Bryn Mawr College

Trayless Dining Study

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I. Introduction

As part of a senior conference course, Mathematical Modeling in the Environment, during Spring 2010, we investigated the costs and benefits of eliminating trays in all Bryn Mawr College dining halls. From an environmental standpoint, going trayless saves energy, saves water, reduces food waste, and reduces polluting chemical use. These benefits are consistent with the college's mission to reduce its carbon footprint by 10% over the next ten years, as per the college Climate Action Plan. While we know the general environmental benefits, this report serves to quantify the potential savings that could be realized without trays, and analyze student sentiment toward this sensitive issue.

II. Methods

During the first couple of weeks of class, our Senior Conference course, Mathematical Modeling in the Environment, held a panel explaining various sustainability-themed projects the students in the class could work on during the semester. After ranking our preferences, we were assigned to head the Dining Services Trayless Investigation project.

Shortly after, we met with Angela Reason and David Chase to prepare for the semesters work and gather data we would need. In order to gauge student reactions and measure food waste savings, we held two "waste weighs" in Erdman during dinners on consecutive Tuesdays. We, along with members of our class, oversaw the events, by directing diners to scrape their food waste into a bin situated on a commercial scale next to the rotating tray belt. We encouraged students to dump only items that were compostable into the bin, requesting that they exclude napkins, bones, and any other plastic/paper products.

During the first Tuesday, April 6th, we conducted the waste weigh at dinner in Erdman with trays still available to students. On the following Tuesday, April 13th, we experimented by removing trays from all dining halls, and conducting the waste weigh at dinner in Erdman again. Using the results obtained from the waste weigh along with the number of students who ate in Erdman during each day for dinner, we were able to calculate the waste per student and compare the trayless versus non-trayless results.

The last step in our process involved sending out a survey to the Bryn Mawr community asking for feedback and information about possible changes in dining habits during the trayless meals.

III. Diners and Tray Users

We have assumed that 80% of students who eat in the dining hall during each meal use a tray, based on observation during the first waste weigh event on April 6th. The average number of diners per meal in each dining hall is given in the table below.

Table 1

	Erdman	Haffner	Total	Tray Users
Breakfast	520	0	520	416
Brunch	515	345	860	688
Lunch	585	427	1012	810
Dinner	530	475	1005	804
Total	2150	1247	3397	2718

Angela Reason, Project Manager for Bryn Mawr College Dining Services, provided this data.

IV. Washing and Drying Costs

Based on information provided by Dan Sorrels, Territory Manager for Ecolab Inc., the breakdown of tray washing and drying costs is as follows:

Table 2

Cost to Wash and Dry a Rack of Trays		Cost Per Tray
Utilities	$0.09	$0.01
Labor	$0.27	$0.03
Indirect	$0.03	$0.00
Ware Replacement	$0.07	$0.01
Chemical	$0.05	$0.01
Total	**$0.50**	**$0.06**

Utilities refer to the cost of the electricity and water needed to wash and dry the trays, which occur in the same cycle in the same machine. Labor costs are those associated with paying the workers needed to staff the dishroom. Indirect costs deal with parts and repair needed on the machine from everyday use. Although we don't have confirmation, we believe that Ware Replacement refers to the cost of replacing and/or repairing parts that have broken unexpectedly as opposed to those worn out over time. Lastly, Chemical costs are those measuring cost of detergents used per rack of trays.

To obtain the cost per tray, we took the values in the second column and divided by 8, the number of trays per rack. By breaking down the cost per tray, we can more easily compute the supposed savings over several categories as our other data is provided on a per tray basis.

Table 3

Period of Savings	Calculation Details	Savings per Period
Day	$0.06/tray * 2718 trays/day	$163.06/day
Week	$163.06/day * 7 days/week	$1,141.39/week
Fall Semester	$1141.39/week * 16 weeks/semester	$18,262.27/semester
Spring Semester	$1141.39/week * 17 weeks/semester	$19,403.66/semester
Total Academic Year	$18,262.27/semester + $19,403.66/semester	$37,665.94/academic year

Taking the cost per tray, $0.06, and multiplying by the assumed number of trays used, 2718, we obtained the aggregate cost of cleaning trays per day, week, semester and academic year. As you can see, Bryn Mawr could realize a savings of nearly $38,000 simply by not having to wash trays at every meal.

In addition to electric, labor and other related cost savings, the college could also save a substantial amount of water, providing environmental and financial benefits. With the help of Steve Regan of Singer Equipment, we were able to calculate the following water consumption of the Champion Model No. 86-PW Dishwasher.

