New Approaches to Managing, Marketing, and Money for Maintaining a Core Facility (4M's)

MSA Facility Operation and Management Focused Interest Group workshop (2006) Organized and facilitated by:
Debby Sherman
Purdue University dsherman@purdue.edu

Developing a Financial Plan for the Long-term "Care and Feeding" of Major Equipment.

Alberto Rodriguez and Charlene Sullivan
Krannert School of Management, Purdue University

1. Introduction

Effective life cycle cost (LCC) management for electron microscope (EM) facilities at Purdue University and in other academic institutions is a complex process. Ideally, it should aim at controlling the cost of ownership of EMs while maximizing the output of the technology and utilization of resources. It could be argued that the current focus of the majority of EM facilities has been one that seeks to obtain the latest technology. However the growing sophistication of the equipment causes more indirect costs including labor, maintenance, and ancillary equipment needed to optimize the output of the base equipment. These costs can easily exceed the purchase price of the equipment over the life of the equipment.

To add to the problem of mounting costs of operation, as the instrument becomes older and newer technologies are acquired, the revenue stream generated from user fees for older equipment dwindles and could fall below the amount required to cover labor and maintenance costs. This hints at the importance of having a coherent University wide purchase policy that allows institutions to acquire the equipment needed but that also incorporates in the purchase decision the cost of ownership of the equipment. In other words, an optimal portfolio of equipment and the optimal replacement cycle should be determined at the institution level. This means that a facility that acquires EMs should keep it for a period of time such that it is replaced by a newer piece when its marginal revenue equals its marginal operating cost.

This approach would require knowledge of the user demand characteristics and have a clear understanding of both the institution's purchase horizon policy and the effect of such purchases on user demand for existing instruments. To a large extent, none of these issues are tracked or studied thoroughly by facilities managers.

Management and planning techniques such as optimum replacement cycle, pricing strategies, consolidation, web-based planning and intra-facility communication are investigated in this document as potentially effective ways to cope with some of the challenges EM facilities face.

2. Operation and Structure

An electron microscopy center is a highly specialized and technical facility. In the majority of cases facilities have specialized technicians who assist users with their work.

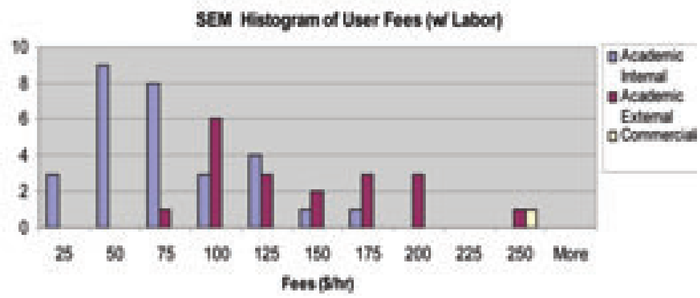
2.1 User Base

There are two types of users: internal users and external users. Based on a survey of 16 institutions, internal users receive an average subsidy level of 55% of labor costs.

Both internal and external users, based on their expertise with the equipment, can be further classified as either dependent users, those who require technician assistance to conduct their work, or independent users, those that require no assistance. Based on a survey of fifteen institutions members of Microscopy Society of America (MSA), users are split almost evenly between independent and dependent users.

2.2 Fee Schedule

The fees schedules of 36 institutions were compiled and studied. 30 data points were used to map the distribution of fees for internal users. About 20 data points were used to map the distribution of fees for external dependent users. Figure 1 shows the frequency distribution of fees for users of TEMs in academic and commercial settings.



The median fee for internal and external users in academic organizations was $65 and $150, respectively. One data point was obtained from a commercial lab. The user rate there was $230 for instrument time and labor. As can be seen from the figure, in the range of $100 to $175 the internal and external user fees overlap. This means that the lack of pricing uniformity for external users provides opportunities for external users to benefit from paying lower fees than they would otherwise have to pay.

2.3 Cost Structure

A survey on member institutions of the Microscopy Society of America was undertaken to determine the average cost structure of an EM facility. Based on 21 respondents, the cost structure presented in Table 1 was obtained.

