Fume Hood Energy Usage and Incentivization

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Abstract

Fume hoods typically use three to four times the energy of a house, accounting for approximately $4.2 billion dollars in energy bills nationwide. At Caltech, there are over 800 fume hoods. The aim of this SURF was to perform a cost analysis of existing fume hoods and to observe behavior patterns in fume hood usage. Variable air volume fume hoods allow for reduced energy consumption, but are seldom properly used. The average fume hood costs Caltech $4718 per year, and is closed only nine percent of the time. However, by increasing awareness, the fume hoods were closed over three-quarters of the time, resulting in savings of $3412 per hood annually.

Text

During this last school year, Caltech made an effort to incorporate the Summer Undergraduate Research Fellowship program into the institute's continuing efforts towards environmental responsibility. The Caltech Energy Advisory Committee directed Vice-Provost Melany Hunt and Professor Harry Gray to examine education as it relates to sustainability issues. At the suggestion of Carol Carmichael, the decision was made to involve SURF students in the institute's studies. In spring of 2008, the announcement of opportunity was created with Dr. Hunt as the mentor, with Jim Cowell, Director of Facilities Management, as the co-mentor.

One characteristic of the "green" SURFs was the freeform nature of the opportunities. During my initial meetings with Melany Hunt, Jim Cowell, and Rezo

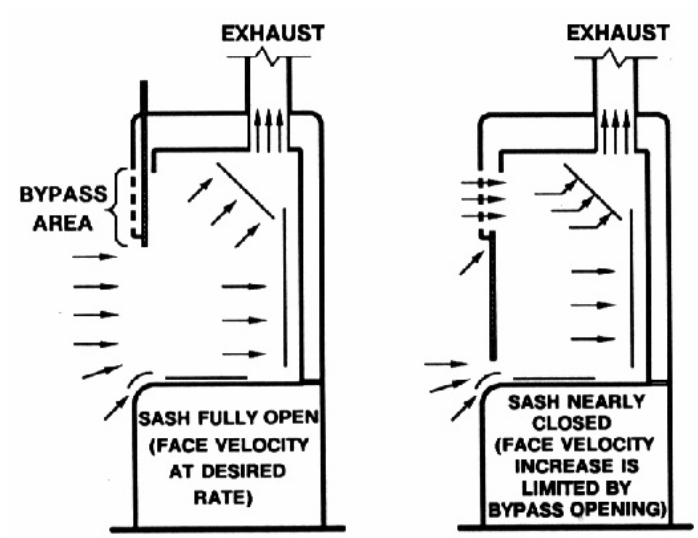
Ohadi, I was given information as to the general scope of the project, some relevant energy use figures, and a goal: attempt to curb campus energy usage at 2007 levels. In the fiscal year of 2007, the campus consumed 107,684,740 kilowatt-hours of power, costing the school approximately $16 million dollars. In recent years, Caltech's energy usage has grown by approximately seven percent each year.[1] We discussed several ways to attempt to reverse this trend, including the potential benefits from moving servers off-campus or updating lighting systems, as well as general examinations of energy usage, both by students and by researchers.

Another key feature of the SURF project was its collaborative aspect. I was informed that approximately four students would be conducting research on energy usage and greenhouse gas emissions, adding an undetermined degree of collaborative effort to the project. As such, it was not until the project began that roles were established and areas of study were chosen. After initial research, I chose to focus on energy usage within laboratories. The energy usage situation at Caltech parallels the scenario discussed by Garrett Hardin in his "Tragedy of the Commons." In Hardin's article, a herdsman who grazes his flock in a common area enjoys all the benefit from adding to his flock, but shares the negative effect of overgrazing with everyone else who uses the common area.[2] Similarly, researchers at Caltech solely enjoy the benefits of actions that might be considered an inefficient usage of energy, such as equipment purchases and daily actions, but share the consequences of this inefficient usage with the entire campus. Research quickly becomes the sole priority, with no concern for sustainability. When describing my project to one of my former professors, he remarked, "Turning things on and off means that they break more quickly." This confirmed for me the value of studying laboratory energy usage. With the area of study established, I proceeded to make contacts for laboratory study via the Caltech Sustainability website, sustainability.caltech.edu. Professors Frances Arnold, Sossina Haile, Harry Gray, and Nate Lewis all agreed to allow me to observe their labs. I visited the labs with Matt Berbee to make an initial energy inventory of the labs. This involved a basic examination of the equipment used in the laboratories, including fume hoods, freezers, computers, refrigerators, furnaces, and lighting, among other things. It quickly became apparent that the labs varied widely in the equipment used. A detailed energy inventory might allow us to identify weak points such as outdated freezers, but it would not contribute much towards a general understanding of the campus-wide state of affairs.

