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Fume Hood Usage: A Qualitative Examination of Energy Conservation in UIUC Labs

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Executive Summary

Research institutions like the University of Illinois face pressures to reduce energy consumption and the emission of greenhouse gases (Gilly, n.d.). As public entities, universities have an obligation to conserve energy not only because they are funded by the state (viz., Illinois Board of Higher Education, n.d.), but also because organizations such as these have an impactful effect on harmful emissions and pollutants (Mihic, Vuckovic, & Vuckovic, 2012; Mihic, Petrovic, Vuckovic, Obradovic, Djurovic, 2012). The 2015 Illinois Climate Action Plan (iCAP) specifies energy conservation as vital to the University's commitment to reach carbon neutrality as soon as possible.

Laboratory environments require an extraordinary amount of energy, and often use more than ten times the energy than other conditioned spaces (McCann, 2005).

Laboratory environments require an extraordinary amount of energy, and often use more than ten times the energy than other conditioned spaces (McCann, 2005). Heating, ventilation, and air conditioning systems supply clean air for occupants, but are quite energy intensive, and they account for up to 70% of energy consumption in large buildings (Gevelber et al., 2011). Fume hoods, as ventilators, are a primary contributor to this usage (Brase, 2013). For example, Mills and Sartor (2006) have demonstrated that a typical fume hood consumes 3.5 times more energy than an American house. This makes fume hoods a primary target for energy conservation programs.

Reducing the energy consumption of fume hoods can be achieved through several means, but one of the most effective methods has been to keep fume hood sashes closed when not in use. Past programs have done this in two ways: automatic sash shutters and behavior management programs (viz. Brase, 2013; Farmer, 2014; Gilly, n.d.). But, despite the effectiveness of automatic sash shutters, they are costly. Fortunately, behavior change programs have proved to be effective in both energy usage outcomes and cost (Delmas, Fischlein, & Asensio, 2013).

[...] The researchers hope to put campus groups in a position to leverage audience-specific, behavioral insights in future energy conservation programs.

We conducted research with lab occupants at University of Illinois Urbana-Champaign who were among the following: undergraduate students, graduate students (Masters and PhD), post-docs, lab technicians, research assistants, lab managers, and maintenance and facilities managers. We wanted to better understand their knowledge, attitudes, and beliefs about fume hood usage and to explore their motivations and barriers to engaging in habitualized, regular shutting of fume hood sashes. By collecting these qualitative data, the researchers hope to put campus groups in a position to leverage audience-specific, behavioral insights in future energy conservation programs.

As such, the following questions guided our research:

1. What general attitudes and beliefs about shutting fume hood sashes characterize UIUC lab occupants? What is the level of knowledge about the recommended procedures for fume hood usage?
2. What are the current, perceived barriers, motivators, attitudes, concerns, and behaviors related to fume hood usage with this group?
3. What communication or marketing strategies does this group think would be effective or not effective in encouraging this behavior change?
4. Are there differences among these types of lab occupants (as outlined above) that would suggest tailored approaches for each of them?

Three focus group were conducted on the UIUC campus in April and May of 2016. A total of 12 lab occupants were included in the sample.

Key Findings

Knowledge

- There is a **marked difference** in audience between the following groups:
 - undergraduate students, graduate students, lab technicians (referred to hereafter as **GLUs**)
 - faculty members, lab managers (hereafter **FMLMs**)These differences span perceived benefits, barriers, motivators, and knowledge.
- There is a smaller knowledge gap in FMLMs; this group is, on the whole, aware of the monetary and environmental costs of improper fume hood usage. Likewise, this group is largely knowledgeable about proper, energy efficient fume hood operation.
- On the other hand, GLUs have a knowledge gap regarding fume hood usage.
 - GLUs were vaguely aware that fume hoods used more energy, but were largely uninformed on the specifics (such as amounts, costs of operation, etc).
 - Because of the various types of fume hoods, **GLUs often did not know the recommended procedure** for each of the different fume hoods in their own labs.
 - Specifically, there is confusion between when one ought to shut the sash or turn the fume hood entirely off.
 - GLUs generally did not report being aware of efforts (internal or external to their labs) to reduce energy consumption through shutting the sash, even things such as reminder stickers or indicators.

