Guest Editorial
A model university analysis and instrumentation facility

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Shared-use analytical instrumentation facilities are becoming increasingly necessary in order for universities to effectively invest their research dollars. As budgets tighten and funding becomes increasingly difficult to obtain/maintain, the shared-use facility is a cost-effective research resource. This article describes a model Centralized Instrumentation Facility (CIF), including its historical perspective, its organization and function, funding considerations, and rate and recharge structure.

Background

Most academic analytical instrument service facilities are located and operated either within a single department (chemistry, biochemistry, biology, etc.) or a single college (sciences, engineering, veterinary medicine, etc.). In some cases, several departments utilize these facilities. A study by Ivanetich, et al.[1] discusses facilities that cater to one general field: biotechnology. The laboratories surveyed performed DNA synthesis and sequencing, amino acid analysis, and other related services. Typically, the departments or the dean of the college in which the facility was located heavily subsidized these facilities. These types of subsidies usually include line-item salaries and an operating expense budget. In the study referred to above, one of the conclusions was that the average DNA facility required a minimum 50% subsidy. Professional organizations, for example the Association of Managers of Magnetic Resonance Labs (AMMRL, home page: http://www.chem.yale.edu/~bangertr/ammrl/ammrl.html) and the American Society of Mass Spectrometry (ASMS, home page: http://www.asyms.org), also provide some data on single-purpose facilities such as their costs and fee structures.

Over the past decade, instrumentation to support basic research in the chemical sciences has been difficult to acquire and even more difficult to maintain.[2,3] The major funding agencies for basic scientific research at the nation's universities, such as the National Science Foundation (NSF), the National Institutes of Health (NIH), and others, require plans to be submitted with instrumentation grant proposals detailing how the equipment will be maintained and operated. NSF has its Major Research Instrumentation Program (MRI), sponsored by the Office of Science and Technology Infrastructure, and NIH has its Biological Research Shared Instrumentation Grant Program. Both promote multidepartment/college organization for shared instruments.

Twenty-five years ago, most major instruments were located within the laboratory of one outstanding professor or a small group of researchers who could request an expensive piece of equipment (for example, nuclear magnetic resonance [NMR] or mass spectroscopy [MS]). When the costs for sophisticated equipment and its maintenance became excessive for individual research groups to bear, the evolution of the departmental center for shared instrumentation began. Shared equipment was typically purchased through an NIH, NSF, or other grant with matching funds from the department or university. The college dean or the department itself promised to maintain and operate the instrument to accomplish the research goals for which the grant was funded. This system is still in wide use today.

As instrumentation funding and individual competitive research grants have become increasingly difficult to obtain, the college-wide or university-wide instrumentation facility has evolved. This article will discuss a model for a university-wide shared instrumentation facility.

Structure

The function of the CIF is to provide access to modern research instrumentation and applications support for it, while also providing maintenance and repair of equipment for as many departments and researchers as possible. This operation can be compared to the function of a university's science library, only for instrumentation services. In the case of a CIF, the research resource is to provide access to modern instrumentation, and the "librarians" are typically Ph.D.-level professionals who assist the researchers in applying the instrumentation to their particular project.

The CIF offers to manage the equipment for university departments while assuring the major users within those units that access will improve due to the CIF's ability to provide a professional organization of operators and maintenance personnel. An added benefit of CIF management is that faculty researchers would no longer be responsible for routine maintenance and operation. In addition, when new instruments are proposed or purchased, consideration should be given to housing them in the university-wide facility.

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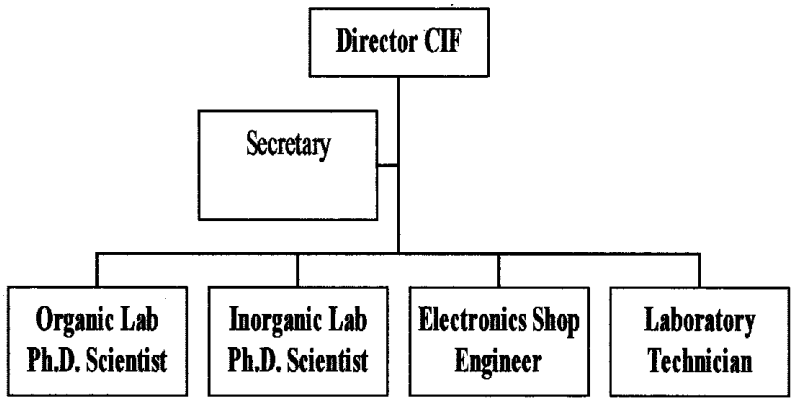

Figure 1 *CIF organizational structure.*

Figure 1 shows a model organizational structure for a CIF. It is divided into three major areas: administration, analysis, and maintenance. The administrative team consists of a director and secretary. This unit is responsible for overall financial management (income and expense tracking), personnel oversight, interdepartmental contacts, etc. The director typically also lends scientific and/or electronics expertise in the instrumentation laboratories.