After this initial survey and further research, I determined that fume hoods were an area of sufficient importance to merit specific study. Other schools have conducted studies specifically addressing fume hoods, viewing it as worthy of dedicated examination. Harvard conducted a "Shut the Sash" campaign, placing magnets on fume hoods informing users of the energy waste. They were able to reduce the average fume hood sash height from 12 inches to 2.4 inches.[3] At the University of California, Santa Barbara, Allen Doyle took a slightly different approach, offering pizza to those who would allow him to shut off unused fume hoods. Closing nine fume hoods saved $16,000 for the school.[4] At MIT, Steven Amanti conducted his senior thesis on potential energy savings, observing the daily usage of fume hoods in a chemistry building, estimating potential savings of $350,000 from eliminating wasteful fume hood usage.[5]

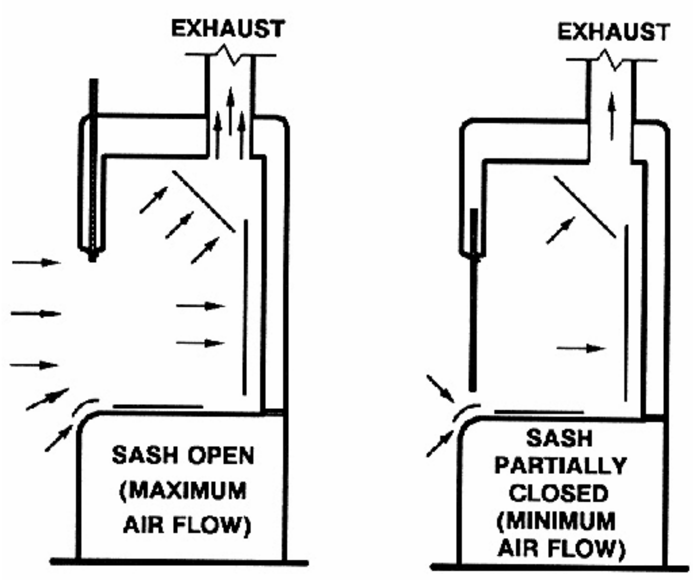
For this SURF project, there were multiple components: One objective was to create an inventory of fume hood energy usage, while another objective was to determine current fume hood usage behaviors by members of the Caltech community, as well as to implement incentivized measures to encourage proper fume hood usage. There are two main types of fume hoods: constant air volume (CAV) and variable air volume (VAV).

For CAV hoods, the supply and exhaust fans supply a constant flow around 1200 cubic feet per minute for each hood. At the opening prescribed by Environmental Health and Safety, the face velocity is at least 100 fpm, the standard required by Cal-OSHA for laboratory safety. If the sash is closed further, it only increases the face velocity at the opening, and the same flow rate means that there are no energy savings.