From Table 1, we know that there are an estimated 2718 diners who use trays per day. Based on information from Dan Sorrels, we know that there are 8 trays per rack. Since water consumption by Singer Equipment was given in gallons/rack, we converted single trays to racks of trays, by dividing by 2718 by 8, to get 340 racks per day. Using 340 racks per day we can calculate the following:

Table 4

Period of Consumption	Calculation Details	Consumption per Period
Day	340 racks/day * .45 gal/rack	153 gal/day
Week	153 gal/day * 7 days/week	1070 gal/week
Fall Semester	1070 gal/week * 16 weeks/semester	17,123 gal/semester
Spring Semester	1070 gal/week * 17 weeks/semester	18,194 gal/semester
Total Academic Year	17,123 gal/semester + 18,194 gal/semester	35,317 gal/academic year

We attempted to calculate the cost savings this reduction of water usage would generate, researching as per suggestions by Deb Grant of Facilities Services, Harold Maryea of Facilities Services and through the Aqua America website. However, neither the information on cost per gallon of water nor the information needed for us to calculate cost per gallon could be found. Although we can't quantify the

amount of money we'd be saving, the values above show that in addition to having a large environmental impact, there are financial benefits to be gained as well.

V. Food Waste

Table 5

Food Waste *With* Trays (04/06/2010)		63.5 lbs
Number of In-Erdman Diners		376
Waste Per Person	(in lbs)	0.169
	(in ounces)	2.702

Table 6

Food Waste *Without* Trays (04/13/2010)		66.0 lbs	61.63 lbs (adjusted)
Number of In-Erdman Diners		382	
Waste Per Person	(in lbs)	0.173	0.16 (adjusted)
	(in ounces)	2.764	2.581 (adjusted)

The information provided in Table 5 shows the amount of waste measured during the 2-hour meal period in Erdman Dining Hall for the first waste weigh. We divided 66 lbs by 376, the number of diners who ate in Erdman that night, to get the amount of waste per person measured in pounds, 0.173, and ounces, 2.764, of which there are sixteen in a pound. Similarly, the first three columns of Table 6 show the same calculations for the data from the second waste weigh, when trays were removed from the dining halls. The fourth column shows the adjusted values, in which we've removed the weight of chicken bones from the total waste weight to better estimate actual compostable food waste. The details of this adjustment are described in the Assumptions section.

To calculate the reduction of food waste attributed to trayless dining, we took (new value of waste per diner– old value of waste per diner)/old value of waste per diner = (2.581-2.702)/2.581 = - 4.48%. This shows that there was a waste reduction of 4.48%. Some of this decrease could have been attributed to the menu and to error in our estimation of the amount of bone weight in the total waste reading. However, assuming that this figure is accurate, we rounded to a 4.5% decrease for simplicity, and calculated the amount of food waste we would save per day, per week, per semester and per year.

Table 7

Period of Consumption	Calculation Details	Consumption per Period (oz)	Consumption per Period (lbs)
Day	2718 students * (2.702 oz - 2.581 oz)	328.878 oz/day	20.555 lbs/day
Week	328.878 oz/day * 7 days/week	2,302.146 oz/week	143.884 lbs/week
Fall Semester	2,302.146 oz/week * 16 weeks/semester	36,834.336 oz/semester	2,302.146 lbs/semester
Spring Semester	2,302.146 oz/week * 17 weeks/semester	39,136.482 oz/semester	2,446.030 lbs/semester
Total Academic Year	36,834.336 oz/semester + 39,136.482 oz/semester	75,970.818 oz/academic year	4,748.176 lbs/academic year

To generate Table 7, we took the average number of students eating in all dining halls during every meal, 2718, and multiplied by amount of ounces of food waste savings that could be realized, 2.702 oz -2.581 oz. In order to see the greater impact of the reduction of food waste, we then determined the potential savings for a week, a semester, and an academic year. Converting the ounces per academic year into pounds per academic year, we see that 4,748.18 pounds per academic year could be saved if Bryn Mawr were to go trayless at every meal in both dining halls.

VI. Cups

Based on information from the waste weigh, we found that diners took 300 cups when trays were provided compared to 275 cups when trays were not used. In order to compare these numbers, we found cups used per person as follows:

300 cups/376 people = 0.7978 cups/person and 275 cups/382 people = 0.7198 cups/person.

Calculating the percentage decrease, we see that:

[0.7198 cups/person - 0.7978 cups/person] / 0.7978 cups/person = -9.77%.