Barriers, benefits, motivators

Barriers

- GLUs reported several barriers (or things that would make shutting the sash difficult or unattractive) to shutting the sash.
 - **The extra step of shutting the sash is burdensome.** Since they often use both hands to move chemicals in and out, it takes extra time and effort to: remove the chemical, close the cash, then pick up the chemical again. This is taxing on their primary focus (the integrity of their work). Likewise, their work may require that they remove their gloves (and then discard them) just to shut the sash.
 - There is confusion between knowing when to shut the sash and turn it off (irrespective of whether a machine *should* be shut off at any time).
 - There is a **lack of perceived benefits** to this behavior (e.g., why it is worth my time? why it worth my attention?).
 - Forgetfulness (e.g., it is a non-routinized behavior) sometimes leads to not shutting the sash when GLUs would otherwise.

Benefits

- GLUs and FMLMs reported several key benefits to shutting the sash.
 - **Increasing the safety** of the lab by keeping the fume hood closed was a strongly perceived benefit (e.g., fume/explosion/smell containment). Likewise, by shutting the sash, the GLU decreases the likelihood that someone else will interfere with his or her experiments.
 - **The money saved through conserving energy** was commonly reported.
 - For FMLMs: keeping operations costs down were important.
 - For GLUs: knowing they could positively benefit their lab and labmates was important. Likewise, knowing that there is a *large* amount of money saved due to *their* and their labmates' efforts is seen as a benefit.
 - Reducing pollutants and GHG emissions **was not** supported as a significantly important benefit to shutting the sash to GLU or FMLM groups.

Motivators

- FMLMs reported that **reducing operations costs** was a motivating factor in increasing shutting the sash. This paired with the knowledge of doing this was part of their job duties (just “doing your job”).
- GLUs found several things motivating:
 - **Tangible metrics of the the lab’s progress** was seen as important (e.g., money saved, improvements in lab-wide behavior).
 - External rewards such as **food (e.g., pizza parties) and competitions** were seen as attractive reasons to engage in the behavior.
 - Reminders, such as colorful stickers and indicators, were identified as useful in the groups held.

Recommendations

Differences between FMLMs (Faculty Members and Lab Managers) and GLUs (General Lab Users) require that different strategies be developed for each. This report recommends that **messages** about shutting the sash primarily target GLUs, as they are the primary users of the fume hoods (in number of users). However, our findings would strongly suggest that future programs consider that various supports outside of just communications be developed (specific suggestions given in the following sections).

Importantly, any program that hopes to have a long-term effect on campus energy usage must address the fact that there is high turnover in GLUs as they graduate or leave their program. For the success of any program like this, organizers will need to maintain a consistent presence in the labs so that new lab users can be acculturated to this behavior.

Faculty members and lab managers

1. Strategies that deal with influencing the FMLMs group will need to focus on the knowledge gap that the GLUs possess and **how FMLMs can bridge this gap**. The success of a program will depend on the buy-in from influencers like FMLMs. As this group is generally the one that establish and enforce a lab's culture (norms, procedures), FMLMs must be considered and consulted in the implementation of any program.
2. Though the vast majority of GLUs do have lab training, FMLMs will need to be made aware that there are large knowledge gaps that still persist. Items such as the following will need to be focused on in day-to-day operations and training:
 - a. The fume hood as a large energy consumer in the lab
 - b. Device-specific guidelines for fume hoods in a FMLM's lab (i.e., whether it is safe or pertinent to have the sash at a certain height on certain models; whether other conservation efforts are more or less useful, i.e., shutting the fume hood off).
3. One approach to achieving compliance with expanded training for general lab users would be to include the need for and use of such training materials as part of a self-assessment for each lab, perhaps as part of a comprehensive "Green Labs" initiative. Another would be for safety and compliance overseers to require that lab managers report annually on such training for their lab users.

