Exploring the Economic, Environmental and Social Implications of Trayless Dining at Colgate University
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ENST 390
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Executive Summary

Throughout the Spring 2011 semester, our Environmental Studies 390 group has explored the environmental, economic and social costs and benefits of implementing a trayless dining system at Colgate University’s Frank Dining Hall.

In order to assess these different aspects, we collected data from primary and secondary sources and conducted our own experiments at Frank Dining Hall. After analyzing the data, we drafted a plan of action that offers recommendations to Frank Dining Hall and Colgate University Administrators.

We began data collection with a literature review of trayless dining and continued with interviews of key constituencies from Ithaca and Middlebury Colleges as well as Colgate University administration and employees. Interviews with Ithaca and Middlebury, institutions that have already switched to trayless dining, provided us with insight on the economic and environmental costs and benefits as well as student perceptions associated with transitioning to a trayless dining system. The interviews conducted within Colgate University yielded information regarding general feasibility and the administrative perspective on switching to trayless dining and provided us with the resources to conduct trayless experiments. Through these interviews, we learned that trayless dining is largely contingent on: 1) structural changes to the dish collection system, 2) student perception of trayless dining at Frank Dining Hall and the fear of increased congestion, and 3) the collection of data demonstrating the waste reduction benefits of trayless dining. With this in mind, we conducted a trayless experiment at Frank Dining Hall and collected energy, water and food waste data, issued optional surveys regarding student perceptions of trayless dining, and measured congestion within the dining hall both on days with and without tray usage.

During our trayless experiment, food waste decreased by approximately 10% on the day without trays relative to the day with trays. The energy data that we collected was not specific enough for our purposes and we recommend further exploration into potential savings. Regarding student perception, 33% of students surveyed did not support moving to trayless, 47% did support the switch, and the remaining 20% were indifferent. Based on survey and timing data, no increased congestion was caused by trayless dining.

Considering data acquired, we recommend that Colgate University:
1) Establish an educational campaign that informs students of the benefits of switching to trayless dining.
2) Following infrastructural renovations, conduct a two-week pilot program to expand the costs and benefits data provided in our study.
3) Implement permanent, non-voluntary trayless dining.
Introduction

Our project addresses the economic, social and environmental implications of trayless dining at the university scale. Specifically, our research question asks: do the benefits of switching to a trayless dining system in Frank Dining Hall at Colgate University outweigh the potential costs? We define a trayless dining system as an operation where students do not utilize trays to transport plates, bowls, utensils, or cups. Trays are only available for those students with special needs or circumstances. We define sustainability as the capacity to utilize resources and services while ensuring economic, social, and environmental equity, both locally and globally with equal consideration of present and future generations. Overall, our research analyzes whether or not trayless dining at Colgate is more sustainable than dining with trays.

Studies conducted at other universities that have implemented trayless dining have outlined the sustainability implications of this transition. In many cases, trayless dining has had positive environmental impacts, including reduced food waste and diminished dish detergent, water, and electricity use.\(^1\) Energy is conserved by eliminating the need to heat water for tray washing. Food waste decreases because students are less able to carry more than they can eat. Economically, less money is spent on water and electricity use as well as food waste removal. We anticipate that such environmental and economic benefits would be seen at Colgate if trayless dining were implemented. Socially, trayless dining promotes awareness of sustainability and encourages student involvement in an initiative which has positive environmental impacts.\(^2\) Both the potential for negative student response and the positive economic, environmental, and social benefits arising from trayless dining are considered in order to determine whether moving to a trayless system is the most sustainable option for Colgate.

Our research began with an analysis of colleges and universities that currently have trayless dining operations.\(^3\) Background research followed by interviews provided us with information that we used as a basis for comparing the implementation of various trayless systems throughout higher education institutions. We then carried out meetings with Frank Dining Hall administration in order to evaluate their perception of how trayless dining would affect operations at Colgate. Finally, we conducted an experiment in Frank dining hall, comparing food waste, congestion, water, and electricity data between days where trays were and were not used. During the experiment, surveys were also administered to gauge Colgate student perception of trayless dining at Frank. Based on our results, we provide several options for increasing sustainability of our dining infrastructure as it pertains to tray collection. We end with our recommendation of the most sustainable option for Colgate and a reflection on how trayless dining fits into the larger sustainability landscape at Colgate and beyond.