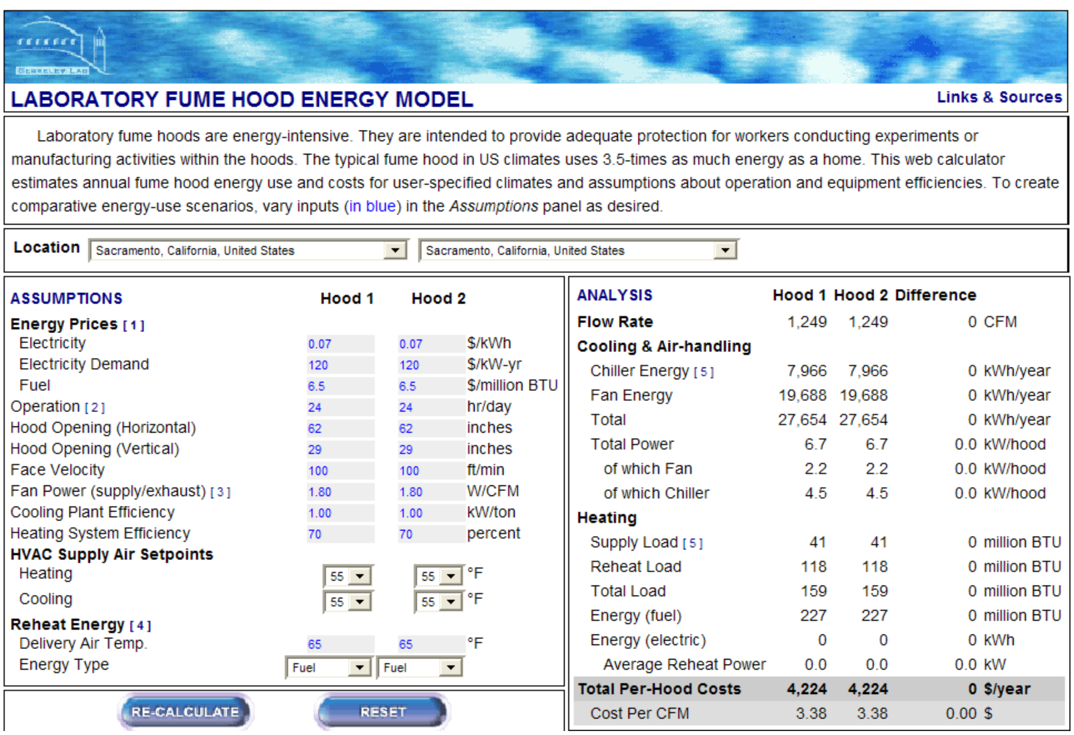
Constant Air Volume Fume Hood

For a VAV hood, a control system is built in that will sense when the fume hood is in a closed position and throttle down the supply and exhaust fans to maintain a constant face velocity, thus decreasing the flow and resulting in energy savings.



Variable Air Volume Fume Hood

The primary source for the calculations of the fume hood energy expenses came via an online fume hood cost calculator, created by Lawrence Berkeley National Laboratories. This calculator requires a list of user inputs, as shown in the figure below.



LABORATORY FUME HOOD ENERGY MODEL — Links & Sources

Laboratory fume hoods are energy-intensive. They are intended to provide adequate protection for workers conducting experiments or manufacturing activities within the hoods. The typical fume hood in US climates uses 3.5-times as much energy as a home. This web calculator estimates annual fume hood energy use and costs for user-specified climates and assumptions about operation and equipment efficiencies. To create comparative energy-use scenarios, vary inputs (in blue) in the *Assumptions* panel as desired.

Location: Sacramento, California, United States | Sacramento, California, United States

ASSUMPTIONS	Hood 1	Hood 2	
Energy Prices [1]			
Electricity	0.07	0.07	$/kWh
Electricity Demand	120	120	$/kW-yr
Fuel	6.5	6.5	$/million BTU
Operation [2]	24	24	hr/day
Hood Opening (Horizontal)	62	62	inches
Hood Opening (Vertical)	29	29	inches
Face Velocity	100	100	ft/min
Fan Power (supply/exhaust) [3]	1.80	1.80	W/CFM
Cooling Plant Efficiency	1.00	1.00	kW/ton
Heating System Efficiency	70	70	percent
HVAC Supply Air Setpoints			
Heating	55	55	°F
Cooling	55	55	°F
Reheat Energy [4]			
Delivery Air Temp.	65	65	°F
Energy Type	Fuel	Fuel	

