

Survey of University Micro/Nanotechnology Cleanroom Facilities as the First Phase in the Development of a UofL Business Model

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INTRODUCTION

Approximately ten years ago, the University of Louisville made a serious research commitment in the emerging fields of micro/nano/biotechnology by allocating funds towards the construction of an effective, but relatively-small, state-of-the-art, class 100 cleanroom. In 1997 that facility (the Lutz MicroTechnology Cleanroom) was unveiled, placing UofL in the select group of US academic institutions with such facilities and the only university in the state of Kentucky with a cleanroom for general micro/nano-fabrication research and educational training. With the addition of new faculty in recent years and with the unprecedented success of those faculty, the university effectively outgrew the original 1,500 square foot cleanroom facility. To address this critical need, the University committed state funds to the construction of a new state-of-the-art \$50M 120,000 sq. ft. Belknap Campus Research Building (the BRB as shown in Fig. 1) which houses a greatly-expanded, true multi-user cleanroom “core facility” to support our escalating research/educational programs in micro/nano/biotechnology.

The April 2006 grand opening of the BRB launched a new era of micro/nano/biotechnology research at the University of Louisville. The 120,000 square foot research building is a unique design in that it intentionally combines complementary and coordinated interdisciplinary micro/nano/bio research efforts from both the School of Engineering (ECE, ME, BE and ChE) and the College of Arts and Science (Chemistry, Physics and Biology). The showcase facility in the BRB is the centrally-located 8,000 sq. ft. core cleanroom positioned on the ground floor (see Fig. 2). Designed by nationally-renown AGI of Phoenix AZ, the large class 100/1000 facility should place UofL among the top universities in the nation in terms of cleanroom size and capacity. The \$8.5M micro-manufacturing facility houses a cadre of state-of-the-art processing equipment for prototyping next generation micro and nano-devices for applications such as microelectronics, homeland security, optoelectronics, biotechnology, sensing, MEMS and nanotechnology. Open to both academic and outside industrial users, the BRB cleanroom promises to enhance the University’s visibility and research productivity in the micro/nano fields for many years to come.

RATIONALE FOR “PHASE 1”

As a first phase in the development of a business model for the operation of our new cleanroom facility, colleagues from the UofL Business School teamed with colleagues from the Engineering School to design and conduct a survey among 20-some universities with comparable cleanroom facilities ranging in size from 2,020 sq. ft. to 25,000 sq. ft. (average = 9,026 sq. ft.). Operational metrics included: size, certification (class 10, 100, 1000), personnel (full-time, part-time), number of users (internal faculty, internal students, external industry, external industry, departments), number of projects, areas of concentration, user fee structure, and teaching. Budgetary metrics included: revenues (internal users, external users, university subsidy, state subsidy, other), expenses (salaries/benefits, supplies/expenses, maintenance/repairs/replacement, and other), and value of equipment. The findings were then normalized for our new 8,000 sq. ft. cleanroom to provide a foundation for the development of a specific business plan for our facility, which will be the focus of “phase two” of our business model development plan.

AREAS OF ANALYSIS

In order to capture data that would be relevant to a business model, a short list of questions were generated that would produce a general understanding of each center’s operations (see Appendix A). The 13 questions (or metrics) were categorized into two basic areas of analysis: budgetary and operational. Budgetary questions focused on revenues, mix of users, subsidies, expenses, and value of equipment. Operation questions targeted cleanroom size, cleanliness, staffing, number of users, number of projects, areas of concentration, user fee structure, and use for formal academic classes. In summary, the main objectives of this survey were to determine how these other facilities operated, generated revenue and balanced those revenues with expenses.

METHODOLOGIES

A list of approximately 30 universities with cleanroom facilities was identified and subsequently contacted by email and/or telephone for participation in the survey. Not all facilities were willing or able to share their budgetary information, and some were either too busy or unwilling to provide us with any data at all. In the end, the team gathered information from 20 of the 25 centers contacted and in some cases, only the totals were available (i.e., total revenues, total expenses, total users). Only 2 of the 20 facilities produced public annual reports from which our data/statistics could be extracted. The remaining facilities needed to be contacted individually by email and/or telephone, a very time-consuming and laborious task. We agreed to share the data/findings directly with all those that participated in the cleanroom survey, and also agreed that the participants would remain anonymous in any publicly-disseminated documents/papers resulting from the survey.

RESULTS

From these data, a set of ranges and averages for each data point was developed to build a descriptive understanding of the metrics. In addition, the Spearman Rank Correlation Coefficient formula was used to see if relationships existed, or if any pairs of variables were strongly correlated among the data. The results of this analysis guided our

recommendations. Appendix B provides a listing of the data obtained from the 20 participants, including range values, number of data points and averages. The average for total revenues was \$2.18M (n=9 data points), with the minimum being \$600K and the maximum being \$6M. The average for annual expenses was \$2.08M (n=8), with the minimum and maximum the same as for revenues. Another question asked was the approximate value of the equipment in the cleanrooms, a hard number to estimate and highly subjective. The average value was \$42.8M (n=17), with the range being \$10M to \$100M.

The other focus of this study was operational planning. This includes issues such as number of users (and mix between internal and external), size of facility (broken down by class), and number of personnel. How these issues interact would be useful to our analysis. The average total square footage of the cleanrooms in our survey was 9,026 (n=20), with the smallest facility being 2,020 and the largest being 25,000. Nine of the cleanrooms reported having class 10 space, 16 had class 100 space, 15 had class 1,000 space, and one cleanroom reported having class 10,000 space. The number of users, both totals and subcategories, varied greatly from cleanroom to cleanroom. The total average number of users was 180 (n=16 data points), with the fewest users being 27 and the most being 600. The largest group of users was internal students, followed by faculty users, external industry users, and external academic users. On average, there were 11 departments using each cleanroom facility (n=18), with the fewest being 5 and the most being 29. In terms of full-time personnel, the average was 8 (n=18), while the range was 1 to 27. Part-time workers were fewer in number overall, with an average of 2 and a range of 0 to 5 workers.