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\(^1\) Aramark, 2008.
\(^2\) Aramark, 2008.
\(^3\) See Appendix I for a list of schools implementing trayless.
Background

Trayless dining has numerous environmental, economic, and social implications. Many of its environmental and economic effects are highly interdependent and can be further subdivided into three main categories: energy savings, water savings, and food waste reductions.

I. Environmental and Economic Implications

In a dining system that employs trays, electricity and water must be used to wash each tray after use. A switch to trayless dining will therefore produce water and energy savings. Costs of maintaining the current conveyor belt system and replacing this system are also considered.

a) Energy Savings

Since the water used to sanitize trays must be heated to between $140^\circ F$ and $160^\circ F$, a significant amount of energy is required during the washing process.\(^4\) Also, the current conveyor belt runs and uses electricity for over 12 hours a day. Replacing this with a more efficient conveyor belt system or a window could therefore also decrease energy use. Additionally, wash water is heated by steam from Colgate’s wood chip gasification system, which itself has several associated environmental and economic costs. These costs include the negative environmental impacts of carbon sink losses due to logging and the production of $CO_2$ emissions generated during woodchip processing and transport. Many economic expenditures arise from this energy use, including the purchasing of wood, transportation, and the hiring of contractors to ensure production and delivery. Because trays are washed in a dishwasher that requires extended electricity inputs, cessation of tray usage would decrease the amount of electricity used by the dining hall and thereby diminish the environmental and economic costs of its operation. The low price of energy in the central New York region makes the economic benefits of this decrease in energy small, so the most significant impacts are the environmental benefits of diminished resource use.

b) Water Savings

Water savings are another obvious benefit to trayless dining. It takes between one third to one half of a gallon of water to wash a single tray.\(^5\) Since the transport and treatment of water entails significant costs, the anticipated reduction in water resulting from trayless dining will lead to significant monetary savings for Colgate. Schools that have already implemented trayless dining systems have reported large water savings, which attest to this projected economic and

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\(^4\) D. Fravil, personal communication, March 3, 2011.  
\(^5\) Curry, 2008.
environmental benefit. Williams College, being somewhat comparable in size to Colgate with approximately 2,029 undergraduates (Colgate has roughly 2,884 students), reports savings of 14,000 gallons of water each year since one of their four dining halls adopted trayless dining in the Fall of 2009.\(^6\)

c) Costs of Conveyor Belt Maintenance and Replacement

While many schools were able to transition to trayless dining without infrastructure changes, this will not be the case with Colgate University because of the structural incompatibility of Frank Dining Hall with trayless dining. The current conveyor belt system requires that plates, cups, and utensils be placed on trays in order to be carried to the dishwashing area. However, this 13-year old system is prone to frequent breakdowns that increase congestion in the dining hall, prevent Frank Dining Hall workers from cleaning dishes and trays in a timely manner, and require immediate attention by Buildings and Grounds.\(^7\) Due to the unreliability and inefficiency of this antiquated system, dining services expects to replace it within the next year. Estimates for replacing this system range from $80,000 to $100,000.\(^8\) We do not however consider this sum to be a direct cost of trayless dining because Dining Services needs to make this replacement to efficiently run the dining hall, regardless of whether or not trayless dining is implemented. Furthermore, any small additional cost that could possibly be incurred by installing a conveyor belt system that facilitates trayless dining would be offset by annual monetary savings resulting from food waste, water, and electricity reductions. Taking this into consideration, Dining Services employees have expressed their opinion that this conveyor belt system is a cost of maintaining the dining hall, and believe that when a new system is implemented, there is no reason for it not to facilitate trayless dining.\(^9\)

d) Food Waste Reductions

Numerous studies have shown consistent reductions in the amount of post-consumer food waste generated in dining facilities when campuses move to a trayless system. Aramark, a leading dining services contractor, conducted a survey of 186,000 students at 25 colleges and universities. The survey found that on days when trayless dining was implemented on these campuses, food waste was reduced by 25 to 30%.\(^10\) Sodexo, the dining services contractor for Colgate and many other higher education institutions, corroborates this finding noting that its campuses that have made the switch to trayless dining have seen, on average, a 30% decrease in

\(^6\) Foderaro, 2009.
\(^7\) G. Murray, personal communication, February 8, 2011.
\(^8\) G. Murray, personal communication, April 5, 2011.
\(^10\) Aramark, 2008.
food waste. These reductions occur because without trays, students can only obtain as much food as can fit on one or two plates.