Thus, the college reduces its cup usage by nearly 10%. This means less water and energy used in washing cups.

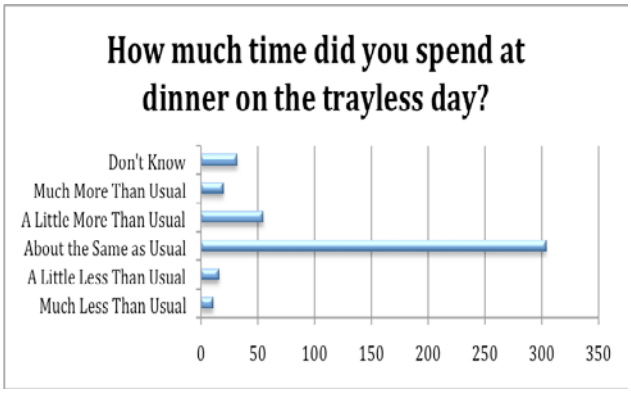
As an aside, we noticed that most Haffner diners take multiple cups of beverages due to their small carrying capacity. If Haffner decided to replace its cups with larger cups, similar to those used in Erdman, for a cost of $426.00, then the college would see a reduction in the number of cups taken by each diner per meal. There is

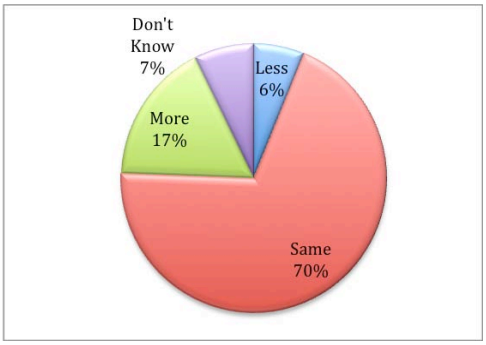
a cost of $51.12 per case (3 dozen or 36 cups). Haffner would need 300 cups and so we obtain 300 divided by 36 to get 8.33 cases needed. Multiplying $51.12 by the 8.33 cases needed, we get $426.00 total cost as cited above. Fewer cups imply lower washing costs and water use. We predict that the initial purchase cost of new cups would be made up in other savings.

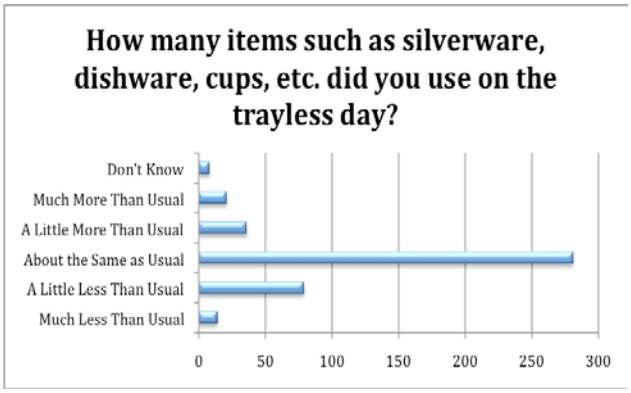
Another possible benefit of purchasing new cups in Haffner would be fewer cup replacement costs. Without trays, it is much more difficult to manage multiple items at once and so it can be expected that more cups will be dropped as a result. While the current Haffner cups are glass and will break, the larger, plastic Erdman-like cups will not shatter if dropped.

