OPERATIONS MANAGEMENT AS A LAB SCIENCE

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ABSTRACT

Undergraduate Operations Management (OM) courses are content rich and include elements of both theory and practice. Typically, practice amounts to chapter end homework problems as opposed to case studies often used in graduate programs. In certain higher education settings, especially where students are time constrained and tend to study on their own, it makes sense to add an operations laboratory experience to supplement the theory taught in operations management class. This paper makes a case for developing an OM laboratory and provides suggestions for its implementation.

INTRODUCTION

As a result of traditional practice, we tend to insert computational problems into undergraduate operations classes. In graduate school, we substitute case study writeups for evidence of mastery becoming less dependent on crunching numbers to produce results numeric homework problems and computational test questions are no longer the focus. At the undergraduate level however, we often accept that if a student gets the right numeric answer, they understand. While this can be true, mastery of numeric manipulation may not always convey real understanding.

Operations Management has seen a rapid expansion in scope as new topics are assimilated into the curriculum. Service, supply chain, logistics, and global issues ranging from low cost suppliers to sweat-shop labor, now create new or enlarged areas of focus in the OM curriculum.

This paper will explore increased use of laboratory classes in OM curriculums as a supplement to perations management and management science lecture and theory.

LABORATORY A TEACHING TOOL IN THE SCIENCES

Back in 1985, the editors of Interfaces [1] wrote a note about the impact of the “microcomputer revolution” and the how it was changing the way business school professors, and management scientists were doing business.

Socalled hard sciences have always used laboratories (“labs”) to reinforce student learning. Tapper [2], among others, found that laboratories provide handson learning, reinforce theory taught in class, and increase peertopeer communications Various authors such as Holt [3], Holstein & Lunetta [4] and Tamir [5] have long defended the role of inquiry in the sciences and some, including Sundberg[6] and Germann [7] have argued that openended labs are the best way for students to learn. Ornstein [8] found a more positive attitude towards science when teachers regularly emphasized handson laboratory activities. Outside of operations, Dyer and Schumann [9] discussed an experiential learning method that created a “traditional laboratory experience” for marketing students in 1993. In 1995, Becker and Watts [10] provided a review of the literature on games, simulations, and laboratories in teaching undergraduate economics.

Ultimately, the idea behind traditional science labs is to reinforce textbook driven learning, lecture concepts, and underlying theory. More recently, a few authors like Dinan [11] have analyzed the power of using casebased laboratories similar to the type suggested in this paper. While some students may plod mechanically through the lab steps, better students will actually learn about relationships of variables, see cause and effect at work, and draw inferences from observations. Basey [12] stated that labs however, are not by themselves, the perfect learning tool.

In business, select topics such as operations can use the laboratory model for a variety of improved outcomes. The challenge then is to identify where and when to use operations management labs for maximum impact. What follows is a proposed plan to make laboratory work a required part of the OM curriculum. This paper does not claim to be the first to advocate this marriage; rather it suggests the best academic settings for incorporating a supplemental laboratory education as part of the OM curriculum. This proposal takes on a higher level of significance in those settings where due to financial considerations, students in the program work a significant number of hours off campus and/or often commute to school.

PUBLIC, STATE, AND NONRESEARCH HIGHER EDUCATION SETTINGS

As is typical of many state and nonresearch institutions of higher learning, these colleges are placed in the difficult role of trying to provide an affordable, quality education. Their mission is to serve the needs of the area population and remain accessible to most. Affordability, access, degree offerings, and proximity become key decision variables for most students who are not financially welloff.

THE STUDENTS

Many students come from working class families. Family situations, average family income, per capita income, work ethics, and a variety of other factors impact a student's decision to enter the business program at a public or state college.

In one fairly typical state college business program known to this author, it is estimated that over 86% of upperclass students work and of that group, over 75% work full time (35 hours/week or more). This creates a special situation where once classes end for the day, students leave campus immediately to hold down jobs, an absolute necessity for many who admit that if they didn’t work, they wouldn't be in college. Simply put no job, no college.

