved data analysis, and increased staff availability.[1] However, a number of survey respondents expressed concern that consolidation might become "over-valued" and would compromise physical accessibility and the availability of individualized assistance. Fortunately, there are many different approaches for facilities to align their efforts, and one should be chosen based on investigator needs, the technologies involved, and existing infrastructure.

- **Facility coordination** is the lightest approach, in which only a few administrative tasks, such as billing systems, are combined. Through a dedicated office or other body, coordinated

[1] **Chang MC, Birken S, Grieder F, Anderson J.** U.S. National Institutes of Health core consolidation-investing in greater efficiency. *J Biomol Tech.* 2015 Apr;26(1):1–3.

reliant on their institutions to fund purchases. Even though major instrumentation acquisition can be capitalized by the institution, a number of respondents described situations where their institutions or units within were unable or unwilling to advance the funds.[59]

Once funding for a new instrument has been secured, the facility's director also must establish support for maintenance and repair (i.e., service contracts), staff training on the new instrument, software and other supporting materials, and future upgrades. These activities help ensure maximal use and lifespan of the instrument. Survey respondents repeatedly indicated that support for these costs is often difficult to obtain,[60] which diminishes the value of the original investment.

Long-term planning and greater coordination at all levels—federal, regional, institutional, departmental, and facility—could help ameliorate these problems and lead to more efficient use of available support. Respondents often expressed concern that federal agencies do not take full advantage of existing resources and infrastructure, resulting in needless duplication and shortages.[61] Many recommended establishing a single federal strategic plan for resources to optimize funding allocation and grant programs.[62] Likewise, greater coordination is also needed at the institutional level. Numerous survey respondents indicated that facility support and oversight is handled in an inconsistent or ad hoc manner by their institutions.[63] Many facilities are under the auspices of a single department or center, even if they serve

[59] See Appendix A, Questions 36, 41, and 54

[60] See Appendix A, Questions 30, 36, 41, 44, and 54

[61] See Appendix A, Questions 36, 44, and 54

[62] See Appendix A, Question 44

[63] See Appendix A, Questions 36, 41, and 54

facilities can align relevant efforts, such as outreach or customer satisfaction surveys, but otherwise operate independently.

- **Facility integration** involves a greater degree of coordination that can extend to technical operations. This might include establishing cross-training so that individuals can be temporarily re-assigned to another facility that is short-staffed. Integrated workflows allow investigators to seamlessly use multiple facilities, while only having to directly work with one. The facilities still have a level of autonomy, but engage in greater shared decision making related to their operations.

- **Facility consolidation** brings individual sites under single leadership. Physical co-location may occur, but is not required as maintaining several satellite sites may be advantageous. Staff at each location might provide a different subset of specialized services in addition to the standard "core" services; they could direct users to the relevant specialist or satellite as needed. Through consolidation, facilities operations may become sufficiently large to facilitate succession planning.

researchers attached to other units. This decentralized approach can result in unreliable support, duplicative cores, and poor overall allocation of institutional resources funding. Furthermore, institutional coordination and planning is necessary for implementing inexpensive approaches that more successfully leverage internal shared resources.[64]

Strategies to better meet evolving resource needs can be found in the recommendations document.[65]

Facility Career Track and Staff Development

Facility directors, core scientists, and technical staff all play key roles in advancing scientific knowledge. Their contributions to research should be recognized—from the expertise and assistance they offer other scientists to the development of new technologies and methods. In practice, however, this career track is often overlooked and inadequately supported. Without greater awareness of this career track and support through each stage, it will be difficult to recruit and retain skilled personnel.

Expert facility personnel are vital to providing the quality services that investigators have come to expect. When asked what would lead them to not use a facility again, the highest ranked response was, "I am not satisfied with the quality of service."[66] Facility directors and staff agree that expertise is indispensable; 92 percent of these respondents rated "technology/technical expertise" as "highly important"—the most highly rated skill on the list. Directing or managing a facility also requires mastering many other skillsets, including those related to customer service and outreach, staff management, data analysis, business skills, teaching, and operational efficiency.[67]

To foster a team of expert personnel, facilities need to offer staff job security and opportunities for professional development. Unfortunately, facility personnel typically experience less stability and support for career progression than their laboratory counterparts. This can result in high staff turnover and loss of expertise, which in turn affects the quality and range of services that can be consistently offered to users, and reduces a facility's cost efficiency.

Directors who defined their primary role as running a facility were much less likely to be in a tenured or tenure track position than facility directors who also operated a research laboratory, even when controlling for career stage or faculty appointment.[68] Facility directors reported difficulty retaining skilled staff due to uncompetitive compensation and benefits packages, annual job insecurity, and limited opportunities for career

[64] For examples, see Appendix A, Question 38, 39, 40, and 41

[65] See Maximizing Shared Research Resources, Part I: Recommendations from the Federation of American Societies for Experimental Biology

[66] See Appendix A, Question 23

[67] See Appendix A, Question 48

[68] See Appendix A, Question 9 (using results also from Questions 4 and 10)

advancement.[69] Support for professional development is critical; it helps personnel keep up with advances in their field, learn to implement and utilize new instruments, and establish cross-training to provide more consistent coverage. Facility directors also wrote about the inability to secure funding for professional development, including the costs associated with participation in a single scientific meeting. Some described this as yet another barrier to staff retention.[70] Many suggested establishing institutional or federal support for a portion of staff salaries to provide protected time for developing new procedures, updating workflows, networking with researchers and personnel at other facilities, and pursuing professional development opportunities. Grant programs exist that are designed specifically for core scientists, such as the "NCI Research Specialist (Core-based Scientist) Award,"[71] but most are new and offer only a small number of awards.

