

CLASS LABORATORIES:



SPACE USE AND UTILIZATION

by Ira Fink, Ph.D., FAIA

As campuses work to increase their efficiency, improving space utilization has gained importance as a key facility planning activity. Increasing classroom use and utilization has long been under the microscope as a target for improving the use of campus space. Improving class laboratory use is another matter altogether. These important instructional spaces remain under the radar, because they are not well understood and because they are so varied.

Are Class Laboratories Being Well Used?

Class laboratories are an important and often underutilized component of campus instructional facilities. For many colleges and universities, the amount of space dedicated to class laboratories exceeds the amount of space used for classrooms.

Class laboratories are essential to the teaching mission, allowing hands-on instruction to be carried out in rooms tailored to a specific academic program need. Class laboratories are, or should be, a significant source of departmental pride. At the same time, on some campuses, underused or unused class laboratory space can provide an opportunity to reclaim and reuse excess space for other high priority needs, such as research.

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Despite the need for and importance of class laboratories to campus instructional programs, there is no published information about their use and utilization. The bibliography, *Campus Planning and Facility Design* (fourth edition)¹, does not list a single specific book or article on class laboratories. This article seeks to fill this gap in the literature of higher education facility planning and to serve as a companion to my earlier article, "Classroom Space Use and Utilization," which appeared in the May/June 2002 issue of *Facilities Manager*.

Class laboratories have unique characteristics that make them difficult to manage. While they are discipline specific, they are also broadly defined within the facility planner's lexicon, and cover a range of spaces from chemistry class laboratories to band rooms. A better understanding of class laboratories as a space use can help facility planners in their efforts to improve the use of space on their campuses.

This article sharpens the definition of class laboratories, identifies the characteristics that differentiate these types of spaces—including the challenges associated with managing these spaces—and offers a couple of solutions that may help facility planners improve campus space efficiency. The discussion concludes by suggesting an approach to improving class laboratory use and utilization.

Defining Class Laboratories

Types of Class Labs

Class laboratories, also known as teaching laboratories, can generally be divided between science and non-science laboratories, each with identified spatial needs to meet the teaching patterns of the sponsoring discipline and to optimize the station count for span of control and safety. Science class laboratories require unique furniture and specialized equipment, both fixed and movable, while non-science class laboratories have less or no equipment generated needs.

With few exceptions, class laboratories are used only for undergraduate instruction. Graduate students generally conduct their experimental work in their own laboratory stations, usually in research laboratories, which have separate room use classification, use, and utilization patterns.

What is a Class Laboratory?

A "class laboratory" is broadly defined by the U.S. Department of Education's National Center for Education Statistics (NCES) as "a room used primarily for formally or regularly scheduled classes that require special purpose equipment or a specific room configuration for student participation, experimentation, observation, or practice in an academic discipline."² On most campuses that broad definition covers all class laboratory spaces, regardless of discipline or use. Class laboratories that have "special purpose equipment" also require special furniture or furnishings to use or store the analytical equipment, such as laboratory benches, study carrels, flat tables, or other space consuming items.

To understand class laboratories better, we employ two classifications: class laboratories and special classrooms. The differentiation between these is based upon whether or not the laboratory requires special purpose analytical equipment, and whether the laboratory can also be used for free-time, drop-in, or open use.

Included in the class laboratory category are rooms such as science and engineering laboratories, instructional shops, drafting rooms, group studios, specialized health profession laboratories, language laboratories, and similarly designed or equipped rooms. These rooms are designed for or furnished with specialized equipment to serve the needs of a particular discipline for group instruction. The design of the space or the use of equipment in the class laboratory room normally limits its use to a specific academic discipline; precludes its use by other disciplines; and forecloses its open use. Moreover, these rooms are generally not interchangeable between disciplines. This, in turn, is reflected in their lower use and utilization.

