Temporary Lighting Laboratories at Two Universities: Comparison of Methodologies for Research Projects in Thailand and USA

Paulette Hebert, Ph.D.[1], Gregory Clare, Ph.D.[1], Singh, Chitra, Ph.D.[1],

Rojarek Seangatith[2], and Yingsawad Chaiyakul, Ph.D.[2]

Department of Design, Housing, and Merchandising, Oklahoma State University

[2] Faculty of Architecture, Khon Kaen University

email: paulette.hebert@okstate.edu, greg.clare@okstate.edu, cyings@kku.ac.th

Abstract

Lighting technology is rapidly evolving and therefore, permanent university lighting research laboratory installations are becoming more scarce. Even when available, permanent university lighting laboratories may become obsolete within a short time period. Worldwide, some researchers have developed temporary laboratory setups which allow them to meet their project needs without the long-term university infrastructure commitments, updates, and maintenance considerations of permanent lighting labs. The purpose of this presentation is to compare the methodologies utilized in two recently completed lighting studies at universities located in Thailand and the United States of America (USA), 13,801 kilometers (8,576 miles) apart. A comparison of laboratory setups, equipment and supplies, financial investments, and study participants are presented. Photographic documentation of the lighting setups, equipment lists, and associated costs are included. Although the researchers did not previously have any contact before or during the respective study periods, their strategies to develop temporary lighting setups had a few main similarities: overall costs, the use of human subjects, participant sampling methods, the reliance on electrical extension cords and the location of their studies in education spaces at their respective Universities. The purpose of each lighting study differed.

Procedures, lighting equipment, supplies and furniture, study period, project costs and human subjects' involvement times and incentives differed.

Keywords:
Laboratory, Lighting, Methodology, International, University

1. Introduction

Traditional laboratories have historically existed as permanent, dedicated, physical facilities which have housed specialized, critical laboratory equipment. That equipment was often large, delicate and expensive. The need for traditional laboratories, where researchers had regularly conducted experiments in-person with large, specialized and expensive equipment, has apparently changed over the years, at least for some researchers [3, 9]. More recently, technology has sometimes made it possible for researchers to utilize less-cumbersome equipment, sometimes solely computers, for their research. The remote use of equipment, the sharing of equipment and other forms of research collaboration are now also more common [6, 2, 13]. Virtual or web laboratories have also been used recently by various disciplines and may supplement or even replace traditional laboratories [1, 4, 5, 7, 8, 12].

Another challenge with large, permanent, traditional laboratories had been that they sometimes needed to be relocated [10]. Recently, traditional laboratories have been examined from facility management and "move management" perspective. Inventories of large, expensive, and delicate lab equipment have been created in anticipation of old laboratories' contents relocation to a new facility [10]. Lab equipment moves may also be needed, when a research project ends or a researcher retires, leaving behind an irrelevant laboratory.

Beyond "move management", other facility management tasks are often necessary for traditional laboratories. Traditional lab equipment and laboratory facilities require maintenance, refurbishment or replacement. From the current study's lighting researchers' point-of-view, a particular challenge has been that lighting technology itself is continuously evolving. The installation of a permanent lighting system for research purposes may become outdated quickly. Further, budgets in higher education have decreased at many universities which have implications for the future funding of traditional University laboratories across disciplines [11].

While collaborating for a Fulbright project, the researchers representing the two countries in the current study learned they had both previously used temporary lab set-ups to conduct their lighting research in order to overcome shortcomings regarding traditional laboratories. The researchers wanted to perform a study to learn about each other's temporary lighting laboratories

2. Research Methodology

The current study explores two temporary, lighting laboratory set-ups utilized by University researchers. One lab was located in the architecture school at a large University in Thailand in 2016 and one lab was located in the design, housing and merchandising department at a University in the United States of America (USA) in 2013. The researchers were curious about how their respective, temporary lighting laboratories and associated methodologies would compare.

Thai Study

The purpose of the Thai research study was to measure visual performance by involving participants for up to three (3) hours each in a review of black, white and grey patterns of different contrast and size, under different levels of incandescent light. The Thai lighting temporary lab area consisted of a former conference room (with rental at no cost to researchers); utilized one (1) desk and (1) chair; two (2) 1,500 watt, quartz halogen (incandescent) scoop fixtures at a cost of 1,000 Thai BAHT (BHT, $33.5 USD) each, manufactured by Micron and controlled by two custom-made portable dimmer modules (6000 BHT, $190.16 USD). Lighting fixtures were mounted on a custom, (2) A-frame, free-standing pipe apparatus with a material cost of 3,000 BHT ($100 USD). A chin rest (1,000 BHT, $31.69 USD), a sloping document platform (1,000 BHT, $31.69 US) . The Thai researchers utilized a Konica Minolta Model # T-10A Illuminance Meter that they already owned to set light levels. The daylight intrusion from the room's two (2) walls of fenestration was minimized with fabric draperies. Study participants in the nearby community were recruited via convenience and snowball sampling techniques and were incentivized to participate.