If we were to apply the common rule that says a student should spend approximately two hours of homework/preparation for each hour spent in class, this would equate to 5 or 6 hours per week of outside preparation for operations classes alone. Then what about prep time for the other 3 or 4 classes in the student's schedule? Is this study/prep time realistic for students under these conditions? If so, then you may not need to consider the lab concept for operations. However, if you find 5 to 6 hours of prep time per class per week to be a bit unrealistic, a lab approach might make perfect sense.

So how does this affect academics and the learning process? After 25years in the classroom and having taught OM at multiple schools at both the graduate and undergraduate levels, I have observed the following about many public and local state college students.

1. Students do not spend much, if any, additional time on campus, other than for classes.
2. Students tend to leave campus immediately for work. Hours available for outside study get cut short.

3. A very large percent utilize financial aid.
4. Group activities outside of the scheduled class, involving team work, group projects, class trips, and study group activities are hard to pull off.
5. Assigned homework, if done, gets squeezed into what's left over at the end of the day.
6. Homework is often viewed as something to be finished with little regard for learning, a task of accomplishment measured by completion rather than mastery.
7. Given the precious few hours left after class and work, student's will utilize study time on the next day's reading assignment rather than completing assigned computational homework.

OPERATIONS MANAGEMENT AS A LAB

In a way, operations management is not much different from other areas of study. Like many of the sciences, operations management has a theoretical side and a hard science, quantitative side. The more technical aspects of operations management can be found in quantitative formulas and numeric solutions commonly associated with OM topics such as forecasting, lot sizing, location analysis, and SPC.

On the other hand, there are more general, ethical, philosophical, and behavioral issues to be dealt with. A question like "Should our supply chain seek minimal costs through global sourcing even though the workers will not take home what we consider a fair day's wages?" should be left for classroom nonlab discussion. Often, a good and full discussion of the theory and related application through quantitative practice, do not fit into the time frame allotted.

Project Management is a case in point. It is very difficult to fit it into a single 1.25 hour undergraduate operations class, especially if you also try to cover: AOA, AON, crashing, forward/backward passes, finding slack, or the probability that the project will be completed ontime. Project Management has a large piece of theory and several quantitative skill sets associated with it. One possible way around this problem of covering theory and applying theory through quantitative exercises is to address the theory in one place and to defer the computational aspects to a lab setting.

MAKING THE CASE

This paper encourages the reader to strongly consider adding an Operations Management Lab to the required operations curriculum. This should not be considered as a standalone lab; rather it should be adjunct learning, a reinforcing handson experience that supplements the traditional OM lecture while optimizing the educational experience. The lab fills in the gaps and opens the door to experiential learning when used properly.

When we think about an undergraduate biology or chemistry class, we associate a lab session with it. We must do the same for operations. If a college offers operations as a 3 credithour class with about 2.5 to 2.7 actual contact hours per week, there just isn't enough contact time in the normal class to lecture, discuss assigned topics, cover homework or computational problems, and assure that students have a deeper understanding of underlying issues. Our goal should be to develop insight into operations and to provide the students with the ability to apply it practically. This combination provides an advantage that will stay with tomorrow's managers and leaders.

A good example of the power of an operations lab can be found with the wellknown "Beer Game." Although often a graduate labtype exercise, those educators familiar with the Beer Game recognize the value of having students experiment with the beer orders in a stochastic setting. In a lab setting, students

experience the supply chain havoc and understand the bullwhip effect caused by minor variations in demand. The success of this lab experience has proven that lab type experiences in operations carry much more impact than would just a lecture or reading alone.

Couple the previous points with the ubiquitous state of computers today on college campuses, and we have a large part of the required OM lab infrastructure already in place.

THE LAB CONCEPT, THE SET UP

Requirements

What are the requirements, conditions, and goals of the Operations Lab?