Definition of a Special Classroom

To distinguish between uses, we have added a second room use we call a "special classroom." We define a "special

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classroom" as a room or studio used for regularly or formally scheduled classes that requires a unique or distinct space, *but does not require special purpose equipment*, and can have open use. Included in our special classroom definition are rooms such as band rooms, choral studios, dance studios, rehearsal rooms, and similarly designed spaces. In this way, we can hone in on room use and utilization by separating these distinct types of rooms. Rooms used for music practice are yet a separate room use category.

Class Laboratory Service Room

It is important in reviewing class laboratories to recognize one more room type: "class laboratory service." This is a room defined as directly serving one or more class laboratories or special classrooms as an extension of the activities of those rooms to provide supplies, services, preparation, or storage. Included in this room use are balance rooms, cold rooms, preparation rooms, specimen rooms, stock rooms, equipment issue rooms, and similar uses associated with the class laboratory. Class laboratory service rooms do not include rooms serving research laboratories.

Characteristics of Class Laboratories that Affect Space Management

Four characteristics of class laboratories are central to understanding their use and utilization and their space management. These factors are: departmental or decentralized control of class laboratories; distributed use of laboratories; specialized laboratory equipment; and required laboratory support facilities. Each of these class laboratory characteristics is in direct contrast to the elements useful for understanding and improving campus classroom use and utilization.

Departmental or Decentralized Control

The first characteristic, that class laboratories are usually under departmental and/or faculty control, rather than central classroom schedule control, means the laboratories are usually departmental "turf." They are an important component of institutional excellence and a student recruitment tool. A recent Internet search of "teaching laboratories" found 15,500 entries, many touting the importance of one or more class laboratories specific to a departmental purpose.

Class laboratories are also part of the ratchet effect of space on campuses. Once assigned, they are held on to, "just in case," regardless of how well they are being used or utilized. In other words, departments or units are loathe to give up the space, even if the class laboratories are unused or not well used.

The amount of class laboratory space kept "just in case" it may be needed for a yet to be identified use, can be reduced by either central scheduling of class laboratories and/or by keeping better track and accountability of class laboratory use on an annual basis. To regain excess class laboratory space, the campus must have an up-to-date space inventory or facilities room database. This database must classify rooms by their use and assignment, including class laboratories, special

classrooms, and class laboratory service rooms, along with identifying other features of the rooms, including square footage, station count, room number, specific use, and departmental assignment. An annual record from the registrar of whether the room is being used for regular or formally scheduled classes is also needed. Matching the facilities database to the registrar's record will identify rooms that are not being used.

For example, one campus had 124 rooms classified as class laboratories in the facilities room database. Yet, the registrar's record of scheduled courses showed only 89 class laboratories in use. In other words, 35 rooms or 30 percent of this inventory was not being used as designated. At another campus, the registrar's record of scheduled use accounted for only 62 out of 192 class laboratories and special class laboratories shown on the facilities room database. Upon further review, some rooms had been converted to other uses, such as research, and some had simply become costly storage areas for old and unused equipment and furniture.

Distributed Space

The second characteristic, distributed space, means class laboratory space occurs across the campus, rather than centralized in a "class laboratory building" or buildings. Because many disciplines and departments have class laboratories, this decentralized "ownership" allows for space to be sprinkled across the campus when excess or unused class laboratory space is identified. This fragmented ownership also can permit the excess space to be hidden from view, especially in those buildings designed for or occupied by a single department or discipline. However, once identified and reclaimed, the space can be better used, which is a considerable aid when small amounts of space are needed to accommodate incremental program growth or other newly identified needs. Excess, unused, or underused class laboratories are reservoirs of potentially available space about the campus, waiting to be reclaimed.

Almost every academic department has some space assigned to it that is identified as class laboratories. While the majority of class laboratories are in the sciences and engineering, most departments in schools of business, education, fine arts, medicine, music, and nursing have class laboratories. The only departments that consistently do not have class laboratories are economics, history, philosophy, and religion.