RE-CALCULATE | RESET

ANALYSIS	Hood 1	Hood 2	Difference	
Flow Rate	1,249	1,249	0	CFM
Cooling & Air-handling				
Chiller Energy [5]	7,966	7,966	0	kWh/year
Fan Energy	19,688	19,688	0	kWh/year
Total	27,654	27,654	0	kWh/year
Total Power	6.7	6.7	0.0	kW/hood
of which Fan	2.2	2.2	0.0	kW/hood
of which Chiller	4.5	4.5	0.0	kW/hood
Heating				
Supply Load [5]	41	41	0	million BTU
Reheat Load	118	118	0	million BTU
Total Load	159	159	0	million BTU
Energy (fuel)	227	227	0	million BTU
Energy (electric)	0	0	0	kWh
Average Reheat Power	0.0	0.0	0.0	kW
Total Per-Hood Costs	**4,224**	**4,224**	**0**	**$/year**
Cost Per CFM	3.38	3.38	0.00	$

Lawrence Berkeley National Laboratory Fume Hood Model

Some of the values I received from existing Facilities data.[6] I selected the summer peak rate from Pasadena Water and Power, of $0.11852. The electricity demand value is a charge from PWP based off of the school's peak energy usage, extracted over the course of the year. This is given as $9.76 per KW per month, or $0.06 per kWH. Current fuel costs are $8.806 per million BTU. A 24 hour per day operation is assumed, to ensure the safety of the lab operators. The hood openings are observed values, particular to each hood, though of course there are standard sizes. The vertical opening is indicated by a sticker placed by Environmental Health and Safety which dictates the maximum allowed opening for the fume hood while maintaining the required FPM. The cooling plant and heating system efficiencies were both obtained from existing Facilities data, as 0.624 KW/ton and 80 percent, respectively. The supply air setpoint represents the temperature to which the outside air is either heated or cooled in order to remove excess humidity in the air. This is given in the operating conditions of the building, and is typically set at 55 degrees F. The delivery air temperature is an observed value, measuring the temperature of the air coming into the room. The energy type gives the energy source used to heat the air from the setpoint to the delivery temperature. Caltech uses electricity from the co-generation plant as the energy source. Fan power is the most difficult of the numbers to calculate, since it requires knowledge of both the supply and exhaust fans, as well as their operating conditions. During a meeting with Phil Vaziri, a Mechanical Engineer in the Facilities department, he demonstrated a software tool provided by the New York Blower company used by the department to size fans. The supply fan, operating at 36,000 CFM and a fan input power of 30.4 bhp, accounted for

0.63 W/CFM. The exhaust fan, operating at 1,200 CFM and 0.9 bhp, account for 0.56 W/CFM, for a total value of 1.19 W/CFM.[7]

Also during my meeting with Mr. Vaziri, I learned that the labs I had been studying contained constant air volume (CAV) fume hoods, rather than variable air volume fume hoods (VAV). I learned that VAV systems were only present in the newer buildings, Broad Center, Beckman Institute, and Moore. I looked up labs which contained two or more fume hoods and recorded the contact information for those rooms. I then informed them of my study and ended up observing six lab groups, five of which were in Beckman, and one in Broad. Between them, these labs contained 20 fume hoods. I took individual data for all of the fume hoods, including posted face velocity and maximum vertical opening, and the observed horizontal and vertical openings. For three weeks, I observed the vertical openings at random points during the day, and I observed that only nine percent of the times were the fume hoods in a "closed" state, less than a quarter of the posted maximum opening. The average vertical opening was 17 inches out of a posted 21 inch maximum height. Many of the fume hoods seemed to remain untouched for days, if not weeks. After three weeks had passed, I emailed the lab groups, offering a pizza party if their fume hoods were closed more than two-thirds of the time over the next three weeks. I also included a link to an online survey I created, hoping to evaluate the value of energy efficiency to members of the Caltech community (Appendix A). Unfortunately, though the survey link was sent to all lab members participating in the study, only two chose to take the time to reply. The change was immediate, and all of the labs exceeded the two-thirds mark, with fume hoods closed an average of 76% of the time, far greater than the 9% observed prior to introducing awareness and incentivization.