TABLE 1

Cost Statement (percentage of total cost)	
Direct Cost	
Labor	52%
Overhead	
Maintenance Contracts	27%
Equipment and Materials	21%
Total Cost	100%
Does not include overhead from School	

It can be seen from the above table that the largest cost driver is labor. School overhead varies from institution to institution and represents the cost of space, utilities, administrative time, etc.

2.3 Breakeven Capacity

It is paramount from an effective EM facility management

perspective to be able to determine with some degree of precision the facility's breakeven capacity (BEC), defined as the utilization at which the facility can cover its overhead and labor costs. For instance, a hypothetical unsubsidized facility consisting of 4 EMs, 2 technicians, operating 8/5 (#hours a days/ days a week), and charging $33/hr per labor and $18/hr per equipment use, can expect to require a utilization of close to 52% to breakeven. The importance in determining BEC, lies in the fact that variations from BEC can result in large deficits or relatively smaller surpluses. These effects for this hypothetical facility are shown in Figure 2.

FIGURE 2

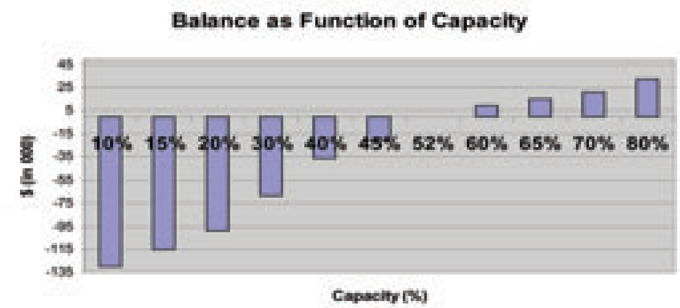


Figure 2 shows the magnitude of changes in deficits and surpluses that result from changes in capacity in a hypothetical facility with 4 EMs and 2 technicians. It can be observed that for the same magnitude of change from BEC (around 52%) a larger magnitude of change results in deficits compared with that in surpluses. This effect can be explained by considering that the major costs of a EM facility is labor. Therefore, at a capacity of about 20% less than the BEC, the utilization of technicians is much smaller than anticipated and the revenue to cover their salaries is not enough, resulting in deficit of about $65,000. Conversaly, a 20% higher utilization capacity than BEC, would allow the facility to increase the utilization of instruments (beam time is in general lower than labor rates), resulting in a surplus of about $20,000, a much smaller number in magnitude than the deficit obtained by a fall in capacity of the same proportion.

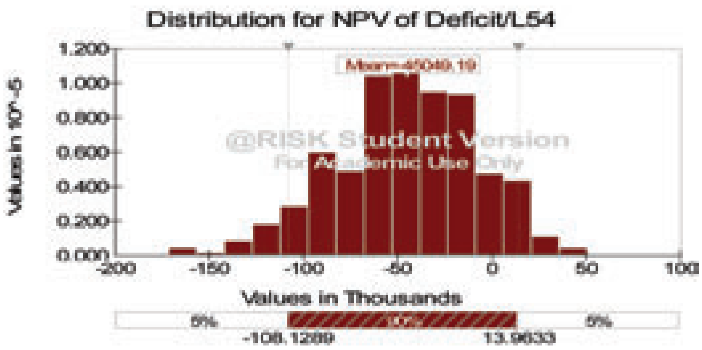
2.3.1 Simulation Scenarios

2.3.1.1 Base Case – No subsidy

A simulation model was built around the facility described previously with the difference that the model encompasses a ten-year period during which capacity was assumed to fluctuate every year according to a triangular distribution with values (35%,50%,70%). Each year's end balance (See Table 2) was discounted to the present using a rate equal to the risk free rate or 5%. The model uses @Risk software to create a Monte Carlo simulation technique.