On average, class laboratories, special classrooms, class laboratory service, computer laboratories, and open laboratories represent about 7 percent of the assignable space on campus, excluding housing. This means the amount of campus space devoted to class laboratories is an even larger amount than space used for classrooms and classroom service, which averages about 5 percent of assignable space, as shown in Table 1.

Class laboratory space (which for space planning purposes are all spaces with NCES Room Use Codes from 200 to 249) ranges from a low of 4 percent to a high of 20 percent of academic, administrative, and support space on campus. This

Table 1. DISTRIBUTION OF ACADEMIC, ADMINISTRATIVE, AND SUPPORT SPACE AT 27 COLLEGES AND UNIVERSITIES, EXCLUDING HOUSING

NCES Room Use Codes and Room Type	25 Public Universities		2 Private Universities Average	27 Colleges and Universities Average
	Average	Range		
100 Classrooms	5.2%	3.3 to 12.4%	15.7%	5.3%
200 Class Laboratories	7.0	4.3 to 19.5%	18.3	7.1
250 Research	15.3	8.3 to 24.1%	3.6	15.2
300 Office	22.5	11.0 to 33.1%	23.0	22.5
400 Library/Study	6.6	4.9 to 12.8%	17.7	6.6
500 Special Use	14.1	1.2 to 25.8%	13.3	14.1
600 General Use	11.2	4.7 to 19.0%	4.6	11.2
700 Support	14.4	5.4 to 26.7%	0.5	14.3
800-900 Health Care	3.7	0.9 to 5.5%	3.3	3.7
TOTAL	100.0%		100.0%	100.0%

Source: Ira Fink and Associates, Inc., based upon data from 25 public universities and two private universities

finding is based on data from 25 public universities, mainly large research campuses, as shown in Table 1. Class laboratory space can be compared to classroom space on these same campuses, which ranges from 3 to 12 percent of total campus space.

The percentage of class laboratory space may be highest among community colleges. For example, among the community colleges in the University and Community College System of Nevada, 25 percent of all assignable square footage is in classrooms, while 27 percent is in class laboratories.

Specialized Equipment

The third characteristic, that class laboratories contain specialized equipment, has two important subcategories: the age and usefulness of the equipment and the amount of floor space required for its use. Class laboratories that house aged equipment are generally less used than laboratories with up-to-date instructional equipment. This results in a need for the campus to plan for and fund equipment (and furniture) renewal to improve class laboratory space use and utilization. When renovation or equipment funds are not available, the little used class laboratory becomes even less used, and often defaults to becoming a storage room.

Class Laboratory Station Size

All class laboratories with furniture for specialized equipment, whether new or old, require more space per student station than other rooms used for instruction, such as classroom or lecture space. On average, class laboratories, when measured in square feet per student station, are two to three

times larger than classrooms station size. At the same time, class laboratories have fewer stations per room. The number and capacity of class laboratories at a variety of campuses are shown in Table 2.

Another important measure is the space per station or square footage per station. This calculation is made by dividing the number of stations contained in the class laboratories into the square footage of the room to determine average area (square footage) per station.

In the Table 2 examples, the assignable square footage (asf) per class laboratory station varied from 39 asf to 63 asf, with an average of 51 asf per station across all campuses. Among the six campuses reported in Table 2, class laboratories had an average of 17.7 stations per room and a range of 16.1 to 19.0 stations per room. This high square footage per station and low station count is typical of class laboratories.

By comparison, classrooms at these same campuses had an average of 44.7

stations per room and an average area of 17 square feet per station.

Also, as shown in Table 2, class laboratories as a room type have considerably fewer stations than classrooms, with one-quarter having nine or fewer stations and none reported having 75 or more. The economies of scale that occurs in large-station count classrooms does not equally apply to class laboratories.