- The student body should be a good fit for an operations lab. We are targeting severely timeconstrained students, working students, who at this stage of their life consider higher education a part of their life BUT not necessarily their whole life.

- An operations lab requires no equipment beyond computers and simple OM software that is often provided free with textbook purchases. The lab can be held in a special room, in the same room as the lecture, or in cyberspace where each student or each pair of students are physically removed from each other. This last option, that of the online lab, requires the lab instructor to be a highly interactive member of cyberspace who remains 100% accessible and in instant communication with all class members during the lab sessions.

- The lab must complement the reading and/or lecture. As long as the lecture and lab reinforcement are timed closely together, the lab may follow or in some cases actually precede the lecture. (Example, in teaching people to fly, you traditionally hold a “ground school class” and then reinforce the concepts in an airplane. However, success can also be achieved by putting the student at the controls, having her bank the aircraft wings, see the results, and then talk about what happened when on the ground after the flight is over.)

- The lab must be run by a highly qualified individual. Ideally, it would be the professor giving the classroom lectures. A good and I mean really good, teaching assistant might be able to pull it off but I’d be careful here. We’re after a knowledgeable teacher who is a superior mentor. Instructors must circulate, lead, challenge, be creative, ask questions but seldom fully answer them, be a friend, teacher, and mentor.

- Think of the lab as a form of “guided learning.” The approach is not the simply give them an assignment and “turn ‘em loose” on a problem. In such situations, the students typically ask the teacher for help only when they encounter trouble. We desire a lab instructor who is teaching and guiding the whole time. The Socratic Method works well in the lab. Suggestions to running a good lab include:

    - Prepare a challenging set of lab exercises. Design a high percent of problem sets to be more or less “open ended” questions rather than the typical problems requiring a numeric answer. Try to get students to explain answers in nonnumeric terms that require specificity. In other words, do not accept weak answers like “The line gets longer?” in a queuing theory lab. You’re not after numbers; you’re after proof of understanding. Force students to frame their answers in everyday terms like

"The guy at the back of the line now has 11 people in front of him instead of just 3."

- Bring involvement into the operations lab. Make it fun. For example in the same lab on Queuing Theory, call on students and ask . . .

1. "What happens when Lambda changes from 2.5 arrivals per hour to 5?" or
2. "If you're in one of 3 lines at the bank given lambda and mu parameters, what would a new customer experience if the bank closed one of the 3 teller cages?" and "Is this waiting time now too long?"
    - Now send students out in the hall with their partner (yes, partners are very important for peertopeer learning) and have one stand on one foot for a time equal to the time you would spend in the queue if they closed one of the 3 teller stations. Ask "Is it acceptable?"

- The lab is not just a place to do homework although homework problems have some merit in the lab setting. The lab is much, much more. Lab assignments are specially designed experiments, not something to be solved. The ultimate result is not a number in a box. The desired outcome is insight and knowledge. The lab exercises must be designed so that the student manipulates variables and sees the instantaneous results. There needs to be an "Ah Ha, I see" moment for each student.