The food waste reductions resulting from trayless dining saves money and benefits the environment. In 2008, food scraps made up the third largest sector of Municipal Solid Waste in the United States and contributed to 12.7% of the 250 million tons of waste. The vast majority of food waste ends up in landfills, where it decomposes to produce methane, a greenhouse gas that has an impact 21 times that of carbon dioxide on global warming. At Colgate, pre-consumer food waste is sent to the landfill and post-consumer food waste is run through a disposal system that is then discharged into wastewater. Consequentially, food waste created at Colgate directly increases the magnitude of environmental harm produced by the local landfill and waste water treatment plant.

Besides enhancing environmental quality, reducing the amount of food waste generated in dining halls also has economic benefits. A 2010 study observed an inverse relationship between food waste and profits in food service operations. Thus, companies like Aramark and Sodexo can reduce their purchasing budgets if food waste is reduced. Furthermore, disposal of food waste also entails costs associated with labor, transportation, and tipping fees. For example, the Madison County Landfill charges a tipping fee of $60 per ton of waste dumped. While the majority of Colgate’s post-consumer food waste goes through a disposal, some must be diverted to the landfill, incurring significant tipping fees. It is therefore in the best financial interest of food service contractors, like Aramark and Sodexo, and Colgate University to reduce food waste in their operations via the establishment of trayless dining at Frank Dining Hall.

II. Social Implications

Transitioning to trayless dining has several social repercussions. At schools that have done away with trays, complaints have arisen regarding increased congestion in dining areas, leading to some students having difficulty adjusting to the new dining experience. Accordingly, Frank administration has expressed concern over this issue and stressed that congestion and longer waiting times hinder adoption of a trayless dining system. This concern is especially relevant

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11 Sodexo, 2011.
14 J. Pumilio, personal communication, February 4, 2011.
15 Kwon et al., 2010.
17 M. Biette, personal communication, February 4, 2011; S. Piech, personal communication, February, 11, 2011
during high volume times, including the lunch and dinner hours, when a large number of
students must be fed during a relatively short amount of time.\footnote{G. Murray, personal communication, March 3, 2011.}

Although trayless dining may initially cause some feelings of dissatisfaction, in the long-term it
produces many social benefits. Firstly, a transition to trayless dining will promote and reinforce
campus-wide sustainability efforts, encouraging students to consider their personal role in
consumption and waste production.\footnote{Aramark, 2008.} Additionally, with green initiatives becoming a trend
amongst higher learning institutions, the switch would also improve Colgate’s image. This would
attract potential students who prioritize sustainability when deciding where to enroll. Finally,
trayless dining will also produce positive health benefits for students. For example, after making
the switch to trayless dining, the University of Illinois reported noticeably healthier eating habits,
such as students consuming smaller portions, in its dining halls.\footnote{University of Illinois Housing, 2010.}

Although the conversion to trayless dining varies across campuses, there are a number of
similarities amongst the case studies that have experienced the smoothest transitions. Generally,
transitions have been driven by dining management rather than students or university
administration.\footnote{M. Biette, personal communication, February 4, 2011; S. Piech, personal communication,
February, 11, 2011.} Most schools have seen reductions in food waste, water and electricity use,
which has thus resulted in direct economic benefits. In every case, there has been some minor
degree of student discontent. However, among schools that have transitioned rapidly (as the
majority of institutions choose to do), student discontent has generally dissipated quickly.\footnote{M. Biette, personal communication, February 4, 2011; S. Piech, personal communication,
February, 11, 2011.} Additionally, few schools have noticed increased congestion in dining areas as a result of
trayless dining. Sodexo has reported that 40% of their contracted campuses have switched to
trayless dining.\footnote{Sodexo, 2011.} One of the more telling facts that emerged from a survey of case studies is that
none of these schools that went trayless have reported switching back to tray use.\footnote{See Appendix I.}