I then modeled this in the online fume hood calculator as a vertical opening of 5 inches versus 18 inches. This propagates to a cost reduction from $4718 to $1305 per year for a standard hood with a 62 inch horizontal opening, a savings of $3412/year.

From the study, we can conclude that fume hood usage is an easily influenced behavior, and one that simply requires proper awareness. During my chemistry lab class, I was never informed of proper fume hood usage, other than not to stick my head inside of it. That level of knowledge seems to be the rule, more than the exception. However, that will hopefully change from this point forward. There are three primary methods which will help spread awareness in light of this study. The first byproduct of this study that can potentially increase the overall level of understanding is the fume hood magnets. They should provide a constant reminder of the scope of the expenses due to fume hoods. Secondly, there will be many members of the Caltech community who gain information directly from this SURF paper and the accompanying presentation, as well as any of public relations to be conducted by the Caltech Facilities Department. Finally, knowledge will spread on a communal basis, as ideas and behaviors are spread by members within the community. Once responsible fume hood usage is established as the norm, new members of the Caltech community will quickly adopt this standard.

References

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2. Hardin, Garrett. "Tragedy of the Commons", *Science*, Vol. 162, No. 3859 (December 13, 1968), pp. 1243-1248.

3. Emig, Jaclyn. " 'Shut the Sash' Behavior Change Programs in Labs at Harvard", Labs21 Conference, October 2006.

4. Grimm, David. “This Man Wants to Green Your Lab”, *Science*, Vol. 318 No. 5847 (October 5, 2007), pp. 39-41

5. Amanti, Steve. “Potential Energy Savings on the MIT Campus”, Senior Thesis, MIT Department of Mechanical Engineering, 2006.

6. Berbee, Matt. Private correspondence, July 2, 2008.

7. Vaziri, Phil. Private correspondence, July 28, 2008.

Acknowledgements

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Appendices

Appendix A – Published Survey

Question 1 – What is your position at Caltech?

Undergraduate student
Graduate student
Post-doc
Professor
Other faculty

Question 2 - What is your major or division of study?

Question 3 – On a scale from 1 to 10, with 10 being the most efficient, how energy efficient are you at Caltech?

Question 4 – What are some of your practices that help save energy? List as many as you feel are relevant, or write “None” if you can not think of any.

Question 5 – On a scale from 1 to 10, how much does the administration encourage energy conservation?

Question 6 – What are your sources of information about energy conservation? Check all that apply.

Caltech publications
Other publications
Caltech websites
Caltech events
Other events
Peers
Posters or bulletin boards
E-mail announcements

Question 7 – How important do you think energy conservation is to the Caltech community as a whole?

Not important at all
Somewhat unimportant
Indifferent
Somewhat important
Very important

Question 8 – On a scale from 1 to 10, how energy efficient are you outside of Caltech?

Question 9 – Have you received training on proper fume hood usage?