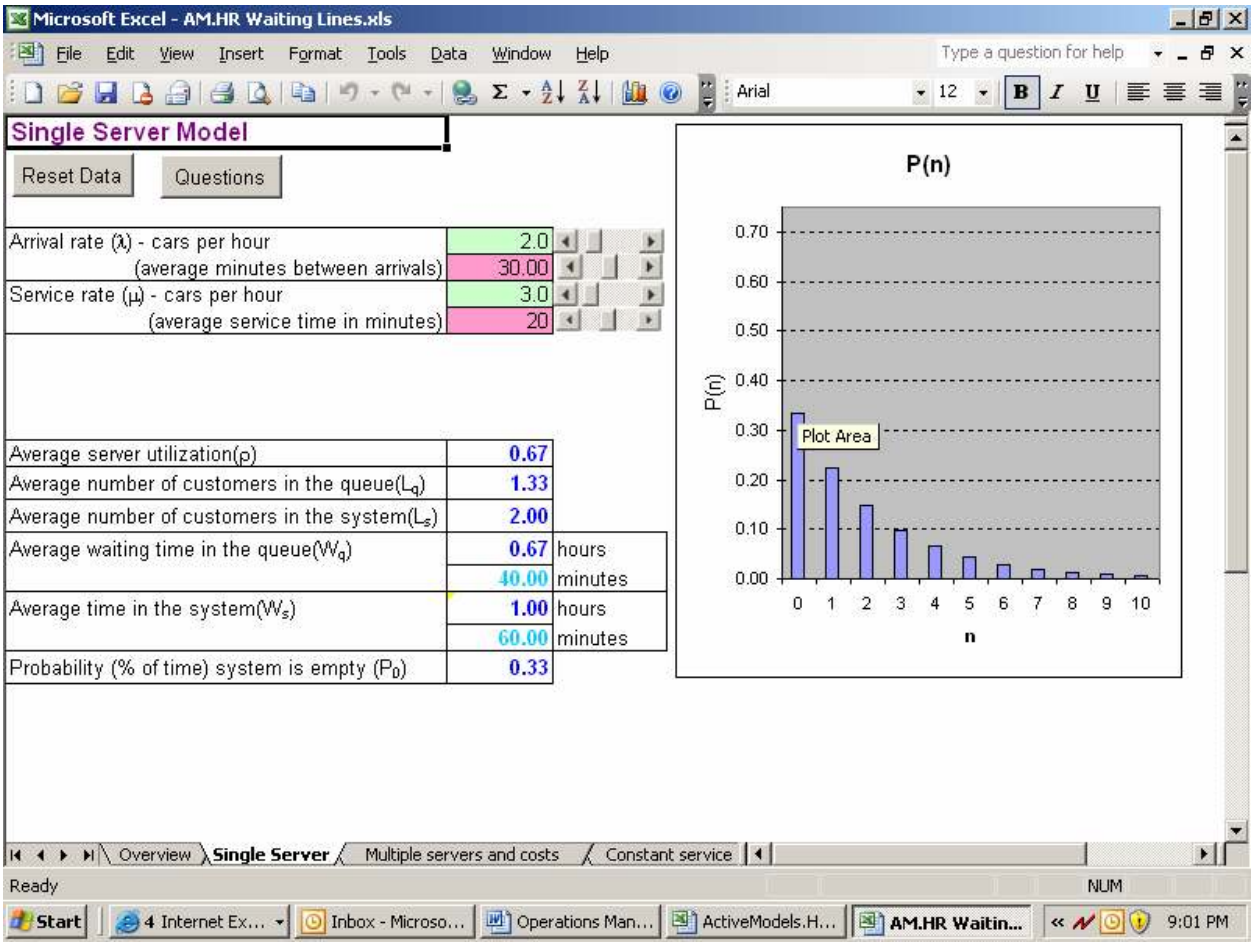
Lab Mechanics

The physical aspects and functioning of the lab are key elements that cannot be taken for granted.