Other issues that were explored, but not included in our correlation analysis because the answers were too varied, included fee structure, areas of concentration and use of the cleanroom specifically for teaching. User fee structures varied among the cleanrooms, with some charging annual fees, monthly fees, supply fees, and/or equipment fees (by the hour, minute or per use). In most cases, the fees were higher for industry users than for internal users. Since each facility had their own mix and cost structure for fees, it would be useful to view each in the “User Fee Structure” in Appendix B.

CONCLUSIONS AND RECOMMENDATIONS

For budgetary metrics, we determined what relationships existed, if any, among the variables. There were a number of strong, positively correlated pairings ($0.8 \leq R^2 \leq 1.0$), including relationships between total revenues and total expenses, total revenues and total cleanroom space, total revenue and total number of users and total revenues and full-time personnel. We next developed scale factors for these strong, positively-correlated pairings. Based on the scale factors and the size of our new 8,000 sq. ft. multi-user, core facility, the study suggests that \$1.67 million be the target revenue for our facility with predicted expenses of \$1.66 million and a total of 231 users. In addition, since there is a relationship between facility size and full-time personnel, the recommended number of full-time personnel for an 8,000 square foot facility is 10. There was no relationship between size and part-time personnel, so no recommendation is made for this metric. These targets are based upon the historical operations of other academic cleanrooms and

will not necessarily be the same for our new facility. However, they do provide a useful guide for what, on average, an 8,000 square feet cleanroom statistically generates in terms of revenues and expenses, and how many users and full-time personnel it requires.



Fig. 1. University of Louisville’s new \$50M 120,000 sq. ft. Belknap Research Building.

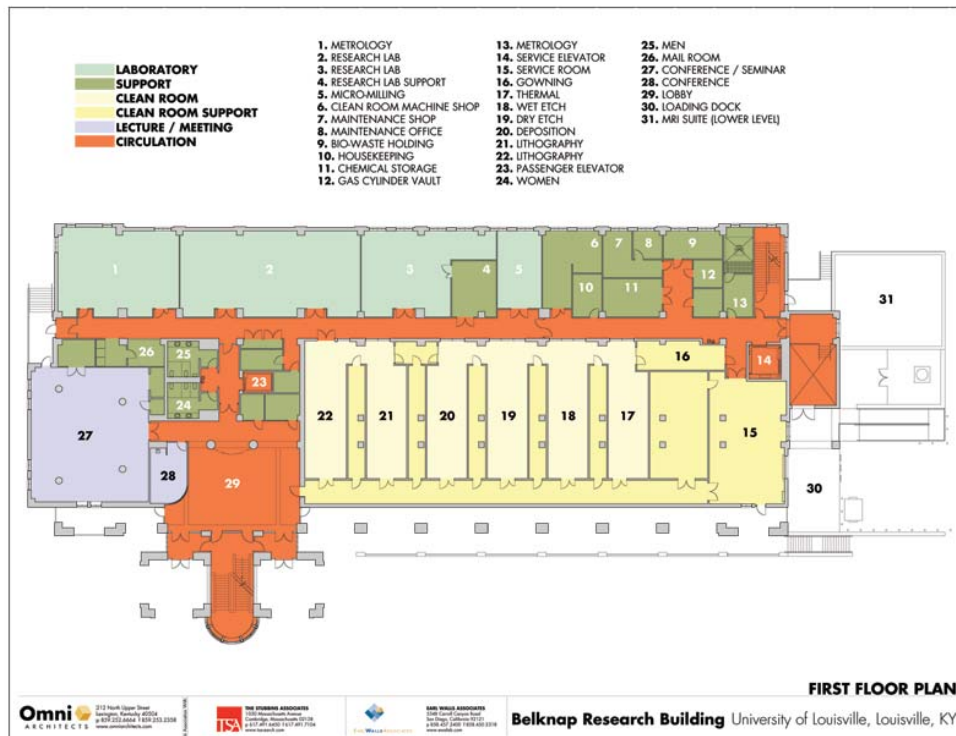


Fig. 2. First floor layout showing the \$8.5M 8,000 sq. ft. cleanroom core facility.

APPENDIX A

Questionnaire

1. What were your total revenues in 2004, broken down by those generated by:
 - a. Internal users
 - b. External academic users
 - c. External industry users
 - d. University subsidy
 - e. State subsidy
 - f. Other (grants, etc.)
2. What were your total expenses in 2004, broken down by:
 - a. Salaries and benefits
 - b. Supplies and expenses
 - c. Maintenance, repairs and/or new equipment
 - d. Other
3. What is the total approximate value of equipment?
4. How many projects did you undertake in 2004?
5. How many square feet of cleanroom space do you have of the following:
 - a. Class 10
 - b. Class 100
 - c. Class 1000
6. Number of fulltime personnel?
7. Number of part-time personnel?
8. How many of the following does your facility have:
 - a. Internal faculty users
 - b. Internal student users
 - c. Departments using facility
 - d. External academic users
 - e. External industry users
9. What is the total number of users that you have?
10. What is your user fee structure?
 - a. Annual "membership" fee
 - b. Monthly user fee
 - c. Per entry fee
 - d. Per day equipment fee
 - e. Per hour equipment fee
 - f. Per minute equipment fee
 - g. Other fee categories
11. Do your internal user fees differ for external users?
12. Does your facility have an area of concentration in which most projects tend to fall?
13. Is the facility used for teaching (and not just as a research facility)?