Appendix B – Observed Fume Hood Data

Date and Time	Lab	Room #	Hood #	Width (in.)	Face Vel. (fpm)	Max Opening (in.)	Observed (in.)
8/1 - 9 AM	Flowers	BI 4	1	64	108	19	14
8/1 - 9 AM	Flowers	BI 4	2	64	114	20	20
8/1 - 9 AM	Flowers	BI 4	3	64	105	19	19
8/1 - 9 AM	Flowers	BI 4	4	64	110	22	14
8/1 - 9 AM	Flowers	BI 4	5	50	104	21	10
8/1 - 9 AM	Flowers	BI 4	6	50	106	25	8
8/1 - 9 AM	Flowers	BI 6	1	64	112	22	15
8/1 - 9 AM	DiGiusto	Broad 133	1	64	132	19	12
8/1 - 9 AM	DiGiusto	Broad 133	2	64	222	19	16
8/1 - 9 AM	DiGiusto	Broad 133	3	64	181	24	19
8/1 - 9 AM	Cameron	BI 207	1	52	108	22	9
8/1 - 9 AM	Cameron	BI 205	1	52	112	25	27
8/1 - 9 AM	Cameron	BI 205	2	52	120	23	23
8/1 - 9 AM	Cameron	BI 212	1	52	142	21	27
8/5 - 9 AM	Flowers	BI 4	1			19	15
8/5 - 9 AM	Flowers	BI 4	2			19	17
8/5 - 9 AM	Flowers	BI 4	3			24	21
8/15 - 8 AM	Laurent	BI 52	1	52	149	20	12
8/15 - 8 AM	Flowers	BI 4	1			19	22
8/15 - 8 AM	Flowers	BI 4	2			20	20
8/15 - 8 AM	Flowers	BI 4	3			19	19
8/15 - 8 AM	Flowers	BI 4	4			22	18
8/15 - 8 AM	Flowers	BI 4	5			27	13
8/15 - 8 AM	Flowers	BI 4	6			25	23
8/15 - 8 AM	Flowers	BI 6	1			22	4
8/15 - 8 AM	Cameron	212 BI	1	Door Locked			
8/15 - 8 AM	Cameron	207 BI	1	Door Locked			
8/15 - 8 AM	Cameron	205 BI	1			25	27
8/15 - 8 AM	Cameron	205 BI	2			23	3
8/15 - 8 AM	Vielmetter	202 BI	1	64	132	20	2
8/15 - 8 AM	Vielmetter	286 BI	1	64	144	24	16
8/15 - 8 AM	DiGiusto	Broad 133	1			19	14
8/15 - 8 AM	DiGiusto	Broad 133	2			19	16
8/15 - 8 AM	DiGiusto	Broad 133	3			24	20
8/19 - 8:30 AM	DiGiusto	Broad 133	1			19	15
8/19 - 8:30 AM	DiGiusto	Broad 133	2			19	17
8/19 - 8:30 AM	DiGiusto	Broad 133	3			24	22
8/19 - 8:30 AM	Flowers	BI 4	1			19	24
8/19 - 8:30 AM	Flowers	BI 4	2			20	20
8/19 - 8:30 AM	Flowers	BI 4	3			19	19
8/19 - 8:30 AM	Flowers	BI 4	4			22	19
8/19 - 8:30 AM	Flowers	BI 4	5			21	21
8/19 - 8:30 AM	Flowers	BI 4	6			25	24
8/19 - 8:30 AM	Flowers	BI 6	1			22	20
8/19 - 8:30 AM	Cameron	BI 212		Door Locked			
8/19 - 8:30 AM	Cameron	BI 207		Door Locked			
8/19 - 8:30 AM	Cameron	BI 205		Door Locked			
8/19 - 8:30 AM	Vielmetter	BI 202		Door Locked			
8/19 - 8:30 AM	Vielmetter	BI 286		Door Locked			
8/22 - 11:30 AM	DiGiusto	Broad 133	1			19	18
8/22 - 11:30 AM	DiGiusto	Broad 133	2			19	17
8/22 - 11:30 AM	DiGiusto	Broad 133	3			24	21
8/22 - 11:30 AM	Flowers	BI 4	1			19	19
8/22 - 11:30 AM	Flowers	BI 4	2			20	20

8/22 - 11:30 AM	Flowers	BI 4	3		21	21
8/22 - 11:30 AM	Flowers	BI 4	4		22	18
8/22 - 11:30 AM	Flowers	BI 4	5		21	18
8/22 - 11:30 AM	Flowers	BI 4	6		25	21
8/22 - 11:30 AM	Flowers	BI 6	1		22	23
8/22 - 11:30 AM	Cameron	BI 212		Door Locked		
8/22 - 11:30 AM	Cameron	BI 207	1		22	17
8/22 - 11:30 AM	Cameron	BI 205	1		25	27
8/22 - 11:30 AM	Cameron	BI 205	2		23	3
8/22 - 11:30 AM	Vielmetter	BI 286	1		24	17