General lab users

4. The confusion and lack of knowledge among GLUs will need to be addressed in messaging. Because there is a large knowledge gap, GLUs will need **messages that clearly connect**

their usage behaviors with the effects that they have. Messages and channels may include:

- a. Signage or flyers that relay the energy (and thus monetary) costs of fume hood usage.
 - i. Messages that were found to be effective were ones that showed either **relative** cost (“A fume hood consumes 3 ½ times the energy of an American house”) or **device/lab-specific** cost (“This fume hood is projected to cost the lab an additional \$xx by the end of the year if not properly shut.”).
 - b. Signage that indicates **the user’s** behavior has a direct effect on the wasting or saving of money for their lab. Messages will need to emphasize that **their actions** have a measurable effect. This pairs well with messages that can show what **a particular fume hood** is expected to use in energy/money in a week/month.
 - c. Stickers or indicators put prominently on fume hoods that show **where** a fume hood sash should be left. Color gradient stickers (e.g., green for “right” blending to red for “wrong”) are simple and informational.
 - d. Stickers or indicators put prominently on fume hoods that show **when** a fume hood sash should be shut. Since GLUs are under-informed about when they should be shutting the sash, messages should highlight situations in which they should shut the sash (i.e., at the end of the day, when stopping work, when working elsewhere in the lab).
5. Messages should pair shutting the sash with other habitualized, routine behaviors, such as:
- a. putting trash into the garbage
 - b. shutting lights off
 - c. washing hands
 - d. cleaning one’s workspace

By reframing this with other, already done behaviors, users are more likely to make this a habit. Possible messages may include:

- e. “You wouldn’t leave the refrigerator open, would you? Shut the sash!”
 - f. “Save our lab money: 1. Close the refrigerator, 2. Turn off the lights, 3. Shut the sash.”
6. **Establish shutting the sash as a safety issue**, as well as a conservation one. Safety was cited as a primary motivator in all focus groups. Safety in the lab is very important, and there exist safety benefits to keeping the sash closed when not in use.
- a. The intended effect is twofold: it is a step in being safe, which is valued, and it frames the conservation effort as one done in conjunction with safety rather than opposed to it.
 - b. To do this, a few things may be done:
 - i. Get the endorsement from and/or partnership with lab safety organizations. This will lend credibility to the effort.
 - ii. Messages that highlight the safety benefits to shutting the sash (e.g., containment, odor, &c).

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7. Establish social norms through messages that highlight peer professionalism. As professionals in the lab, **all users** can and should be behaving in a responsible manner. This step requires the cooperation of FMLMs.
 8. Though cost is prohibitive, develop ways by which lab users can get tangible feedback on their and their peers' performance in a sash shutting program. This was seen as very important in focus groups. Things such as energy usage per lab (if possible), estimates of cost per hood in each specific lab, rates of sashes being closed (with checks being done consistently when labs are unoccupied). Results should be made publicly so labs can see their own and others' performance.
 - a. This is made more impactful by holding formal competitions between labs (e.g., by lab, by floor, by building). Rewards such as social gatherings with food (e.g., pizza parties, catered parties) are great motivators.

Conclusion

Many lab occupants at UIUC either do not know about proper fume hood usage or do not see shutting the sash as a personally worthwhile behavior. Though they may understand the benefits to shutting the sash, a sense of personal agency and responsibility must be fostered through communication campaigns. Additional supports, in the form of lab competitions and lab-specific performance feedback, must be paired with any communication efforts. We believe the formative research conducted here at UIUC has produced rich and useful data that can inform planners involved energy conservation, sustainability, and lab and facility managers as they strive to reduce costs and greenhouse gas emissions.