As Table 2 illustrates, class laboratories, due to their fixed furniture or furnishings, require considerably more square footage per station than classrooms with movable table and chair rooms. Fixed table rooms that are Americans with Disabilities Act (ADA) compliant require 35 to 40 asf or more per station since fixed tables and an instructor's podium take up considerably more space per station than moveable furniture.

Class Laboratory Stations and Headcount

One way to grasp the amount of class laboratory space on a campus is to compare headcount enrollment to the number of class laboratory stations. On the large public campuses shown in Table 2, there are approximately ten headcount students per class laboratory station. On the small private university campuses, there are approximately six headcount students per class laboratory station. In other words, small private universities have more class laboratory stations per student than do large public universities.

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Table 2. DISTRIBUTION OF CLASS LABORATORIES BY NUMBER OF STATIONS AND ASF AMONG FOUR PUBLIC UNIVERSITIES AND TWO PRIVATE UNIVERSITIES

Class Laboratory (Stations)	Large Public University		Large Public University		Large Public University		Large Public University		Small Private University		Small Private University		TOTAL	
0 to 9	24	20%	26	37%	12	26%	20	36%	--	0%	5	23%	87	26%
10 to 19	34	28%	14	20%	16	35%	12	22%	5	31%	8	36%	89	27%
20 to 29	46	38%	19	27%	12	26%	12	22%	11	69%	5	23%	105	32%
30 to 39	13	11%	9	12%	1	2%	6	11%	--	0%	4	18%	33	10%
40 to 49	3	2%	1	1%	5	11%	4	7%	--	0%	--	0%	13	4%
50 to 74	1	1%	2	3%	--	0%	1	2%	--	0%	--	0%	4	1%
75 & above	--	0%	--	0%	--	0%	--	0%	--	0%	--	0%	--	0%
TOTAL	121	100%	71	100%	46	100%	55	100%	16	100%	22	100%	331	100%
Class Laboratory ASF	124,041		44,036		42,188		50,043		19,154		19,775		299,237	
Total Class Lab Stations	2,256		1,140		785		971		304		407		5,863	
Stations/Room	18.6		16.1		17.1		17.7		19.0		18.5		17.7	
ASF per Room	1,025		620		917		910		1,197		899		904	
ASF per Station	55		39		54		52		63		49		51	
Headcount	23,600		11,500		13,000		9,600		2,200		2,100		62,000	
ASf per Headcount	5.3		3.8		3.2		5.2		8.7		9.4		4.8	
Headcount per Class Lab Station	10.4		10.1		16.6		9.9		7.2		5.2		10.6	
Source: Ira Fink and Associates, Inc.														

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Enrollment Headcount and Number of Instructional Spaces

As illustrated in Table 3, there is variation in the number of headcount students per class laboratory room measured as a campus-wide average. The range in headcount enrollment to the number of class laboratories varied from a low of 95 students per class laboratory at a small, private university to 293 students per class laboratory at a large public university. By comparison, for classrooms, the data show considerably fewer students per room, with the range of headcount students per classroom ranging from a low of 27 students per room at a small private university to a high of 126 students per room at a large public university.

A rule of thumb is that in research universities there should be about 1.3 times as much total class laboratory square footage as classroom; for comprehensive universities and for small private colleges and universities, there should be an equal amount of total class laboratory and classroom space.

Class Laboratory Support Facilities

The fourth characteristic of class laboratories that affects space management, support facilities for class laboratories, reflects the fact that many other types of rooms are needed to supply and prepare for class laboratory use. For example, prep rooms and equipment rooms are needed to support biology, chemistry, and physics class laboratories. If the class labs are underused, it is likely their supporting facilities are unused or underused as well.

Based on data from the six campuses shown in Table 3, class laboratory service space as a percentage of class laboratory space ranged from a low of 14 percent to a high of 52 percent, with an average of 28 percent. In other words, for every 1,000 square feet of class laboratory space, an average of 280 square feet of support space was needed. This results in an increase in the reservoir of available space when class laboratories are unused or underused. At the same time, it is important to plan for and include necessary service and support space when programming or considering new or renovated class laboratories.