Date and Time	Lab	Room #	Hoods Open	Hoods Closed
8/25 - 12 PM	Laurent	BI 52	0	1
8/25 - 12 PM	Flowers	BI 4	0	6
8/25 - 12 PM	Flowers	BI 6	1	0
8/25 - 12 PM	Cameron	BI 212	1	0
8/25 - 12 PM	Cameron	BI 207	0	1
8/25 - 12 PM	Cameron	BI 205	1	1
8/25 - 12 PM	Vielmetter	BI 286	1	0
8/25 - 12 PM	Vielmetter	BI 202	0	1
8/25 - 12 PM	DiGiusto	Broad 133	1	2
8/27 - 2 PM	Flowers	BI 4	0	1
8/27 - 2 PM	Flowers	BI 6	0	6
8/27 - 2 PM	Laurent	BI 52	0	1
8/27 - 2 PM	Vielmetter	BI 286	1	0
8/27 - 2 PM	Vielmetter	BI 202	0	1
8/27 - 2 PM	Cameron	BI 207	1	0
8/27 - 2 PM	Cameron	BI 205	0	2
8/27 - 2 PM	Cameron	BI 212	0	1
8/27 - 2 PM	DiGiusto	Broad 133	1	2
8/28 - 4 PM	Flowers	BI 4	0	1
8/28 - 4 PM	Flowers	BI 6	0	6
8/28 - 4 PM	Laurent	BI 52	1	0
8/28 - 4 PM	Vielmetter	BI 286	1	0
8/28 - 4 PM	Vielmetter	BI 202	0	1
8/28 - 4 PM	Cameron	BI 205	0	2
8/28 - 4 PM	Cameron	BI 207	0	1
8/28 - 4 PM	Cameron	BI 212	0	1
8/28 - 4 PM	DiGiusto	Broad 133	1	2
8/29 - 9 AM	Flowers	BI 4	1	5
8/29 - 9 AM	Flowers	BI 6	1	0
8/29 - 9 AM	Laurent	BI 52	1	0
8/29 - 9 AM	Laurent	BI 60	0	1
8/29 - 9 AM	Flowers	BI 26	1	0
8/29 - 9 AM	Cameron	BI 212	0	1
8/29 - 9 AM	Cameron	BI 207	0	1
8/29 - 9 AM	Cameron	BI 205	0	2
8/29 - 9 AM	Vielmetter	BI 286	1	0
8/29 - 9 AM	Vielmetter	BI 202	0	1
8/29 - 9 AM	DiGiusto	Broad 133	1	2
9/2 - 12:30 PM	DiGiusto	Broad 133	1	2
9/2 - 12:30 PM	Flowers	BI 4	1	5
9/2 - 12:30 PM	Flowers	BI 6	0	1
9/2 - 12:30 PM	Cameron	BI 212	0	1
9/2 - 12:30 PM	Cameron	BI 207	0	1
9/2 - 12:30 PM	Cameron	BI 205	0	2
9/2 - 12:30 PM	Vielmetter	BI 202	0	1
9/2 - 12:30 PM	Vielmetter	BI 286	0	1
9/2 - 12:30 PM	Laurent	BI 52	0	1
9/2 - 12:30 PM	Laurent	BI 60	0	1
9/3 - 2:30 PM	DiGiusto	Broad 133	1	2
9/3 - 2:30 PM	Flowers	BI 4	3	3
9/3 - 2:30 PM	Flowers	BI 6	0	1