The analytical laboratories provide access to the shared equipment and support it. The analysis areas can be loosely divided into organic (including biological) and inorganic. The laboratories would charge hourly rates for instrument usage and operation/consultation. Laboratory personnel are responsible for all routine maintenance of the equipment, verification that instrumentation is operating properly, and reconfiguration of the instruments as needed for different experiments. Laboratory personnel assist users with training, methods development, and data interpretation. For repair of CIF equipment, laboratory personnel would work closely with CIF (and/or vendor) engineers to ensure timely and effective maintenance.

The maintenance group would perform in-house repairs of CIF and other university equipment located within separate departments. The CIF could sell service contracts to other internal university researchers or departments for 75% of the cost of the same contract from the equipment manufacturer. For that cost, the CIF would repair the instrument systems in a timely and professional manner. The CIF would add the guarantee that, if it is not able to repair the instrument within a reasonable time, the CIF will call in the vendor service person at university expense. The group would also repair equipment on a per-call basis, charging for labor and parts. Typically, since CIF service personnel would be located on-site, repairs would be effected before a vendor service engineer could arrive. The goal would be to have a CIF engineer respond within 24 hr of receiving a service call.

One of the main differences between this proposed model and most other university facilities is the scope of instruments and services provided under a single umbrella. *Table 1* lists some possible instrumentation (not a comprehensive list) and its approximate replacement value (list price estimate) that could be placed under CIF auspices.

The diverse services offered by the CIF will lead to a broad user base that could include departments within a medical school, school of engineering, college of arts and sciences (chemistry, biochemistry, biology, geology, etc.), and other units, such as veterinary medicine. Additionally, the CIF could provide services to other universities and corporate clients. If the CIF is unable to accommodate a particular or unusual request, information could be provided to the researcher about alternative sources. This referral can be to another department within the university or to an outside entity. The percentage of work performed for nonuniversity researchers should be sufficient to help offset costs, but low enough to ensure that researchers have adequate access to instrument time.

Funding

The key to a successful CIF is good personnel and funding. Reasonable salaries are necessary to attract the scientists and technicians who will operate and maintain the equipment. Sources of funding should include a commitment from the university for 60% of the total CIF budget. Experience has shown that a properly implemented recharge system can recover the other 40% of operation costs.

Table 1
CIF equipment and replacement cost

Equipment	Replacement cost
500-MHz NMR	$800,000
High-resolution MS	600,000
GC-MS (3)	228,000
GC	35,000
C, H, N, S/Oanalyzer	60,000
Thermal analysis equipment	150,000
FTIR	85,000
TEM	450,000
SEM(2)	300,000
Confocal microscope	215,000
WD-XRF	350,000
ED-XRF	160,000
XRD	225,000
ICP with USN	160,000
GFAAS	55,000
EPR	260,000
MALDIMS	250,000
Sample prep equipment	275,000
Test equipment	50,000
Other departments (service contracts)	300,000
Total replacement value	$5,008,000

In many cases, funding can be consolidated from current line-item salaries within individual departments. Many departments have technician lines that can be more efficiently utilized within a CIF umbrella. Assurances must be made to those departments that the important functions of those

positions will be continued and, in some cases, even improved. A recharge system should be set up to charge grants for some services. The recharge structure should include annual operating and maintenance expenses (excluding space and utilities) for the CIF. Salaries typically total approx. 65% of a CIF budget. Laboratory supplies and equipment maintenance costs comprise the bulk of the rest of the expenses. *Table 2* shows a model budget based on a six-person organizational structure (director, secretary, two Ph.D.-level scientists, and two technicians).

Table 2
Model operating budget

Item	Expenses
Salaries and fringe benefits (six salary lines)	$260,000
Operating supplies and expenses	135,000
Equipment	5,000
Total budgeted expenses	$400,000

Recharge structure

In order to generate the income necessary to offset the portion of the expense budget not covered by the reorganized salary line items plus any subsidy provided by the university, a CIF should charge its users. If the income generated from federal grants is significant, the CIF should be designated by the university to be a Specialized Service Facility. Users of the facility will often pay for services from federal grants and contracts. The Federal Office of Management and Budget (OMB) has strict guidelines (OMB Circular A-21) for developing and charging fees against grants and contracts. The term Specialized Service Facility is reserved for service centers that are large, utilize specialized facilities and/or equipment, and recover their large costs through charges to users.