Unique Patterns of Class Laboratory Use by Days of the Week

A common misnomer in higher education planning is that most classroom instruction occurs on a Monday-Wednesday-Friday schedule, to allow

class laboratories to take place on a Tuesday-Thursday sequence. Like many other icons of space use, this too needs to be revisited. For example, on two campuses where we have recently conducted class laboratory use and utilization studies, we found the Tuesday-Thursday laboratory schedule to be very limited.

The pattern of laboratories occurring on the sequence of Tuesday-Thursday applied to slightly less than one-quarter of class laboratory courses at one example campus and 7 percent at another. What is most surprising, and as shown in Table 4, is that more than one-half of the laboratory courses, 51 percent, met only one day per week on one campus, and 91 percent met only one day a week at a second campus.

Tuesday Is the Busiest Day

While Tuesday and Thursday are peak class laboratory instructional days, the busiest of the two days for class laboratory enrollment is Tuesday, as shown in Table 5. It is

Table 3.
CLASS LABORATORY AND
CLASSROOM STATIONS
PER HEADCOUNT

Source:

Ira Fink and Associates, Inc.

Institution	Head Count Enrollment	Class Laboratories		Classrooms		Enroll per CLab	Enroll per CRm
		No. of Class Labs	No. of Stations	No. of Classrooms	No. of Stations		
A Large Public	23,600	121	2,256	187	9,456	195	126
B Large Public	11,500	71	1,140	218	7,457	162	53
C Large Public	13,000	46	785	150	9,141	293	87
D Large Public	9,600	55	971	203	8,939	175	47
E Small Private	2,200	16	304	53	1,591	138	42
F Small Private	2,100	22	407	79	2,571	95	27

Table 4. CLASS LABORATORY MEETING TIMES

Class Laboratory Meeting Days	Campus A		Campus B	
	Total Courses	Percent	Total Courses	Percent
Monday Only	41	7.2%	29	14.4%
Monday-Tuesday-Wednesday-Thursday-Friday	7	1.2	--	--
Monday-Wednesday	57	10.0	2	1.0
Monday-Wednesday-Friday	66	11.6	1	0.5
Monday-Friday	6	1.0	--	--
Tuesday Only	82	14.4	52	25.8
Tuesday-Wednesday-Thursday	2	0.4	--	--
Tuesday-Thursday	136	23.7	14	7.0
Wednesday Only	72	12.6	49	24.4
Wednesday-Friday	2	0.4	--	--
Thursday Only	81	14.2	47	23.4
Friday Only	19	3.3	7	3.5
TOTAL	571	100.0%	201	100.0%

Source: *Ira Fink and Associates, Inc.*

important to note that not only is Tuesday the busiest class laboratory day at this campus, but it is also the busiest classroom instruction day as well.

While classroom enrollment on Friday was about 70 percent of the peak Tuesday enrollment, class laboratory enrollment on Friday was less than 45 percent of Tuesday. One reason is that for some class laboratories, instruction is not offered on Fridays, as the day is set aside to take down and set up experiments.

Class Laboratory Use and Utilization

Utilization Analysis for Class Laboratories

One of the more contentious issues in higher education facility planning is the concept of measuring class laboratory

Table 5. AVERAGE ENROLLMENT BY DAY OF THE WEEK

Day	Class Laboratories		Classrooms	
	Courses	Enrollments	Courses	Enrollments
Monday	177	3,094	903	26,458
Tuesday	227	3,807	948	29,032
Wednesday	206	3,654	941	27,318
Thursday	226	3,759	926	28,060
Friday	100	1,682	603	20,015

Source: *Ira Fink and Associates, Inc.*

utilization. An excellent discussion of the development and evaluation of institutional utilization criteria for classrooms and class laboratories, including critical comments on utilization guidelines, is in Manual Two of the WICHE *Higher Education Facilities Planning and Management Manuals*.³ The authors note that utilization studies suffer from serious deficiencies in research design, including, for example, issues of one size fits all, too narrow of a focus, the use of overall averages, oversimplification of summary data, and lack of insight into total institutional resources. What has occurred in utilization guidelines is that a method for forecasting the needed amount of class laboratory or classroom space has been inverted to become a utilization guideline.