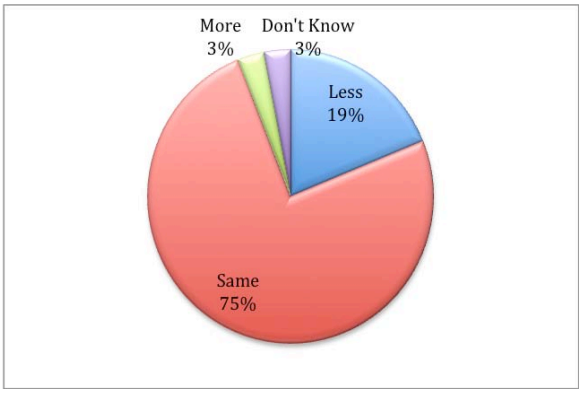
VII. Survey Results

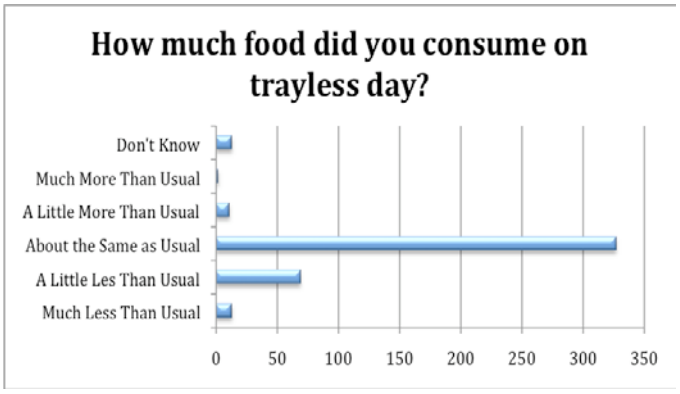
A week after the second waste weigh, we sent out a survey to the Bryn Mawr undergraduate community to ask for their change in eating habits and overall feedback on the trayless dining experience. The answers to the questions are as follows:

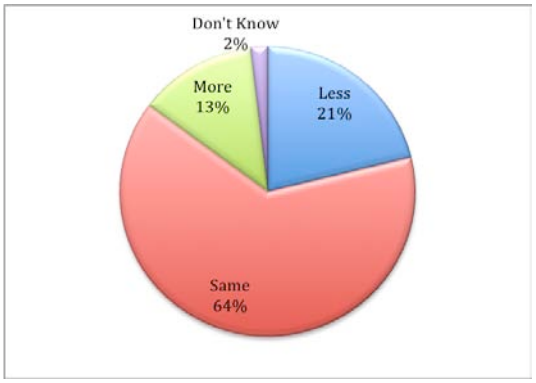


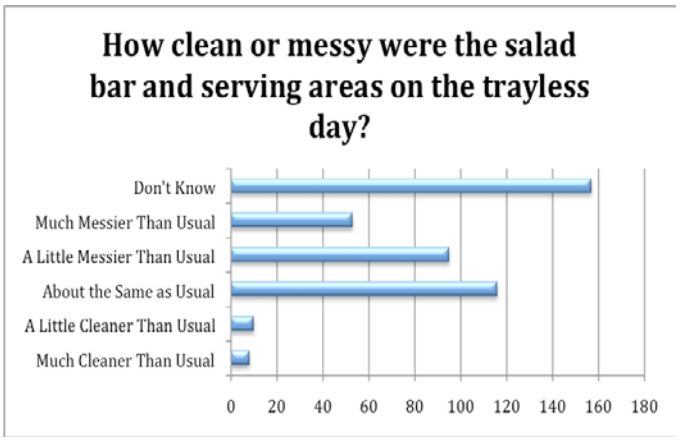


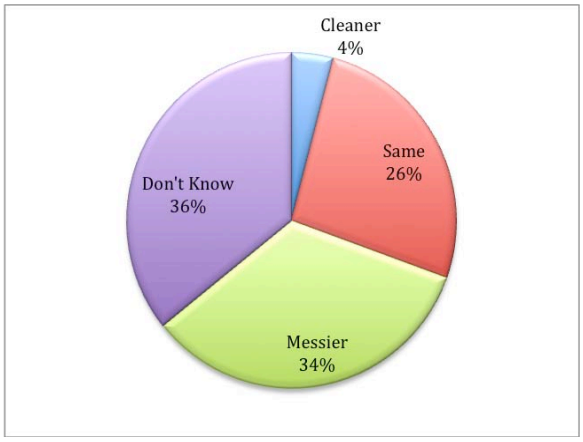


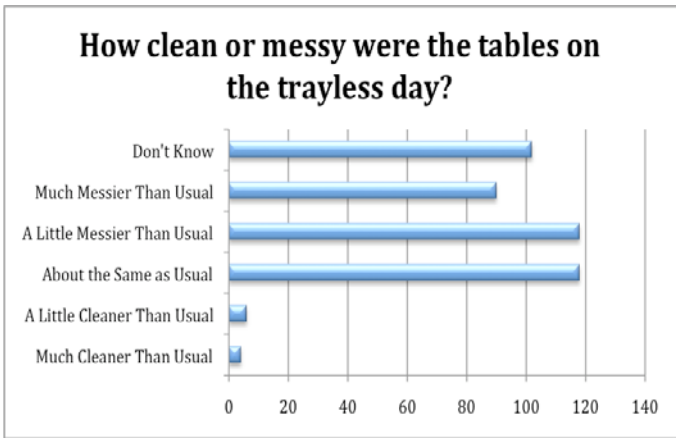


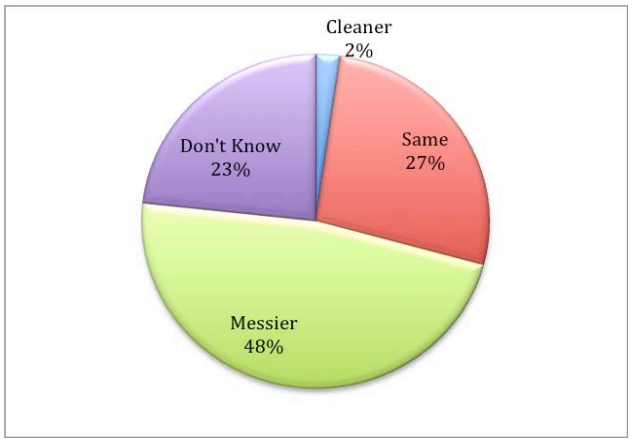




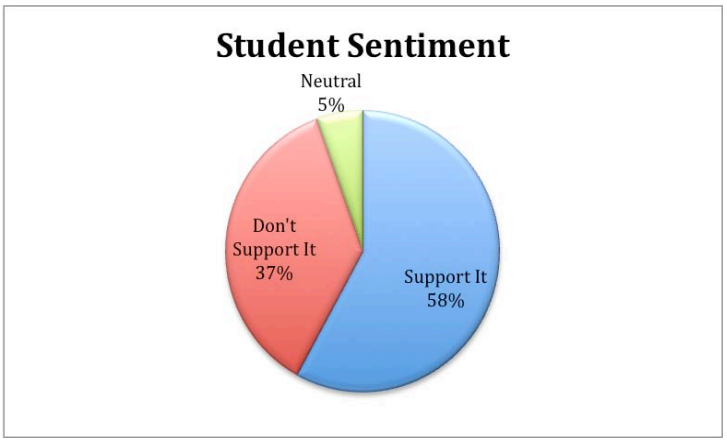








Student Sentiment	Count	Percentage
Support	244	57.96%
Don't Support	154	36.58%
Neutral	23	5.46%
Non-Tray Users	106	25.18%
Total	421	



The first 5 pairs of graphs and charts give student answers to the questions listed at the top of each bar chart. Each pie chart shows the same data from the bar chart directly to its left, but aggregates data into fewer categories. The table at the bottom of page 8 gives the breakdown of student sentiment and support of going trayless.

We found that most students, 58%, support the elimination of trays. However, even among supporters there were various suggestions about how the college should make the transition, including the purchase of larger cups and a slow reduction of trays available during each meal over a period of time. The majority of complaints raised the issues of student accessibility, cleanliness, dish breakage, and inconvenience.

VIII. Conclusion

In summary, our results show a potential:

- $37,665.94 savings in tray washing and drying costs over the academic year
- 35,317 gallons of water saved per academic year
- 4.5% reduction in food waste, or 75,970.818 ounces (4,748.18 pounds) per academic year
- 9.77% reduction in cup usage per meal

These values are based on assumptions made as described in Section IX. As our data collection was imperfect, these values are estimates only.

IX. Assumptions

Below is a list of assumptions we made in calculating the results presented in this report:

1. *20% of students don't use trays when dining* - This value is estimated based on our observations during the first waste weigh.
2. *Chicken bones* – We encouraged students not to place their chicken bones in the bin during the second waste weigh, but as there was some heavy traffic during certain periods, some people did not get the message in time. Our estimation that 35 people scraped their chicken bones into the bin comes from observation at the waste weigh. Based on internet research, we found that chicken thigh, leg and breast bones weigh between 1.5-2.5 ounces per serving. We took the estimated 35 people who threw bones into the bin and multiplied by the minimum and maximum range of the bone weight to get a range of 52.5-87.5 ounces in our total waste measurement. Converting ounces to pounds, we found the range to be 3.28-5.46 lbs. Taking an average of the maximum and minimum in the range, we got 4.375 lbs and subtracted

this from the total 66 lbs of waste measured on the scale to get the adjusted waste weight of 61.63 lbs.

3. *Academic year costs* – The savings results reported here do not include savings that could be realized during the summer months when Dining Services is open for other groups.
4. *Food consumption* – We are assuming that the same amount of food is consumed at each meal by an individual.
5. *Dish washer* – We assumed that the dish washers in Erdman and Haffner used the same amount of water and energy because we were unable to obtain the details of the Haffner unit.