Basically, the OMB A-21 rule requires universities to apply consistent and sound cost accounting practices when developing rates. The resultant CIF rates must not discriminate among internal users. The rates charged should be set as a result of a management and business decision, and the actual charges cannot exceed the recovery of full cost. An oversight committee of university administrators and users and a recognized university-wide recharge center committee must approve the rates on an annual basis. An annual self-audit should be performed to ensure that the cost recovery is appropriate.

Rate setting

Setting the rates requires skillful negotiation with potential users. There should be two tiers of rates: internal and external. All internal researchers should pay the internal rate. Typically, the internal rate is lower than the calculated permissible rate. Researchers without adequate funding to pay the full rate may still have work performed. The university subsidy and the "profit" from external users can be used to cover this difference. Researchers often require a letter of support for costs of analyses for grant budgets being submitted to funding agencies. An estimate of instrument use charges should be included in their proposal. When the grant is for multiple years, the analytical budget should be increased by approx. 4% per year to cover small increases in rates. If a specific rate increase causes their funding to fall short, every effort should be made to complete the project and utilize university subsidy or "profits" from external work to cover the difference.

External rates should be set much higher than internal rates. The university laboratory cannot directly compete with private businesses. In other words, the university laboratory cannot offer identical services or products for a lower price than the local industry. However, it must be remembered that the laboratory staff are experts in their fields and, generally, the client is receiving much more comprehensive support for that unique sample/project than is found in an industrial setting. Charging external clients a higher rate also generates income that may be used to offset unfunded university work and to generally lower the internal rates.

In most cases, researchers would save money by providing their own instrument operators (typically students), who would be thoroughly trained by CIF personnel. If CIF personnel were used on a project, an operator/consulting surcharge would be levied in addition to the hourly instrument rate. As with instrument rates, the operator/consulting rate would be based on projected expenses. A salary matrix would be established for each CIF staff member. The percentage of their time that is spent maintaining equipment in a specific cost center, performing administrative functions (personnel management, laboratory paperwork), and operating/consulting on equipment in a specific cost center would be distributed. The salary costs for operator/consulting would then be summed. This total would be divided by the total number of hours that CIF staff expect to spend operating/consulting for analytical projects to establish the rate.

As mentioned previously, the electronics laboratory should charge 75% of the vendor price for a service contract. When this vendor information is unavailable, the service contract can be charged at 7.5% of the replacement value of the equipment. For hourly labor rates, $75/hr is reasonable. This rate is significantly lower than typical vendor rates, but high enough to recover costs. Parts may be charged with a 10% markup to cover shipping and paperwork.

Rate audit

Performing an annual audit of the rates is an important exercise. It permits a review of the previous year's performance and allows correction for gross overcharges. To perform the audit, the actual performance figures for the previous calendar year are put into the rate formulas. If it is obvious that there has been a gross overcharge, this "profit" must be subtracted from

the next year's expenses so that, over a several-year period, there is a break-even performance. Meticulous records should be kept about each sample and project. Logbooks should be located next to each instrument so that all charges can be traced from the invoice back to the data acquisition. This provides the CIF with a paper trail capable of withstanding an audit.

Conclusions

By utilizing its professional staff to cover a number of areas of expertise and instrumentation, a CIF is able to provide the most efficient, reliable analytical services to the faculty, student, and external researchers who make up its clientele.

Table 1 gives an example of $5,008,000 as the total replacement value of equipment that a CIF may offer. The CIF should routinely request quotations from vendor service departments for full service contracts. Experience has shown that the cost of these annual contracts runs approx. 10% of the replacement cost of the instrument.[3] Using this 10% rule of thumb, the university would have to pay approx. $500,000 annually for vendor service contracts that would only provide comprehensive routine and emergency maintenance, parts, and repair. An annual vendor service contract only guarantees an operational instrument. For much less expense ($400,000, see Table 2), a CIF is able to similarly maintain the equipment. In addition, a CIF is able to provide complete applications and training support, as well as data analysis, sample preparation, and more.

The visibility of a university-wide center is a less obvious but important asset to the university. Departments trying to recruit quality research faculty may schedule tours of the CIF facilities with prospective applicants. Equipment vendors have told the authors and others[4] that they have been willing to provide an extra discount on equipment being purchased and located in such a prestigious centralized facility. Another major benefit to the university is that students leave with hands-on experience with state-of-the-art research equipment, thus increasing their value to prospective employers.

Finally, it is the opinion of the author that the ideal university-wide instrumentation facility should be subsidized at the 60% level. Such a subsidy will allow the internal rates to be reasonable. This is important due to the increasing strains being placed on individual research grants. Also, much more pilot data (work for unfunded researchers who need data to submit with research proposals) can be accommodated if the subsidy is placed at that level of the total budget. This situation still provides the university with a tremendous bargain considering the total savings over full service contracts alone. Experience has shown that the model outlined in this paper is a cost-effective mechanism for a university to share instrument resources.

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