III. Previous Research at Colgate University

In November 2009, Mike Girard, a student in Global Change and You, conducted four two-hour
sessions of plate-scraping at Frank Dining Hall. All four sessions occurred from 5:30 pm to 7:30
pm. The first two sessions, were conducted in conjunction with Colgate Hunger Outreach
Program (CHOP) on Tuesday, November 3rd and Thursday, November 5th. During these
sessions, students dined in the typical format, using trays. The second two sessions were
conducted on Tuesday, November 17th and Friday, November 20th, during which students were not allowed to use trays. Mike’s data showed an average 23.79% reduction in total food waste with trayless dining.\textsuperscript{25}

\textsuperscript{25} Girard, 2009.
Methods

We conducted a trayless experiment at Colgate University’s Frank Dining Hall seeking to determine the extent to which the implementation of trayless dining could decrease food and liquid waste and water and electricity use. We simultaneously addressed the administration’s concerns regarding possible congestion and the student perception of trayless dining through the use of student surveys. Data collection was performed over the course of two days. On March 10, 2011, students were able to use trays in order to collect data that could be used as a basis for comparison to our trayless data. Then, on March 24, 2011, data was collected and students were not allowed to use trays. On the trayless day, we handed out surveys for voluntary completion. In order to quantify congestion, time trials were conducted on both days comparing the time it took an individual to get their food. Independent t-test and g-test (log-likelihood test) analyses from the Statistical Package for the Social Sciences (SPSS) were used to determine differences between tray and trayless day for time trial/congestion data and the survey data, respectively. Water savings were computed using figures from Hobart Service, the manufacturers of Colgate’s dish-washing system, and electricity numbers were provided for Frank by a sub-metered system.26

For consistency and credibility, the data was collected on two Thursdays during the dinnertime rush, from 5:00 pm to 7:30 pm. The number of patrons during these times was recorded by Frank Dining Hall’s cash register at the entrance to the facility. On March 10th, the menu included a made-to-order omelet bar, spaghetti and meatballs, a self-serve nacho bar, and a curry based vegetarian dish. On March 24th, the menu contained grilled cheese sandwiches, chicken Pad Thai, carved spiral ham, and a vegetarian stuffed pepper dish. Consumer food waste was collected in front of the area where students normally return trays and plates to the automated conveyor belt, whereby they are brought to the dishwashing area. To avoid congestion, we asked students to place their trays and plates on a table, after which we scraped their waste into large garbage bins. Liquid waste, including beverages, soup, etc. was collected in nine-Liter containers. At the end of each collection period, food waste was measured (in pounds) on an industrial kitchen scale.

During the dinner period, two types of time trials were conducted to measure possible congestion. The first trial randomly selected students and recorded the amount of time they waited to get their food in a single line, noting the number of students in that line. The second trial also randomly selected students, recording the total amount of time it took them to gather their entire meal, which may have entailed collecting food from multiple lines.

Finally, we administered a survey to address the administration’s concern over student perception and congestion relating to trayless dining. Using a five-prong Likert scale, students

26 Hobart, 2011; P. Babich, Sub-metered Data, 2011.
were asked to evaluate their level of agreement with three statements from ‘strongly disagree’ to ‘strongly agree’. The statements were: “I felt inconvenienced by not having a tray”, “I think that the dining hall was more congested than usual”, and “I support moving to a trayless dining system at Colgate”. The opposite face of the survey listed some facts on trayless dining acquired during our background research. The complete text of the survey can be found in Appendix II.

27 Hay 2010.
Results

I. Food Waste Reductions

Our food waste calculations make the following assumptions:

1. Colgate produces 82 tons of food waste every year.\(^{28}\)
2. Colgate Dining Halls are open 210 days every year.
3. Colgate’s food budget was $2,061,000 in 2009.\(^{29}\)
4. Frank Dining Hall uses \(\frac{2}{3}\) of Colgate’s food budget, which equals $1,374,000.
5. Reductions in food waste will be reflected pound per pound in reductions in food purchasing.

Table 1: Experiment Results

<table>
<thead>
<tr>
<th>Patrons</th>
<th>Trays</th>
<th>Trayless</th>
<th>Reductions (trays-trayless)</th>
</tr>
</thead>
<tbody>
<tr>
<td>660</td>
<td>660</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Food Waste (lbs)</td>
<td>105</td>
<td>95</td>
<td>10</td>
</tr>
<tr>
<td>Liquid Waste (L)</td>
<td>34.5</td>
<td>22.5</td>
<td>12</td>
</tr>
</tbody>
</table>

Summary of the number of patrons entering Frank and the resulting liquid and food waste generated during our experiment.