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Appendix

A. Consent Form

Informed Consent

Laboratory Fume Hood Usage

You are invited to participate in a research project. This project will be conducted by Sam Wilson, a graduate student in the Department of Communication University of Illinois at Urbana-Champaign (UIUC) under the direction of Dr. Marian Huhman, professor in the Department of Communication at UIUC. We are inviting you to take part in a discussion group as part of formative research towards a pilot program on fume hood behavior.

The purpose of this discussion group is to learn more about the behaviors, attitudes, and perceptions regarding fume hood usage of UIUC lab occupants. This discussion group will be with about 4 other UIUC lab users and should last about 60 minutes.

Only first names will be used during the discussion and nothing you say will be linked to your name. If you agree to participate in this discussion group, you are consenting to having your voice recorded on tape. After the discussion, the audiotapes will be transcribed and then erased. Your real names will not appear in the data reports. Although we will do everything we can to protect the confidentiality of your responses, we cannot guarantee that other members of the group will keep your responses private. Results of this research study may be used in reports, presentations, journal articles, or community campaigns.

Your study-related information will be kept confidential as much as is possible. In general, we will not tell anyone any information about you. When this research is discussed or published, no one will know that you were in the study. However, laws and university rules might require us to disclose information about you. For example, if required by laws or University Policy, study information which identifies you and the consent form signed by you may be seen or copied by the following people or groups:

- The university committee and office that reviews and approves research studies, the Institutional Review Board (IRB) and Office for Protection of Research Subjects;
- University and state auditors, and Departments of the university responsible for oversight of research

Refreshments will be served prior to the discussion with the group. You will receive \$10 in cash as compensation for your participation.

Your participation is completely voluntary. You may decline to participate at any point. If you decide to leave during the group, you may still enjoy the refreshments and receive the cash. Also, you are not obligated to respond to any questions that you do not feel comfortable answering. Participating in the discussion poses minimal risk to you, but there is always the chance that discussing your experiences may be uncomfortable at times. The decision to participate, decline, or withdraw from participation will have no effect on your grades at, status at, or future relations with the University of Illinois.

Your input is very valuable to us. The broad benefit of your participation is to help us better understand some of the issues involved with reducing energy consumption through changed fume hood behavior. In the short-term, we hope that you will find this focus group to be an opportunity to openly discuss your daily experiences.

If you have any questions about this study, please contact me by email or phone at swilsn3@illinois.edu, 217-218-9790. You may also contact my faculty supervisor, Dr. Marian Huhman, at 217-244-6138 or mhuhman@illinois.edu. If you have any questions about your rights as a research participant in the study or any concerns or complaints, please contact the University of Illinois Institutional Review Board (IRB) at (217)333-2670, via email at irb@illinois.edu.

If you would like to participate, please complete the information below. By signing below, you are agreeing that you have read and understood this letter. You will be given a copy of this consent form to keep for your records.

My Permission

Yes No I have read the information about the study provided in this permission form and have been given a copy. I have had the chance to ask questions, and they have been answered to my satisfaction.

Yes No I am 18 years of age or older.

Yes No I give permission for audio recording of interviews, as explained above.

Signature: _____ Date: _____

Printed Name: _____

B. Moderator Guide

Shut the Sash

MODERATOR GUIDE

Problem or issue: Need for lab occupants to more fully close the sash on laboratory fume hoods when not in use.

Set up: *As participants arrive, make sure each person has a name card on which to write their name. Arrange chairs comfortably. Offer refreshments to participants as they enter.*

I. Introduction (6 minutes)

Thank you for coming to talk with us today. My name is Sam Wilson and I will lead this discussion. I am a graduate student in the Department of Communication and I am doing work about energy conservation on campus. We are talking to lab users about the fume hood usage in laboratories.

Purpose

We are interested in learning about your knowledge and awareness of VAV fume hood usage. We'd like to hear your opinions about increasing energy conservation and possible programs we might implement across all labs on campus. As I will explain later, the basic behavior we are looking to investigate is shutting the sash on fume hoods when they are not in use.

What laboratory researchers like you think is important and will help us understand the best ways to reach out to and inform other labs on this topic in the hopes of increasing how often fume hood sashes are closed in labs.