Thus, professionalizing this career track could not only lead to greater job security, it could increase the value facilities provide to the research community. One strategy towards professionalization is ensuring recognition of facility personnel in measurable ways. Researchers can help by acknowledging shared resource facilities and instrumentation in their scientific communications, as affirmed in a standing FASEB policy position.[72] The Department of Energy Office of Science has been very proactive in encouraging acknowledgment of its user facilities. Citation data enable facility personnel to quantify the impact of their work and make a stronger case for support from their home institutions and external sponsors. Greater recognition could help to recruit and retain talented individuals in this field, and through increased awareness, promote greater use of shared resources and collaboration with facility personnel.

Strategies to professionalize careers in shared resources can be found in the recommendations document.[73]

[69] See Appendix A, Questions 36, 41, 44, and 54

[70] See Appendix A, Questions 41 and 54

[71] **National Institutes of Health.** NCI Research Specialist (Core-based Scientist) Award (R50), Program Announcement number PAR-17-050. Posted November 4, 2016.

[72] **Federation of American Societies for Experimental Biology.** Ensuring Proper Acknowledgment of Shared Resource Facilities and Instrumentation. Policy Position Statement. April 5, 2016.

[73] See Maximizing Shared Research Resources, Part I: Recommendations from the Federation of American Societies for Experimental Biology

Section 3: Methods and Respondent Demographics

Methods

The survey was created and administered using SurveyGizmo. It consisted of 54 questions that examined the following topics: (1) resource utilization and unmet needs; (2) the role of facilities in providing access to resources; (3) sources of funding and support for resources; (4) careers in resource provision and development as well as training on best practices. Basic demographic information was also collected. Using a combination of display and skip logic, questions were targeted to the most relevant subpopulation; thus, each respondent was asked only a subset of the 54 survey questions.

Launched on January 5, 2017, the survey was shared through email, electronic newsletters, and social media platforms such as Facebook and Twitter. Responses were accepted through March 2, 2017. Participation in the survey was voluntary and open to all US individuals who use or provide biological resources; therefore, results may reflect self-selection bias.

Respondent Demographics

A total of 751 respondents completed the survey. Additional demographic information was collected in each survey branch, including the career stage and tenure status of respondents and the emphasis of their research on the basic-to-applied spectrum. A summary of respondent demographics can be found in Appendix A.

Position: The majority of respondents were facility directors, PIs, or faculty. Initially, respondents were sorted into the following groups:

	Number of Respondents	Percent of Respondents
Facility or Center Staff (manager, staff scientist, technician, administrator, etc.)	118	16%
Facility or Center Director	243	32%
Principal Investigator or Faculty that does not direct/manage a facility or center	253	34%
Laboratory Staff (lab manager, staff scientist, technician, etc.)	50	7%
Graduate Student, Postdoc, or Fellow	87	12%

Of the 243 respondents indicating their position as Facility or Director, 91 (38 percent) also indicated that they operate a research laboratory. These individuals were allowed to choose which role they would assume to complete the survey: 37 selected "Facility Director," 19 selected "PI/Faculty," and 35 selected "Both."[74] Those who selected both were presented with questions targeted to the PI/Faculty subpopulation and the Facility Director subpopulation.

[74] See Appendix A, Questions 1, 4, and 6

Institutional Affiliation: Forty-four percent of respondents cited primary affiliation as Public University with a Medical School. The categories Private University with a Medical School (20 percent), Non-profit Research Institution (14 percent), and Public University without a Medical School (9 percent) were also well represented among respondents.[75]

Federal Funding Sources of Respondents: The majority of PIs, Laboratory Staff, and Trainees indicated that their research is supported by federal funding (367 out of 444). Nearly a quarter of these respondents selected more than one source of federal funding. NIH was selected most often (73 percent) by respondents as their funding source, followed by NSF (11 percent) and the Department of Defense (10 percent).[76]

Representation of FASEB Member Societies: Of FASEB's 30 member societies at the time of the survey,[77] 29 were represented among survey participants. A total of 338 respondents indicated membership in at least one society; within this group, approximately one-third were members of multiple FASEB societies. Society membership rates were highest among directors who also operated a laboratory (71 percent) and PIs/faculty (66 percent).[78]

[75] See Appendix A, Question 13

[76] See Appendix A, Question 12

[77] The Society for Toxicology (SOT) became a FASEB constituent society after the survey had closed.

[78] See Appendix A, Question 54