Table 2: Annual Estimate of Savings

<table>
<thead>
<tr>
<th>Study</th>
<th>Food Waste Savings (tons/year)</th>
<th>Reductions (%)</th>
<th>Financial Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Our Experiment</td>
<td>7.8</td>
<td>9.52%</td>
<td>$128,234</td>
</tr>
<tr>
<td>Mike Girard</td>
<td>19.5</td>
<td>23.79%</td>
<td>$326,875</td>
</tr>
<tr>
<td>Sodexo Report</td>
<td>24.6</td>
<td>30%</td>
<td>$412,200</td>
</tr>
</tbody>
</table>

Expected food purchasing savings due to decreased food waste.
(See Appendix III for calculations on food waste data.)

Given our assumptions and various sampling data, Colgate can expect to save between $128,234 and $412,200 annually.

\(^{28}\) J. Pumilio, personal communication, February 4th, 2011.
\(^{29}\) Girard 2009.
II. Water Savings:

Colgate’s dishwasher is capable of washing 14,316 dishes per hour. Each dish is subjected to three stages of washing: pre-wash, wash, and rinse. The water usage for these stages has the ratio of 1:1.95:1.95, respectively. The pre-wash uses 68 gallons of water per hour, while the wash and the final rinse each use 132 gallons of water every hour. Adding these up, we find that the dishwasher uses 332 gallons of water every hour. From this, we can determine the amount of water used per dish, and therefore the amount of water savings Colgate could expect if trays were done away with.

Every day Frank washes between 2,300 and 2,875 trays. This means that 9,600 to 12,075 gallons of water per year are devoted solely to tray washing. Going trayless will completely eliminate this water usage.

III. Energy Savings

Sub-metered data collected by Peter Babich was not targeted enough to draw any conclusions about the effect of trayless dining on energy use. While trayless dining should produce energy savings, the sub-metering at Colgate can only look at Frank Dining Hall’s energy usage as a whole, of which tray washing accounts for only a small percentage. Thus, changes in energy usage throughout the building, due to variables such as the outside temperature or the types of meals being cooked for the day, render it extremely difficult to measure the energy savings arising from decreased water heating for trays.

IV. Student Perception

We gauged student perception with a survey distributed to 79 voluntary respondents. We did G-tests (or log-likelihood tests) on the data from our survey.

Table 3: Responses to Survey Question 1

<table>
<thead>
<tr>
<th>I felt inconvenienced by not having a tray</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Totals</td>
<td>25</td>
<td>17</td>
<td>9</td>
<td>15</td>
<td>13</td>
<td>79</td>
</tr>
<tr>
<td>Percentage</td>
<td>32%</td>
<td>21%</td>
<td>11%</td>
<td>19%</td>
<td>17%</td>
<td>100%</td>
</tr>
</tbody>
</table>

For the data on whether or not people were inconvenienced by not having a tray, we calculated a p-value of 0.09. There is not a statistically significant difference of our data from the expected values of 50% agree (including agree and strongly disagree) and 50% disagree (including agree

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30 Hobart, 2011.
31 See Appendix IV for calculations on water savings.
32 P. Babich, Sub-metered Data, 2011.
and strongly disagree). This implies that there were not significantly more or less people who felt inconvenienced due to the removal of trays.

Table 4: Responses to Survey Question 2

<table>
<thead>
<tr>
<th>I think that the dining hall was more congested than usual</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Totals</td>
<td>22</td>
<td>34</td>
<td>20</td>
<td>2</td>
<td>1</td>
<td>79</td>
</tr>
<tr>
<td>Percentage</td>
<td>28%</td>
<td>43%</td>
<td>25%</td>
<td>3%</td>
<td>1%</td>
<td>100%</td>
</tr>
</tbody>
</table>

For the data on whether or not people felt the dining hall was more congested during the trayless day than usual, we calculated a p-value of <0.001. There is a statistically very significant difference of our data from the expected values of 50% agree (including agree and strongly disagree) and 50% disagree (including agree and strongly disagree). This implies that there were significantly less people who thought there was not added congestion due to the removal of trays.