Your honest opinions are what we are interested in, and this is the purpose of my research. I encourage you to share any opinions you hold, negative or positive. To thank you for participating today we are providing refreshments. At the end of the discussion I will also be giving you \$10.

In just a minute I'll ask you to introduce yourself, but first I would like to go over a few things with you.

Informed Consent (Participants may have already done this when they arrived.)

We are conducting this group as formative research so that we might increase energy conservation on campus. As such, we are conducting discussion groups with lab occupants about lab conduct. This is a safe environment, and we will not tell anyone what you said specifically in here. We will use the information you give us to write a report, but your names will not be included nor any identifying information about you. You do not have to answer any questions that you do not want to answer. We aren't planning to ask any sensitive questions. You can skip the questions you

do not want to answer and still stay in this discussion group. If you do not want to participate, you do not have to do so. *(If anyone wants to leave let them do so now)*. If you have not already signed the consent form, and are willing to participate, please read and sign the consent form now.

Notetaker and Recording

We will be writing a report from this discussion, but we don't use anyone's names in the reports. Since we need to write a report, I have an assistant moderator, Olivia, helping me with notes.

(The notetaker should be sitting outside the group and away from the vision of the participants as not to be a distraction.)

I will also record our talks *(show recorder)* because I want to make sure I don't miss anything, but like I mentioned earlier your names will not be included.

(Turn on recorder) *The digital recorder should be placed in a location to record but not a distraction.*

Ground Rules

Once we get started, I will ask you some questions. To make sure that everyone gets the chance to participate in the discussion and feels comfortable, please follow these ground rules.

- **Listen carefully** to the questions and to what everyone else has to say. We are really interested in what you think, so we need you to pay close attention during the discussion.
- **Everyone's ideas are important.** I will make sure everyone has the chance to speak. Sometimes I will ask each of you a question and sometimes just a few people may respond. But is important that everyone participate because each of your ideas is important.
- **Let one person speak at a time.** Try to avoid side discussions and speak up so we all can hear you. Remember that the discussion is being recorded.
- **Everything you tell us here is private.** Although I understand some of you know each other, names of the other participants in this group should also be kept private, so please be respectful of that.
- **Turn off cell phones please.**

II. Warm-Up/Ice-breaker (3 minutes)

Now that you've gotten to know a little more about why we are here and how things will go, I'd like you to introduce yourselves.

Please tell us your name, your research interests, and your favorite place to get food in town.

Moderator goes first to model process. Show sign that says

My name is _____; I am _____ researching _____. My favorite place in town for food is _____.

IV. [General questions to get participants thinking about the topic] (5 minutes)

One of the topics we are interested in is lab occupants' current awareness and knowledge of fume hoods and the energy they use. Is this something you are aware of?

Probe: What have you heard or been told?

What about specifically closing the sash as much as possible—is that something that you have knowledge about?

We are simply wanting to get a better idea of what lab users like you know about this because it's useful for us as we think about addressing fume hood efficiencies or sash closings.

By a quick show of hands... before coming here today, how many of you have been aware of efforts here at UIUC to keep fume hood sashes partially or fully closed when not in use?

For those of you that raised your hand, can you please share with us what you know or have heard about it?

(Thank them for sharing information.)

Now that we have a better idea of your current awareness, I would like to ask you more about your opinions on behaviors related to fume hoods.

Please be honest with your responses. There are no right or wrong answers and the more honest you are, the more helpful it will be for us.

V. BARRIERS TO DOING THE BEHAVIOR (5 MINUTES)

Any activity like this has benefits and costs.

Just thinking about being in the lab using fume hoods, what are some challenges you might face if you had to shut the fume hood sash all or most of the time?

If a lab manager were to suggest you be more careful about shutting the fume hood sash when not in use, what concerns would you have about doing this?

Probe: What might you want to ask your colleague before you agreed?

Are there any obstacles to your making a wholesale change in how often you use the sashes?

Probe: What about lab users in general?