USA Study

The purpose of the American research study was to consider participants' preferences for raw ground beef packages illuminated under three (3) different light sources by simulating grocery store meat department conditions: fluorescent and two types of light emitting diode (LED) at the same light levels. Participants were involved for approximately (15) minutes each and were randomly assigned to review beef packages in one of the three lighting condition stations. Researchers utilized a section of a collegeshared classroom/lab space with three tables (with rental at no cost to researchers) for their research area. They purchased (6) gooseneck, clip-on, task lights, manufactured by Wisam which cost $12.00 USD each (360 BHT). They used an Extech LT300 light meter they already owned and set light levels by adjusting gooseneck fixtures at the appropriate distance from ground beef packages. Researchers used Cooper instant-read Thermometers #1246-02 at a cost of $7.00 USD (210 BHT) each to continuously monitor safe temperatures for retail ground beef presentation. (Constant temperature was critical as it also affected the raw ground beef appearance.) They utilized (3) styrofoam ice chests $22.04 (695.38 BHT) with (6) reusable ice-packs at a cost of approximately $8.00 USD (252.41 BHT), (3) raw ground beef packages at a cost of $33.00 US (1041.18 BHT). Researchers utilized numerous extension cords that researchers already owned. The room was darkened with existing vertical vinyl louvers and roller shades over the windows and researchers also applied additional black plastic they already owned to prevent daylight intrusion into the study area. Study participants were recruited via convenience and snowball sampling techniques. No incentives were paid to participants, however, student participants were given “extra credit” in their courses to participate. Refer to Table 3 for a detailed itemized cost for the USA study.

3. Research Results

A comparison of laboratory set-ups, equipment and supplies, financial investments, and study participants is presented. Refer to Figures 1-10 for photographic documentation of the lighting setups.
Thai Temporary Laboratory Set-up

Figure 1. 1500 watt quartz halogen and visual acuity test scoop fixtures

Figure 2. Sloping document platform

Figure 3. Custom dimming module fixtures

Figure 4. A-frame, free-standing pipe apparatus with scoop

Figure 5. A participant taking visual acuity test

American Temporary Laboratory Set-up

Figure 6. Three lighting treatments (LED - warm, LED - cool and compact fluorescent,) illuminating raw ground beef packages in styrofoam ice chests

Figure 7. Researchers utilizing a light meter and a temperature probe to check settings on the raw ground beef package.

Figure 8. Gooseneck Lighting Fixtures

Figure 9. Checking the temperature of the ground beef package

Figure 10. Participant completing perception survey

Comparison of Thai and American Laboratory Set-ups

Although the researchers did not previously have any contact before or during the respective study periods, their strategies to develop lighting laboratory set-ups had a few main similarities: the temporary nature of the lighting labs, the use of human subjects, sampling methods, the location of their studies in rent-free education spaces at their respective University and the reliance on electrical extension cords. The costs for the temporary labs' set-ups were similar. (The Thai laboratory set-up was 17,500 BHT ($558.50 USD) and American study was 14,134.85 BHT ($448.00 USD). Refer to Table 1 for overall comparison and refer to Tables 2 and 3 for detailed cost comparisons by country.

Table 1. Comparison of Two Methodologies

		Thai University	American University
Purpose of the Study		To measure the visual performance of participants who reviewed black, white and grey patterns of different contrast and size under different levels of incandescent light	To evaluate participant preferences for raw ground beef package labels under three different light sources: incandescent, fluorescent and light emitting diodes (LED) at the same light levels

Table 1. Comparison of Two Methodologies (Continued)

Sample and Sampling method	Age	20-50 years	18-80+ years
	Sex	Male and Female	Male and Female
	Education Level	Undergraduate and Graduate Students	Undergraduate and Graduate Students; faculty, staff, older adults
	Participant recruitment	Convenience and Snowball Samples	Convenience Sample
	Number of participants	36	275
	Incentive to participants	300 BHT ($9.50 USD)	Extra course credit for students
Laboratory set-up	Experiment location	On-campus conference room	On campus classroom/
	Length of the study period	4 months	8 hours
	Furniture	One desk, one chair	Three tables
	Light meter	Konica Minolta #T-10A illuminance meter	Extech LT300 light meter
Lighting	Light Source	Quartz Halogen (incandescent)	Compact Fluorescent and LED