The second row from the top of Table 2 shows the values chosen at random by the software from the triangular distribution of the capacity. Towards the bottom the table it can be seen that year end balances are calculated from each year, cumulative balances, and finally the net present value (NPV) of the year end balances for the 10-year period. It is important to recognize that the presented output corresponds only to a single scenario and thus it does not represent the expected value of the simulation. The expected NPV value for the simulation is presented in Figure 3.

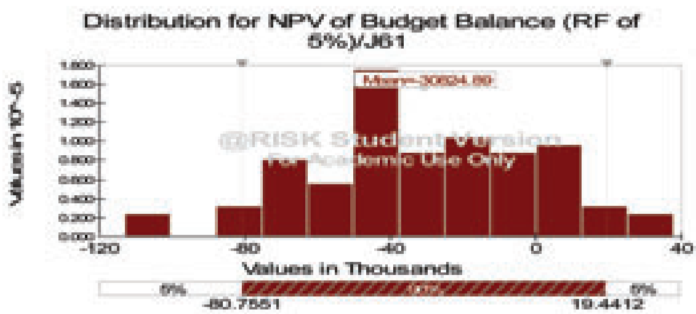
FIGURE 3



It can be seen that the expected NPV of deficit is $45,000. Also there is a 5% chance of experiencing an NPV loss of $108,000.

2.3.1.2 Subsidized Facility

FIGURE 4



If the facility in question were to have a subsidy that approximates a random triangular distribution of (0%,30%,50%) while its capacity can fluctuate as described previously, the expected NPV of the deficit would be $30,824. This smaller expected deficit is a result of the proactive subsidy level approach. Embedded in the simulation model is a % user increase per % rate reduction relationship that attempts to model the behavior of users as rates decline due to subsidies. In other words, the model assumes that lower rates due to subsidies will result in a larger pool of users with the result of increased net revenue. Figure 4 shows the resulting distribution and expected value of the net present value of deficits.

The net present value of the subsidy received during the 10 years by the facility was $227,000.

TABLE 2

INCOME STATEMENT - CHANGING SCENARIOS

Year	1	2	3	4	5	6	7	8	9	10
Actual Capacity	41%	54%	50%	41%	52%	45%	62%	64%	56%	55%
Revenue										
Set up	30,881	35,525	34,089	33,884	35,525	35,525	35,525	35,525	35,525	35,525
Internal	54,131	62,676	60,143	59,429	62,676	62,676	62,676	62,676	62,676	62,676
External	2,849	3,299	3,161	3,128	3,299	3,299	3,299	3,299	3,299	3,299
	87,661	101,500	97,397	96,241	101,500	101,500	101,500	101,500	101,500	101,500
Beam time (no labor)										
Internal	49,237	59,830	54,705	54,256	57,849	71,261	68,629	70,285	61,437	60,439
External	2,591	3,149	2,879	2,845	3,045	3,751	3,612	3,489	3,234	3,181
	51,828	62,979	57,584	56,901	60,893	75,011	72,241	73,774	64,670	63,620
Consumables	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000
	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000
	169,489	194,479	184,981	183,141	192,393	206,511	203,741	205,274	196,170	195,120
Costs										
Total ID tech labor	101,500	101,500	101,500	101,500	101,500	101,500	101,500	101,500	101,500	101,500
Overhead										
M administration	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000
M stock/and Equipment	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Total Cost	191,500	191,500	191,500	191,500	191,500	191,500	191,500	191,500	191,500	191,500
Year end Balance	($22,011)	$2,979	($6,519)	($8,359)	$893	$15,011	$12,241	$13,774	$4,670	$3,620
Cummulative Balance	($22,011)	($19,032)	($25,551)	($33,910)	($33,016)	($18,005)	($5,764)	$8,010	$12,680	$14,300
NPV of School adjustment (RF of 5%)	$4,388									

https://doi.org/10.1017/S1551929500055723 Published online by Cambridge University Press