1. The lab must accommodate a limited number of students. Typically, lab sessions are limited in enrollment on purpose. Beyond approximately 20 students, the group size becomes unmanageable. The lab instructor often ends up splitting his or her time with so many individual students that the instructor gets tied up and fails to move the entire lab forward towards the goal. That goal is a full and comprehensive understanding of the associated lecture topic(s).
2. Start each lab with a challenge that can be attempted, examined, and hopefully solved, in the "lab" time allotted.
3. Student partnering may be warranted but may not always be best. Although this can be fraught with danger (i.e., one is dominant, the other just goes along for the ride, or they pick their best friend and get nothing accomplished save for choosing Friday night's happy hour location.), peertopeer learning in this setting can provide excellent results.
4. Ideally, each student should have a computer or at least share one if partnered. Many colleges now require laptops for all incoming freshmen. Another plus is when your entire campus is fully wired for WiFi (802.11B/G) wireless network communications. Such a combination allows a lab like the one proposed here, to be held in virtually any space on campus including outdoors. Almost any room will do and cyber classes online are today a reality.
5. Software: A good piece of interactive OM software is a good place to start. Ideally, the software should not be of the total "black box" variety that takes inputs and just produces a numerical answer. The software should allow for quick and easy inputs and produce numeric and visual outputs that are easy to comprehend. The desired software need not be costly and software often accompanies popular textbooks at little or no additional cost. A case in point is the "Active Models© " software that accompanies the Heizer & Render Operations Management textbook. The Active Models software is built upon Microsoft's Excel©and uses macros. (Note: Excel is part of the Microsoft Office package, which is standard on many campuses today.) The Active Models software contains proform a builtin models for popular OM topics and the results are shown side by side with the input parameters used to produce the results. The key feature of this

software that makes it idea for the Operations Lab is the student's realtime interactive ability to change the parameters and see the instantaneous results. The results can be numeric but are frequently graphic in nature speeding the learning process.

Figure 1 – Active Model Screen Shot



6. The right instructor. This is not a dumping ground for underfinanced teaching assistants or your lowest level lab instructors. If you care about students learning and you want to show them the power and magic of operations management, then make sure you at least rotate your best people into these labs. This is the place real one on one learning and discovery takes place. Don't miss out on the chance. Professors get to know their students and students get to know their professors. Rapport increases greatly.
7. Credit, Hours, Contact Hours – Ideally, a one to one ratio might yield the best results. However, this translates into adding a 3credit hour lab (2.5contact hour lab) onto a student schedule when they sign up for operations. Often in a lab setting, the contact hours exceed the credit hours. An additional 1credit hour lab schedule might be easier to sell on campus and would also be seen as less of a burden on time constrained students. An extra hour a week of actual contact time does wonders for student learning. Some colleges have had success working with computers in class especially where computers are required by the college. This idea blends the lab experience directly into lecture time frame. But if the regular class meeting time is not expanded to allow for interactive in class lab time, we suffer the fate of all zero sum games namely, we've robbed Peter

to pay Paul.

POINTS OF FAILURE

1. Degeneration We must be careful. We can easily allow the operations lab to degenerate into a place where you go to do homework and perhaps get help. Nothing could be farther from the desired outcome. SOLUTION: Consider the OM lab to be thought of as another class taught parallel the OM class. Do not think of the OM lab as a physical place, but rather as a learning place. The teaching staff must be supportive and believe in the value of the OM lab.
2. Student Buy In – There is a danger in calling it a "lab." Some students will immediately draw a parallel to the required biology and chemistry labs. If those labs are not centers of true learning, then the imprint left on the student will be "How can I get the silly lab done and turned in as soon as possible." SOLUTION: Staff the labs with your best teachers. Ideally, the lecture instructor would also be the lab instructor for the same students. In addition, students always balk at taking on more classes or additional work loads. The OM lab can be seen as adding one more class to a student's schedule and it may even have to displace a more desirable class. Today, more and more schools doing away with "lab" word in course names or descriptions for this very reason. Instead, name the lab class "Applied OM", "Interactive OM", "OM skills", or something like that.
3. Faculty Buy In – Some faculty will look at this as adding lowlevel, nonresearch type work to their existing workload. Rather than looking at it as another opportunity to teach, they will see it as babysitting. SOLUTION: Frame and sell the concept properly. Faculty Chairs and Deans must create motivation for getting good faculty into the lab sections. Release time might help here.
4. Administrative Buy In
    a. Schedule – Adding fixedspace laboratory sessions change the room availability schedules. Labs require staffing. However, OM labs can use any rooms with computers and computer network or "WiFi" access. WiFi (802.11G) capabilities open up many more options on campus. Cyber lab is another possible alternative.
    b. Costs – Additional computertype labs use assets and require professional staff to run them. The staff needs to be paid or provided with release time from other duties or teaching. Hence a professor assigned to a lab would probably teach one less class to compensate.
    c. SOLUTIONS for success with administrative resistance:
        i. Sell operations as a science. This might be easier if you're teaching management science as opposed to operations.
        ii. Sell the handson tool. Computer simulations and software make learning fun if done right.
        iii. Sell the idea of using scenarios and simulation. Software like the "active models" software mentioned earlier are tools to change conditions/parameters and observe the results.
        iv. Sell the lab idea. Business is so dynamic that it is our job to prepare our students for ever changing worlds. A laboratory approach, when coupled with a good operations theory, allows for student exploration.
        v. Consider "dovetailing" a stand alone lab session immediately following the associated operations class lecture. Move operations from 3credit hour course to a 4hour course. This make scheduling easier.