Table 1. Comparison of Two Methodologies (Continued)

	Fixtures	Scoop Fixtures	Gooseneck clip-on lamps
	Controls	Custom Dimming Module	Switch Integral to Gooseneck Lamps
	Supplies	A-frame, free-standing pipe apparatus, sloping document platform	Cooper # 1246-02 instant-read thermometers, three styrofoam ice chests with reusable ice-packs, two raw ground beef packages
	Daylight control	Fabric window draperies minimize daylight intrusion	Vertical, vinyl window louvers and roller shades minimize daylight intrusion
Procedure	Participant time involvement	3 hours	15 minutes
	Instrument	Black, white and grey patterns of different contrast and size were viewed under different levels of incandescent light.	With a random assignment to three different lighting treatments, hard copies of light perception survey were completed.
Laboratory & Costs		17,500 BHT ($558.50 USD)	$448 USD (14,035.84 BHT)

Table 2: Detailed Itemized Cost for Thai Temporary Lighting Laboratory Set-up

Description	Quantity	Cost BHT/ USD	Extended Cost BHT/ USD
A-frame, free-standing pipe apparatus	2	1,500.00 BHT/ $47.54 USD	3,000.00 BHT/ $95.08 USD
1500 watt Quartz halogen Scoop Fixture	2	1,000.00 BHT/ $31.69 USD	2,000.00 BHT/ $63.39 USD
Custom Dimmer Module Materials	2	3,000.00 BHT/$ 95.08 USD	6,000.00 BHT/ $190.17 USD
Extension Cords	2	1,000.00 BHT/ $31.69 USD	1,000.00 BHT/ $31.69 USD
Desk privacy panel	1	1,500.00 BHT/ $47.54 USD	1,500.00 BHT/ $47.54 USD
Sloping document platform	1	1,000.00 BHT/ $31.69 USD	1,000.00 BHT/ $31.69 USD
Chin rest	1	1,000.00 BHT/ $31.69 USD	1,000.00 BHT/ $31.69 USD
Labor cost for dimmer fabrication	1	2,000.00 BHT/ 63.39 USD	2,000.00 BHT/ $63.39 USD
Total Supplies, Equipment and Labor			17,500.00 BHT/ $585.50 USD

Table 3: Detailed itemized cost for USA Temporary Lighting Laboratory Set-up

Description	Quantity	Cost BHT/USD	Extended Cost BHT/USD
Ground Beef Packages	6	1041.18 BHT/ $ 33.00 USD	2082.37 BHT/ $66.00 USD
Gooseneck Lighting Fixtures	6	220.54 BHT/ $6.99 USD	1323.25 BHT/ $41.94 USD
Reusable Ice-Packs	6	252.41 BHT/ $ 8.00 USD	1514.45 BHT/ $48.00 USD
Styrofoam Ice Chests	3	695.38 BHT/ $22.04 USD	2086.15 BHT/ $66.12 USD
Acuity Brands #212P46 (A19) 50K Hours, 620 Lumens, 11 W, Warm White LED Lamp, CRI 80, 2800K	2	1341.86 BHT/ $42.53 USD	2683.73 BHT/ $85.06 USD
Westinghouse Luma Pro #6GEM3 (A19), 50K Hours 490 Lumens, 8 W, Cool White LED Lamp, CRI 85, 5000K	2	1209.67 BHT/ $38.34 USD	2419.33 BHT/ $76.68 USD
GE Energy Smart #74436 (A19), 8K Hours, 450 Lumens, 9W, Soft White Compact	2	492.20 BHT/ $15.60 USD	984.39 BHT/ $31.20 USD

Table 3: Detailed itemized cost for USA Temporary Lighting Laboratory Set-up (Continued)

Fluorescent Lamp, CRI 82, 2700K			
Paper and Printing for Surveys	300	3.47 BHT/ $ 0.11 USD	1041.18 BHT/ $33.00 USD
Total Supplies & Equipment			14134.85 BHT/ $ 448.00 USD

The stated purposes and procedures of each lighting study differed. The study period differed with the Thai study period spanning 4 months in 2016 and the American study period spanning 8 hours on one day in 2013. Light sources, equipment, supplies and furniture, project costs and human subjects' involvement times and incentives differed. Incentives were paid to (36) study participants in Thailand at 300 BHT ($9.50 USD) per participant. 275 undergraduate students were not given monetary incentive but rather were given extra course credit to participate.