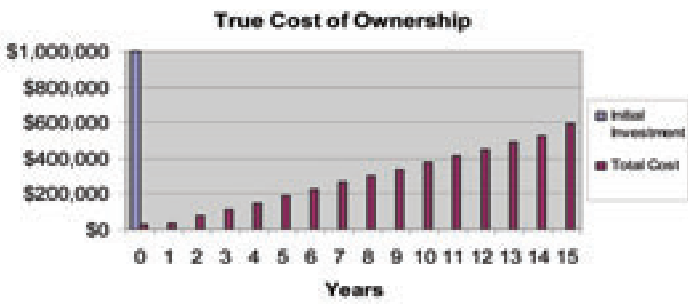
3. Effective Management

3.1 True Cost of Ownership

It could be argued that so far the focus of EM acquisition decisions has been on the purchase price of the equipment, disregarding almost completely the mounting lifetime costs of maintenance and general overhead.

For instance, Figure 5 shows the total cost of ownership of a $1,000,000 EM.

FIGURE 5



The above figure shows the cumulative overhead cost of operating a $1M EM (excluding depreciation) can represent approximately 60% of the purchase price by the 15th year of operation in an unmanned facility.

Furthermore, as the instrument becomes older and newer instruments are acquired, users of the older technology migrate towards the newest technology reducing the revenue inflow for the older equipment and making the facility run a deficit. This problem points to the need to determine the optimal replacement cycle for EMs. The optimal replacement cycle would be approximately the period of time after which the marginal cost of operating a piece of equipment exceeds the marginal revenue it generates. Figure 6 depicts this relationship.

FIGURE 6

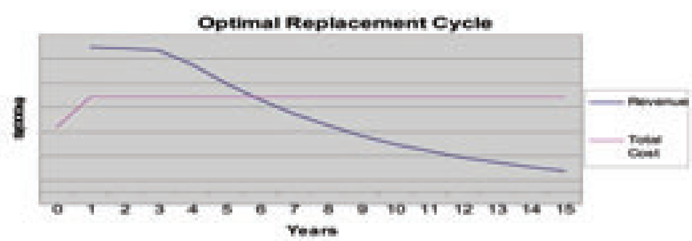


Figure 6 shows that by year 6, the equipment cannot generate enough annual revenue to cover its annual costs of operation. The downward pattern of the revenue curve could be easily accelerated by the purchase of a newer and functionally comparable instrument that promotes the migration of users from the old to the new technology.

3.2 Newer Equipment Charge Policy

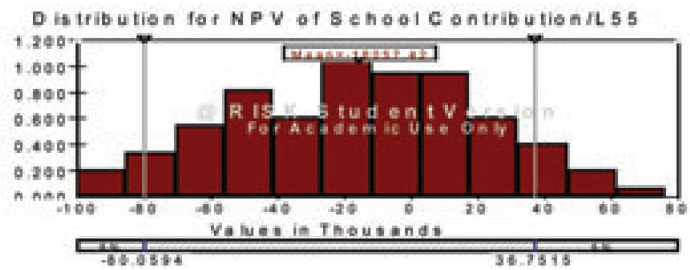
New skills have to be developed to operate more sophisticated instrumentation. Schools need to invest in keeping their lab techs up to date with newer instruments. In order to recover training costs and considering the complexity of operation of newer technologies, users of newer instruments should be charged a premium over the regular fee for the first couple of years of operation until technology becomes standard. Proceeds from these fees could be used to create a fund to cover future maintenance costs. Therefore,

https://doi.org/10.1017/S1551929500055723 Published online by Cambridge University Press

built into this recommendation is the ability of EM facilities to roll-over surpluses in accounts from year to year, a practice not currently allowed by many Schools.

In a simulation of a fee schedule that allows for a premium to be charged to users for the first three years starting at 15% and then declining to 14%, and 2% for the second and third years, respectively, the NPV of the expected deficit for our base case facility declines to $ 16,000. This is a deficit reduction of $27,000 compared to the non-charge policy base case scenario (deficit of $45K). Figure 7 shows the expected NPV of the deficit.

FIGURE 7



3.3 Consolidation

Some of the benefits of consolidating separate facilities into a single facility are:

- Central Planning
- Planning horizons that accommodate needs of EM center.
- More effective coordination and scheduling.
- Reduction in overhead costs and duplicity of efforts.
- Greater negotiating power with vendors.