Table 5: Responses to Survey Question 3

<table>
<thead>
<tr>
<th>I support moving to a trayless dining system at Colgate</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Totals</td>
<td>11</td>
<td>15</td>
<td>16</td>
<td>13</td>
<td>24</td>
<td>79</td>
</tr>
<tr>
<td>Percentage</td>
<td>14%</td>
<td>19%</td>
<td>20%</td>
<td>17%</td>
<td>30%</td>
<td>100%</td>
</tr>
</tbody>
</table>

For the data on whether or not people supported moving to trayless dining, we calculated a p-value of 0.16. There is not a statistically significant difference of our data from the expected values of 50% agree (including agree and strongly disagree) and 50% disagree (including agree and strongly disagree). This implies that there are not significantly more or less people who support trayless, and therefore not significantly more or less people who have a negative response to moving to trayless.
V. Congestion Data

Figure 1: Data from timing of people in the pizza line at Frank. The p=0.459 for the independent t-test run on this data, showing that there was not a significant difference in time over number of people (representing congestion) between the trayless and tray days. Error bars show standard error.

Figure 2: Data from timing of people in the entree line at Frank. The p=0.037 for the independent t-test run on this data, showing that there was a significant difference in time over number of people (representing congestion) between the trayless and tray days. Error bars show standard error.

Figure 3: Data from timing of people in the deli line at Frank. The p=0.387 for the independent t-test run on this data, showing that there was not a significant difference in time over number of people (representing congestion) between the trayless and tray days. Error bars show standard error.

Figure 4: Data from timing of people in the whole dining area at Frank. The p=0.000 for the independent t-test run on this data, showing that there was a significant difference in time (representing congestion) between the trayless and tray days. Error bars show standard error.
Data on time spent in line and the number of people in line demonstrated increases in waiting times for students in the pizza and deli lines\textsuperscript{33}, but these data were not statistically significant. The data collected on mean waiting times in the entree line and overall time spent in the dining area indicated statistically significant less time spent on the trayless day\textsuperscript{34}. This suggests that congestion should not be considered a significant reason for dismissing trayless dining in Frank Dining Hall.

It should be taken into consideration that the Dining Hall menus were different on our two observed days. This extra variable suggests that our timing data is neither exhaustive nor conclusive. The observed variations in the general dining area, pizza line, and entree line could be explained by differences in the food served. However, the data for the deli line is not affected by menu variation because the deli offerings remain relatively constant.

VI. Summary of Findings

On the day where trays were available, 369 (56\%) patrons opted to use a tray. The current dining system yields an average of 0.16 pounds of food waste and 0.05 liters per person per meal.

Our data and projections suggest that if trayless dining is implemented:
- Between $128,234 and $412,200 will be saved from annual food waste reductions\textsuperscript{35}.
- Between 9,660 and 12,075 gallons of water will be saved annually.
- There will be no increase in congestion, as demonstrated by both our timing data and survey responses\textsuperscript{36}.
- There will not be an overwhelmingly positive or negative response, as shown by the lack of a significant difference in the number of students who support or do not support trayless\textsuperscript{37}.

\textsuperscript{33} See Figures 1 and 3
\textsuperscript{34} See Figures 2 and 4
\textsuperscript{35} See Table 2
\textsuperscript{36} See Figures 1, 2, 3, and 4 and Table 4
\textsuperscript{37} See table 5
Options to Improve Sustainability

I. Assumptions
Our recommendations assume that the current conveyor belt system will be renovated and changed to facilitate trayless dining. We know that the current system breaks often and is in need of replacement. Costs to complete this project are estimated to be between $80,000 and $100,000. Because this update is a dining hall necessity, this price will not be considered an economic cost of switching to a trayless system. Furthermore, Mr. Fravil and Mr. Murray note that if a new system is to be integrated it will facilitate trayless dining.

Currently, the dining hall is researching a new conveyor belt system. While the construction of such a system has been highly successful for schools such as the Rochester Institute of Technology, it may be worthwhile for Frank Dining Hall to consider other options. One such option is to have collection bins and a collection window (as implemented by Ithaca College), which could ultimately be less expensive to construct. This would be more economically sustainable because it would eliminate the cost of repairs and electricity to run the conveyor belt. Hence, additional infrastructure options available should also be considered when renovating the current conveyor belt system in order to reduce economic and environmental resource use to the largest feasible extent.