To emphasize the point of the deficiencies of these analyses, and for purposes for this article, daytime class laboratory utilization is presented for two campuses where we have recently conducted use and utilization studies. These studies were based on a 45-hour class week (8 a.m. to 5 p.m.), with 50 percent room use rate, which is an indication of the percent of time a room is used each week. The station occupancy rate—the percent of stations or seats in use—is pegged at 80 percent for class laboratories. These are guidelines that are generally used for estimating the amount of space needed in biological science, business, education, languages, law, mathematics, physical science, psychology, and social science class laborato-

Table 6. CLASSROOM AND CLASS LABORATORY UTILIZATION FACTORS, USED FOR FORECASTING SPACE NEEDS

Room Type	Hours Available	Hours Utilized	% Hours Utilized	% Stations Occupied
Classrooms	45 hours/week	30 hours/week	66.7 percent	60.0 percent
Class Labs ^a	45 hours/week	22.5 hours/week	50.0 percent	80.0 percent
Class Labs ^b	45 hours/week	11.25 hrs/week	25 percent	80.0 percent
a: Biological Science, Business, Education, Language, Law, Mathematics, Physical Science, Psychology and Social Science Class Laboratories b: Engineering, Health Professions, Agriculture Class Laboratories				
Source: Space Planning Guidelines. Columbus, Ohio: Council of Educational Facility Planners, Int'l, 1985, pp. 5-12.				

ries. In the two example campuses, the calculated use of reported class laboratories was 58.3 percent at one campus and 52.8 percent at the second. Class laboratory utilization was 54.5 percent and 51.7 percent respectively.

The Council of Educational Facility Planners in its *Space Planning Guidelines* (1985),⁴ suggests an alternative guideline of a 25 percent class laboratory use factor (11.25 hours per week) for forecasting class laboratory space needs in engineering, the health professions, and agriculture, because these disciplines are likely to require a wider variety of laboratory types. Table 6 summarizes typical classroom and class laboratory guideline factors used in higher education.

Class Laboratory Utilization

To determine the degree to which class laboratory use and utilization is actually measured on campuses, we recently polled 30 universities as part of a classroom use and utilization study. We obtained data from 11 campuses, with nine campuses reporting in a comparable method. We assumed the 19 campuses that did not respond did not have data on their class laboratory use and utilization.

The information obtained from the nine campuses is reported in Table 7. The data show a pattern of low use and utilization of class laboratory space. Among the institutions where information was available, five reported class laboratory use in the range of 20 to 35 percent, three in the range of 60 percent. Class laboratory utilization at the five institutions where data was available ranged from 32 percent to 84 percent. As Table 7 illustrates, one campus based their class laboratory utilization on a 30-hour week, five did so on a 45-hour week, one on a class week of 50 hours, and at two of these institutions the data was based on a 70-hour week.

It is difficult to gauge the significance of information on class laboratory utilization, because the data is usually an average taken across all class laboratories on a campus and because the requirements concerning the class week vary so widely. For campuses that conduct such studies, the utilization results should not be an end in themselves. Rather, the data can be used as part of an analysis to help identify the circumstances that control the amount and level of class laboratory use. If it is possible to consolidate or better schedule the class laboratories, a campus may gain better efficiencies or reclaim unused class laboratories for other uses.

It is important to use the utilization analysis process to identify class laboratories that are little used. They may be consolidated for use with another similar laboratory. It is also important to identify class laboratories that have no regular or formal scheduled use and can be reclaimed into the space inventory for reassignment and reuse.