For instance, let's assume that there are four facilities whose operating characteristics are the ones shown in Table 3. At the bottom of the table there are the operating characteristics of the consolidated facility.

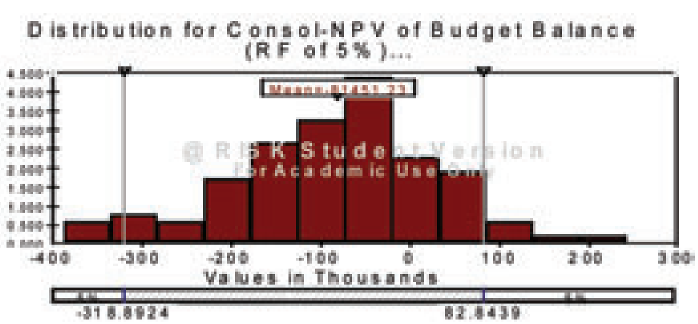
TABLE 3

TABLE 3
Operating Characteristics of Unconsolidated vs Consolidated Facility

Facility	*#Admin	#EMs	# Techs	EM Capacity (%)	**Overhead Rate ($/hr)
1	1.0	4	2	52	1.08
2	1.0	3	1	35	1.23
3	1.0	8	2	26	0.85
4	1.0	3	0	35	0.93
Consolidated	1-1.0	18	5	29	0.78

Table 3 shows that the consolidated facility due to its larger size requires three times the administrative time relative to the other facilities. However, its overhead cost (as dollar amount per practical capacity) is the lowest of all facilities including that of facility 4 which has no personnel. The results of the simulation for this consolidated facility are presented in Figure 8.

FIGURE 8



The NPV of the deficit is $81,451, which is the largest for any of the scenarios shown so far but the magnitude of the deficit is only twice as large as the base case ($43,000) for a much larger facility. Also, the NPV of the savings obtained through reduction of fixed costs is $92,000.

Of course, consolidation, at this degree at least, implies capital investment for the construction of a new building. Interestingly enough, some institutions, two of them being Rice University and University of Florida have adopted this approach. The University of Florida reports a considerable reduction in overhead costs resulting from consolidation

3.4 Scheduling and Planning

There is a current trend in user scheduling to move from traditional to web-based systems. In the former, users had to typically reserve instruments for specific periods of time by either calling lab managers or by using log sheets. Web-based systems allow users themselves to sign up for the instrument time they need at any time that is convenient for them. In addition they can see other available times and use of the instruments by other people and so they can plan more efficiently for future usage. Another big advantage of web-based versus traditional systems lies in the fact that web-based systems can log user demand and provide facility managers with an insight into the demand pattern. This should help them plan more effectively their facilities' utilization forecasts.

3.5 Specialized Technician

The idea behind having a specialized technician maintain some of a facility's equipment bears validity only if the technician's cost is less than the cost that the facility would otherwise have to pay to vendors for external maintenance. With enough older equipment in a facility and with those instruments' technologies already in the mainstream it is possible to obtain savings by employing a technician of that sort. However, with replacement cycles becoming shorter and with newer technologies hardly being common knowledge but to vendors' own technicians, the worth of having a technical expert will become even more questionable in the future.

3.6 Marketing

EM facility managers have to be aware that they are subject to many of the same market forces that affect many of their counterparts in public and private companies. They should assess the value proposition of their services and from that stand point attempt effective pricing strategies. For instance, bundling of services could be marketed. This approach would provide hours of both labor and instrument time for a given price. Users buying packages of bundled services could help reduce uncertainty in forecasting and planning—the earlier they commit the less uncertainty in the planning stage. Discount pricing could be used to incentive early user coommitment. Also, lower rates should be offered during lower utilization times as a way to help fill capacity. ■

Acknowledgement:

The authors would like to thank the many Directors and Managers of Microscopy Facilities who shared information about their facilities that served as the basis for this report.