CLOSING THOUGHTS

This paper is designed to get the reader to think about the possibility of making an operations management lab a regular part of the OM curriculum. The author feels this is of particular importance when the situation involves students who do not always live on campus or who divide their time between school and work. Campuses where students generally do not commute enjoy certain advantages. The least of which is the ability to gather students together after the formal class ends. This provides an opportunity that is not available on campuses where students close their books and head to the car. Those of us not blessed with selfcontained, residential campuses need to supplement traditional approaches to teaching operations management. An OM business laboratory while not an entirely new idea still provides the opportunity for deeper understanding through reinforcement of operations concepts by taking advantage of the networking power of computers and today's software. Learning experiences and skills gained in the OM lab setting are necessary to help students compete in tomorrow's business world.

REFERENCES

[1]. (Note) A microcomputer revolution in the school of business. Interfaces, 1985, 15 (5), 35-38.

[2]. Tapper, J., Topics and manner of talk in undergraduate practical laboratories. International Journal of Science Education, 1999, 1 (4), 447-464.

[3]. Holt, C. E., Abramoff, P., Wilcox, L. V., & Abell, D. L. Investigative laboratory programs in biology: a position paper for the commission on undergraduate education in the biological Sciences. BioScience 19, 1104 - 1107.

[4]. Holstein, A. & Lunetta, V. N. The role of the laboratory in science teaching: neglected aspects of research. Review of Educational Research, 1982, 52, 201-217.

[5]. Tamir, P., Stavy, R., and Rather, N. Teaching science by inquiry: assessment and learning. Journal of Biological Education, 1998, 33, 27-32.

[6]. Sundberg, M. D., Dini, M. L., and Li, E. Decreasing course content improves student comprehension of science and attitudes towards science in freshman biology. Journal of Research in Science Teaching, 1994, 31, 679-693.

[7]. Germann, P. J., Haskins, S., and Auls, S. Analysis of nine high school biology laboratory manuals: promoting scientific inquiry. Journal of Research in Science Teaching, 1996, 33, 475-499.

[8]. Ornstein, A. The frequency of hands-on experimentation and student attitudes towards science: a statistically significant relation. Journal of Science Education & Technology, 2006, 15 (3/4), 285-297.

[9]. Dyer, B. & Schumann, D. Partnering knowledge and experience, the business classroom as a laboratory. Marketing Education Review, 1993, 3 (2), 32-39.

[10]. Becker, W., & Watts, M. Teaching tools: teaching methods in undergraduate economics. Economic Inquiry, 1995, 33 (4), 692-701.

[11]. Dinan, F.J. Laboratory based case studies: closer to the real world. Journal of College Teaching, 2005, 35 (2), 27-29.

[12]. Basey, J.M., Mendelow, T.N., and Ramos, C.N. Current trends of community college lab curricula in biology: An analysis of inquiry, technology, and content. Journal of Biological Education, 2000, 34 (2), 80-87.