Approaches To Improving Class Laboratory Use and Utilization

New Approaches

This article has concentrated on the importance of class laboratories, their spatial characteristics, and their reported low use and utilization. Problems in this area are being

Table 7. SUMMARY OF COMPARATIVE CAMPUS BENCHMARK DATA

University	Classroom		Class Lab		Class Week Time Period	Year/Term
	Use %	Util %	Use %	Util %		
A	63% - 71%		30% - 42%		50-hour week	2001-02
B	32.5%		21.1%		45-hour week	Fall 2001
C	34.6%	59.6%		71.5%	30-hour week	2001-02
D	86.0%	60.0%	57.0%	31.8%	45-hour week	Fall 2001
E	60.7%		61.6%		45-hour week	2001-02
F	57.1%	65.0%	34.3%	67.0%	70-hour week	Fall 2002
G	58.6%	72.0%	34.3%	84.0%	70-hour week	Fall 2002
H	83.6%		29% - 51%		45-hour week	Fall 2002
I	74.2%	85.4%	58.3%	54.5%	45-hour week	Fall 2001

Source: Ira Fink and Associates, Inc.

addressed by many campuses. Some, with aging facilities, build new replacement class laboratories or install new casework and equipment; others incorporate new instructional approaches or look for alternative solutions; some do nothing.

One change that is occurring is the use of computer simulation for hands-on experimentation. An example is the Studio Physics program at Rensselaer Polytechnic Institute (RPI). The traditional experimental "wet" physics class laboratory at RPI has given way to physics instruction in which students are paired at a computer workstation and experiments performed through course designed computer software. At the University of Iowa, undergraduate chemistry class laboratories are taught in a laboratory-studio system: during one week, one-half of the students conduct experiments in chemistry class wet laboratories; in the alternate week they are in a computer classroom working on case studies. With the two groups of students trading places each week, the campus has been able to match its class laboratory resources to its instructional demand.

Other changes in the methods of instructional delivery are occurring. Some of these changes have resulted in the repackaging of course sequences among lecture, demonstration, experiment, and recitation. These changes are being reflected in laboratory courses which occur only one day per week rather than two or three. These changes may eventually result

in reductions in station sizes and in the number of rooms by discipline.

Specialized Class Lab Furniture and Equipment

One concern in developing or redeveloping class laboratories, particularly in the sciences, is the cost. In addition to the investment in movable analytical equipment used in laboratories, there is the cost for casework (benches, counters, cabinets) and fixed equipment such as fume hoods.

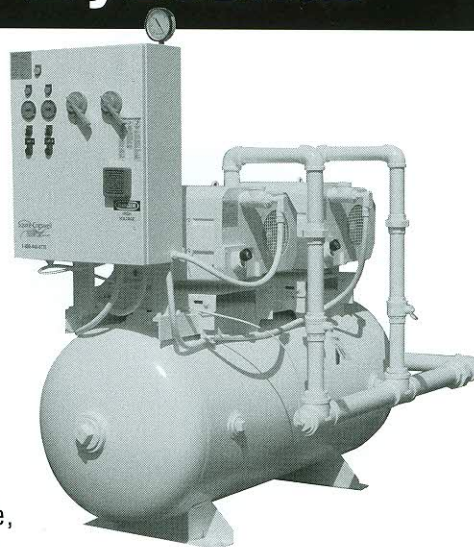
Finding data to estimate the cost of laboratory furniture and equipment is difficult. To provide an understanding of what campuses can face in renovation or new construction, listed in Table 8 are current costs for fixed casework and installed fixed equipment for various science teaching and research laboratories being constructed in California.