4. Conclusion and Discussion

The purpose of this presentation was to compare the methodologies utilized in two recently completed lighting studies at universities located in Thailand and the United States of America (USA), 13,801 kilometers (8,576 miles) apart. It appears as though temporary lighting laboratories have been successfully used by University lighting researchers in two countries across the globe.

The current study found both striking similarities and striking differences in the laboratory set-ups in Thailand and the USA. Both studies relied on the use of several extension cords to power the lighting. This reflects both facilities lack of electrical receptacles to plug in the needed devices. Extension cords can be a trip hazard and fire hazard.

While the total costs were similar for the laboratory set-ups in both countries, the Thai study paid incentives to participants and also paid labor for laboratory set-up. It should be noted that the minimum hourly wage in Thailand at the time of the Thai study was 37.5 BHT ($1.08 USD). The minimum hourly wage in the USA at the time of the American study was $7.25 per hour. (227.14 BHT). These facts should be considered when one compares the monetary costs of the two lighting laboratory setups.

5. Limitations and Future Research Directions

This research utilized a convenience sample of laboratory setups. The current study reported on a case study comparison of only two setups for lighting research which happened to occur during a three-year time span. Future research efforts should examine multiple lighting research studies and their laboratory setups, across various countries, across time. The traditional and temporary laboratories from other disciplines than lighting could also be examined and compared for their similarities and differences. Additionally, researching a representative random sample of temporary laboratory set-ups could allow for statistical comparisons of the types of common equipment and infrastructure utilized.

6. References

[1] Arango, F., Chang, C., Esche, S. K., & Chassapis, C. (2007). ***A scenario for collaborative learning in virtual engineering laboratories.*** Paper presented at the 2007 37th annual frontiers in education conference-global engineering: knowledge without borders, opportunities without passports.

[2] Barker, M., Olabarriaga, S. D., Wilkins-Diehr, N., Gesing, S., Katz, D. S., Shahand, S., Scott, H., Tristan, G., Keith, J., Corrie, B. (2019). The global impact of science gateways, virtual research environments and virtual laboratories. ***Future Generation Computer Systems, 95***, 240-248.

[3] Chandrasekera, T., & Yoon, S.-Y. (2018). The Effect of Augmented and Virtual Reality Interfaces in the Creative Design Process. International Journal of Virtual and Augmented Reality (IJVAR), 2(1), 1-13.

[4] Deniz, D. Z., Bulancak, A., & Ozcan, G. (2003). ***A novel approach to remote Laboratories.*** Paper presented at the 33rd Annual Frontiers in Education, 2003. FIE 2003.

[5] Ertugrul, N. (2000). Towards virtual laboratories: A survey of LabVIEW-based teaching/learning tools and future trends. ***International Journal of Engineering Education, 16***(3), 171-180.

[6] Finholt, T. A., & Olson, G. M. (1997). From laboratories to collaboratories: A new organizational form for scientific collaboration. ***Psychological Science, 8***(1), 28-36.

[7] Finkelstein, N., Perkins, K., Adams, W., Kohl, P., & Podolefsky, N. (2005). ***Can computer simulations replace real equipment in undergraduate laboratories?*** Paper presented at the AIP Conference Proceedings.

[8] Finkelstein, N. D., Adams, W. K., Keller, C., Kohl, P. B., Perkins, K. K., Podolefsky, N., Sam, R., LeMaster, R. (2005). When learning about the real world is better done virtually: A study of substituting computer simulations for laboratory equipment. ***Physical review special topics-physics education research, 1***(1), 010103.

[9] Hebert, P., Clare, G., Chung, Y., Slevitch, L., & Leong, J. (2015). Effects of Experimental Conditions on Consumer Perceptions of Ground Beef: An Interdisciplinary Study. ***Journal of Social Sciences and Humanities, 1***, 275-282.

[10] Hebert, P. & Kang, M. (2015). Facilitating Move Management: Examining Existing Equipment at a National Laboratory. ***Scientific and Academic Publishing***, ***5***(2), 34-39

[11] Howard, D. J., & Laird, F. N. (2013). The new normal in funding university science. ***Issues in Science and Technology, 30***(1), 71-76.

[12] Hua, J., & Ganz, A. (2003, November). Web enabled remote laboratory (R-Lab) Framework. Paper presented at the IEEE Frontiers in Education Conference, Boulder, Colorado.

[13] Zhang, Z., Zhang, M., Chang, Y., Aziz, E.-S., Esche, S. K., & Chassapis, C. (2018). Collaborative virtual laboratory environments with hardware in the loop. ***Cyber-Physical Laboratories in Engineering and Science Education***, 363-402.