Is there anything about being careful to shut the sash that seems like a negative?

VI. BENEFITS (6 MINUTES)

What are some reasons you might want to shut the sash when not in use?

Let's say that you working in a lab where no one monitors closing the sash and you are told that your behavior in specific would save the building \$1,000 per month. How would you feel if you were able to do this?

Besides saving the university money, are there other benefits to shutting the sash? Tell us about those benefits you would see, if any.

Probe: What would your colleagues or lab manager think if they heard you had been doing this?

Now that we have talked about the possible benefits and drawbacks, does it seem like the benefits outweigh the negatives *for you*?

Probe: Do you feel like you have enough information to answer this? What other questions might you have?

VII. MOTIVATORS (6 MINUTES)

I would like you to take what we have just discussed and think through a hypothetical scenario with me.

Imagine you are a new lab user who knows little about fume hoods and is beginning work in a lab. What would you recommend an organization like us do to raise your attention about proper sash usage? What would make you want to be more careful about sashes?

Thank you. I'd like you to consider another situation with me.

If there were a program that rewarded energy conservation with things like catered parties, do you feel competitions between labs would be motivating for you?

What are any other reasons you would be motivated to consistently shut the sash?

Could you see yourself making a habit of this behavior?

If not mentioned before: How much do you consider energy conservation or sustainability a worthwhile issue when working in the lab?

VIII. COMPETITION (5 MINUTES)

How do you feel lab safety might interfere with efforts to conserve energy?

How do you think monitoring the sash might affect your primary duties, like doing research?

Depending on replies, probe: would thinking about energy usage take away from time spent on more important things?

IX. ASSESSING COMPELLING FACTS AND INFORMATION

Now I am going to read you some facts about food hood usage.

(Read these out slowly and conversationally, so participants have time to take these in.)

1. Laboratory environments cost 10 times more than other spaces to operate
2. A typical fume hood consumes 3 ½ more energy than the typical American house
3. At Harvard, for example, labs occupy 23% of campus space but are responsible for 50% of its energy consumption
4. Energy consumption in labs greatly contributes to the amount of greenhouse gases released into the environment
5. Universities such as Harvard, Duke, UC Berkeley, UC Santa Barbara, UC Davis, MIT and the University of Toronto, to name a few, all engage in these behavioral programs, and we hope to pilot a program that will include UIUC among their numbers.
6. This behavioral approach focuses on reducing energy waste by closing fume hoods when inactive.
7. The potential savings for these programs lies in the fact that users sometimes neglect to close fume hoods after use. Studies have shown that fume hoods are only used for an average of 2.6 hours per day, but many hoods are open 50% of the time.
8. Hoods in Harvard's Shut the Sash program resulted in a 38% energy reduction, which, from a cost perspective alone, resulted in nearly \$1,200 saved *per hood* annually

What do you think about this information?

Do you feel like any facts are more compelling than others?

Are any less compelling than the others?

Additional probe:

What makes you feel that way?

X. SUPPORTS (6 MINUTES) (THINGS THEY NEED TO DO THE BEHAVIOR)

Say you're interested in closing the sash more often when it's not in use; what would make doing this easier for you?

Probe: Reminders? Energy monitors?

XI. IDEAS FOR MORE SUPPORT (UNIVERSITY COULD DO/CAMPAIGN?)

Considering everything we've heard today, what could sustainability groups on campus do if they wanted input in how to design a campaign?

XII. THANK YOU AND CLOSE (2 MINUTES)

You've told me some great information about your feelings towards shutting the sash. Our goal is to determine the best way to reach out to lab occupants to: 1. increase awareness of this topic, and 2. increase how often fume hoods are closed when not in use.

Does anyone else have any thoughts or ideas they would like to share before we wrap up?

Is there anything important that you think we missed or wasn't said?

Okay, this marks the end of our focus group; do any of you have questions? (*Answer relevant questions*)

I have learned a lot from you and thank you very much for your time!

(Turn off recorder)