A funding proposal for a new system will be submitted in the fall of 2011 and renovations will hopefully begin in summer of 2012. Recommendations are made based on this time frame. Within all of our recommended options, we believe that awareness efforts should be carried out prior to the implementation of any further actions.

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40 S. Piech, personal communication, February 11, 2011.
41 G. Murray, personal communication, April 5, 2011.
II. Awareness

Offer educational materials and raise awareness regarding trayless dining. Even without a formal trayless dining system intact, student tray use will hopefully decrease as they gain knowledge of the economic, environmental, and social benefits of going trayless.

a) Costs & Benefits

The cost of supplying educational information to students would be minimal, with benefits likely to outweigh costs. Costs include the price of printing educational materials and time and effort spent compiling information and making it available to students (posting on website, having conversations, etc). With education about trayless dining, students may be more likely to choose and promote trayless dining. More students choosing to dine without a tray will translate to Colgate receiving the various economic, environmental, and social sustainability benefits associated with trayless dining.

b) Guidelines for Implementation

An informational board about trayless dining should be set up in Frank providing case studies of schools that have gone trayless and an overview of the various benefits of making the switch. Similar information should be posted on the Colgate sustainability web page, which could be linked off of the dining services portion of Colgate’s website. Other options include having a Brown Bag about trayless dining as it relates to food waste and sustainability or having a committee at Green Summit which focuses on implementing trayless dining. Compost Club and Colgate Hunger Outreach Program’s (CHOP) efforts relating to food waste awareness should be encouraged. Currently, CHOP holds several “Scrape the Plate” events throughout the year where CHOP volunteers scrape students’ food waste during dinner. Ideally, a trayless day could be combined with Scrape the Plate and all food should be taken to Colgate’s compost site.

III. Two Week Pilot Project

A two-week pilot project where students are encouraged not to use trays (or not allowed to use trays) would be beneficial to collect and compile more data on food waste, water, and electricity use. During this time, educational efforts should be expanded upon where students have a trial period to get used to trayless dining. After reviewing the data and student reactions over two weeks, a decision should be made as to whether Colgate should implement occasional or permanent trayless dining.

a.) Costs and Benefits
Extensive support by students, clubs, the dining hall, and other individuals will be necessary to carry out the pilot project. Individuals will have to devote time and effort to educating students about trayless dining, collecting data, and facilitating the project. However, this two week commitment may make students, as well as Frank staff and administration, more receptive to permanent trayless dining. Greater support is likely to correlate with greater economic and environmental savings.

b.) Guidelines for Implementation

Based on our trayless experiment, at least four people are needed to collect and scrape food waste and put dishes and silverware on the conveyor belt. Collecting many dishes on a single tray and putting many trays on the conveyor belt at once may have inconvenienced the dishwashing staff by causing periods of congestion in the dish-washing room. No other method of tray collection and waste disposal was feasible with the number of volunteers present. While CHOP and Compost Club may be willing to provide student volunteers to facilitate such events, it is unlikely that they would have the man power resources necessary to conduct a full day of trayless dining or have more than a few trayless days per semester. Thus, in order to avoid both negative perceptions of trayless dining and significant time inputs by both Frank staff and students, we recommend that the two-week pilot project not be attempted until a new conveyor belt system is in place.

Interested students should collaborate to plan the pilot project during the spring semester and the project should begin during the fall semester immediately following renovations. Whether a club to support sustainable dining should be formed or existing clubs should collaborate to promote this initiative depends on the amount of student support. Data collection should follow the methods used for this study and, if possible, expand to full days of data collection that gather data on all meals for two weeks.

IV. Occasional Trayless Dining

Another option for implementing trayless dining is to have weekly meals or days designated as being trayless on a permanent basis. For example “Trayless Tuesdays” or “Wasteless Wednesdays” should be designated as the one day a week that students are not allowed to use trays in the dining hall.

a.) Costs and Benefits

The costs of occasional or voluntary trayless dining are similar to those arising from a university dining facility becoming permanently trayless; however fewer benefits make this a less attractive option. Student resistance to a transition could either increase or decrease with occasional
trayless dining. Students may be more accepting of a trayless system if a complete switch is not demanded, or they could be less willing to adapt because trayless days would feel more like an inconvenience instead of part of their routine. The reduction of resource use for washing trays and reduction of food waste will yield economic and environmental benefits, but not to the same degree as permanent trayless.

b.) Guidelines for Implementation

Theoretically, occasional trayless dining could begin next fall, although facilitation would be much more difficult without the installation of a new conveyor belt system that facilitates trayless dining. For the reasons outlined above, we do not recommend occasional trayless dining begin until fall 2012, after renovations.