At the top of the cost scale are organic chemistry class laboratories. The estimated cost for fixed casework and installed fixed equipment alone, including hoods, could average about \$120 per square foot of laboratory area. The cost for installation of fixed casework and installed fixed equipment for other teaching and research laboratories shown in the table are less costly, and vary by, and within, a discipline. In biology, for example, there is less spread between the cost of biology class laboratories and research laboratories. Other science class laboratories, as well as all non-science class laboratories, would

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Table 8. COST OF FIXED CASEWORK AND FIXED EQUIPMENT, PER SQUARE FOOT OF LABORATORY AREA, CALIFORNIA COLLEGES AND UNIVERSITIES

Type of Laboratory Space	Average Cost per Square Foot of Laboratory Area for Fixed Casework and Installed Fixed Equipment
Organic Chemistry Teaching Laboratories	\$120
Organic Chemistry Research Laboratories	\$110
Inorganic Chemistry Teaching Laboratories	\$110
Inorganic Chemistry Research Laboratories	\$100
Molecular Biology Research Laboratories	\$75 to \$100
Physics Research Laboratories	\$60 to \$90
Source: Davis Langdon Adamson, Cost Consultants, Santa Monica, California, 2003	

fall below these ranges. For example, autoclaves can have a large impact on cost—since it is easy in biology laboratories to spend \$100,000 on an autoclave, with some costing well over \$250,000. This alone could add \$5 per square foot of laboratory area for each autoclave.

The Future Challenge

To review the use and utilization of class laboratories on a campuses, three steps are needed:

First, match the facilities room inventory database of class laboratories with the registrar's record of regularly and formally scheduled class labs and identify any rooms that have not been scheduled for use.

Second, analyze class laboratory use and utilization to identify any sparsely used laboratories, and single these out for additional analysis.

Third, from these steps identify and document the class laboratories that have little or no use—too little demand, too much capacity, outdated equipment or obsolete space that no one wants to use.

Based on this information, decide how to proceed: revise or consolidate the laboratory portion of the course to better manage the space; provide physical improvements to the space to encourage and promote better use of the room; or, remove the space from departmental use and reassign it for another higher priority need.

Since the management of class laboratories is an area that doesn't receive much attention, the action of conducting a space use analysis may result in developing an inventory of class laboratories that are better used. Generally, low room use or utilization does not result in a change in assigned room use until there is a competing demand for the space. Follow-

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ing the above process will make the campus proactive, and can save the institution considerable capital funds.

If the result of the study and analysis is a need to reconfigure or renovate the class laboratories, be deliberate. Carefully program and size the number of stations in all class laboratories. Match the room capacity to the section size used in the academic instruction program and the span of control for purposes of instruction and of safety. If the typical section size for hands-on laboratory work is 16 to 20 students, there is likely no need to build 28-station class laboratories, with the expectation that enrollments may change dramatically.

If the class laboratory is for advanced, rather than entry-level course work, remain cautious about building and outfitting rooms that have station capacity above the level of demand as measured by majors, course offerings, and degree requirements. Analyze carefully the instructional demand for all laboratories—new, renovated, and remaining—and simulate the instructional pattern both before and after improvements to be assured the need for even one more class laboratory is justified.

Recognize the total project cost of adding class laboratory space. These costs could be \$150 to \$200 dollars per gross square foot for construction, plus laboratory casework and equipment, plus soft costs (fees, contingency, inspection, movable equipment) all added together to account for total project costs.

If the need to construct new space or renovate existing space is confirmed, then build the class laboratory or laboratories, so they too will be touted by the departments and become a calling cards for the campus. They may have to serve the campus and its students for a generation or more. 🏛️

Endnotes

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3. WICHE. *Higher Education Facilities Planning and Management Manuals. Manual Two: Classroom and Class Laboratory Facilities*. Boulder, Colorado: Planning and Management Systems Division, Western Interstate Commission on Higher Education, May 1971. For a thorough discussion read pages 139 through 154 on "The Development and Evaluation of Institutional Utilization Criteria for Classrooms and Class Laboratories."
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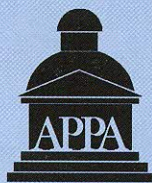
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