9/3 - 2:30 PM	Laurent	BI 60	0	1
9/3 - 2:30 PM	Vielmetter	BI 286	0	1
9/3 - 2:30 PM	Vielmetter	BI 202	0	1
9/3 - 2:30 PM	Cameron	BI 205	1	1
9/3 - 2:30 PM	Cameron	BI 207	0	1
9/3 - 2:30 PM	Cameron	BI 212	0	1
9/5 - 8:30 AM	DiGiusto	Broad 133	1	2
9/5 - 8:30 AM	Flowers	BI 4	2	4
9/5 - 8:30 AM	Flowers	BI 6	0	1
9/5 - 8:30 AM	Vielmetter	BI 286	0	1
9/5 - 8:30 AM	Vielmetter	BI 202	0	1
9/5 - 8:30 AM	Cameron	BI 205	0	2
9/5 - 8:30 AM	Cameron	BI 207	0	1
9/5 - 8:30 AM	Cameron	BI 212	0	1
9/8 - 10 AM	DiGiusto	Broad 133	0	3
9/8 - 10 AM	Flowers	BI 4	1	5
9/8 - 10 AM	Flowers	BI 6	0	1
9/8 - 10 AM	Laurent	BI 60	0	1
9/8 - 10 AM	Vielmetter	BI 286	0	1
9/8 - 10 AM	Vielmetter	BI 202	1	0
9/8 - 10 AM	Cameron	BI 205	1	1
9/8 - 10 AM	Cameron	BI 207	0	1
9/8 - 10 AM	Cameron	BI 212	0	1
9/9 - 2 PM	DiGiusto	Broad 133	1	2
9/9 - 2 PM	Flowers	BI 4	2	4
9/9 - 2 PM	Flowers	BI 6	0	1
9/9 - 2 PM	Cameron	BI 212	0	1
9/9 - 2 PM	Cameron	BI 207	0	1
9/9 - 2 PM	Cameron	BI 205	0	2
9/9 - 2 PM	Vielmetter	BI 202	0	1
9/9 - 2 PM	Vielmetter	BI 286	0	1
9/9 - 2 PM	Laurent	BI 52	0	1
9/9 - 2 PM	Laurent	BI 60	0	1
9/10 - 11:30 AM	DiGiusto	Broad 133	3	0
9/10 - 11:30 AM	Flowers	BI 4	1	5
9/10 - 11:30 AM	Flowers	BI 6	0	1
9/10 - 11:30 AM	Laurent	BI 60	0	1
9/10 - 11:30 AM	Laurent	BI 52	0	1
9/10 - 11:30 AM	Vielmetter	BI 202	0	1
9/10 - 11:30 AM	Vielmetter	BI 286	0	1
9/10 - 11:30 AM	Cameron	BI 205	0	2
9/10 - 11:30 AM	Cameron	BI 207	0	1
9/10 - 11:30 AM	Cameron	BI 212	0	1
9/11 - 4 PM	DiGiusto	Broad 133	1	2
9/11 - 4 PM	Flowers	BI 4	2	4
9/11 - 4 PM	Flowers	BI 6	1	0
9/11 - 4 PM	Laurent	BI 60	0	1
9/11 - 4 PM	Laurent	BI 52	1	0
9/11 - 4 PM	Vielmetter	BI 202	0	1
9/11 - 4 PM	Vielmetter	BI 286	1	0
9/11 - 4 PM	Cameron	BI 205	1	1
9/11 - 4 PM	Cameron	BI 207	0	1

9/11 - 4 PM	Cameron	BI 212	0	1
9/12 - 9 AM	DiGiusto	Broad 133	1	2
9/12 - 9 AM	Flowers	BI 4	1	5
9/12 - 9 AM	Flowers	BI 6	1	0
9/12 - 9 AM	Laurent	BI 60	0	1
9/12 - 9 AM	Laurent	BI 52	1	0
9/12 - 9 AM	Vielmetter	BI 202	0	1
9/12 - 9 AM	Vielmetter	BI 286	1	0
9/12 - 9 AM	Cameron	BI 205	1	1
9/12 - 9 AM	Cameron	BI 207	0	1
9/12 - 9 AM	Cameron	BI 212	0	1

Lab	**Total Percentage**
DiGiusto	0.7
Laurent	0.764705882
Cameron	0.854166667
Vielmetter	0.727272727
Flowers	0.776470588
Overall	0.761904762