V. Permanent and Non-Voluntary Trayless Dining

The final and most traditional option for going trayless is to completely remove trays from Frank (except for students with special circumstances). Middlebury is an example of an institution that successfully implemented this option. Under this scenario, students would not have an option to use trays. All meals would be trayless, as opposed to one meal a day or week. Such a change could be made at Colgate as soon as the current conveyor belt system is renovated.

a.) Costs and Benefits

The cost of switching to a permanent trayless system will be primarily social, and benefits will be environmental, economic, and social. The main social cost to consider is student resistance. Based on our survey, 33% of students oppose trayless dining at Colgate. However, other schools noted that resistance present during the beginning stages of trayless dining dissipated rapidly, and we can expect that this will be the likely outcome at Colgate as well. The social benefits to switching to permanent trayless dining include raising campus-wide awareness of food waste and sustainability as it relates to trayless dining by inciting a dialogue about such benefits. Economic benefits include reductions in the cost of water, electricity, detergent, and food. Environmentally, these reductions will also diminish resources consumption and waste generation.

b.) Guidelines for Implementation

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42 See Table 5
Whether or not a pilot project is conducted, permanent trayless dining can begin following renovations. Trays should be removed from the dining hall and donated to local schools or soup kitchens. Research will need to be done to determine if any local organizations are in need of trays, and if not, if they can be recycled. Surveys should also be conducted to determine if student perception of trayless dining has improved. Data on savings of food waste, water, and electricity use should be documented.
Recommendation

Following an educational campaign and pilot program, Frank Dining Hall should implement a permanent, non-voluntary trayless dining system over the summer of 2012.

Based on our primary and secondary research, this recommendation will produce the largest decline in the social, environmental, and economic costs associated with campus dining systems when compared to systems that involve occasional or voluntary trayless dining. Going trayless over the summer will allow Colgate to renovate Frank during a time when there is not a large influx of students. Implementing the change over the summer also has the benefit of introducing a new class of freshmen to the system who have no prior exposure to the old system and therefore cannot use it as a basis for disgruntled comparison. Additionally, by choosing to implement this plan, the renovation will pay for itself in less than a year.\textsuperscript{44}

\textsuperscript{44} See Table 2.
Reflection

Colgate has made many advances in sustainability, including increasing recycling bin infrastructure, building a community garden, hiring a sustainability coordinator, serving more local foods at dining halls, and experiencing the proliferation of green groups on campus. Trayless dining has been part of the sustainability movement at many of Colgate’s peer institutions, including Middlebury and Ithaca, due to the decrease in food waste, electricity, and water use when trays were removed. These reductions in consumption have economic, social, and environmental benefits which affect the local and global community. This is due to the fact that resources are limited and ecological impacts of consumption are dispersed through space and time.

Trayless dining offers a more socially, environmentally and economically sustainable approach to campus dining at Colgate. As fuel and energy costs rise, the cost of food also increases due to increasing costs of transportation and farm operation. Mike Stagnaro, the Executive Chef at Frank Dining Hall, notes the pressure to supply students with local and quality foods while maintaining a reasonable cost for meal plans. Additional higher quality, more sustainable local foods may become more feasible for Colgate to purchase if the budget savings associated with trayless dining are utilized in Frank. Food and liquid waste are directly related to decreasing profits in dining services. Coupled with rising food prices and increasing landfill tipping fees, this creates an economic burden. Environmentally, food and liquid waste at Colgate are either put in disposal, to end up in the waste water system, or taken to the landfill. Amounts of food waste are directly related to the amount of energy and chemicals needed to clean water and the amount of pollution created by landfills, as well as landfill size. Socially, our current dining system with trays does not promote sustainable practices or awareness of local and global equity as it pertains to sustainability.

As an educational institution, Colgate plays a role in shaping the opinions and choices of its students, who in turn shape the institution. Implementing trayless dining influences more than just the raw numbers of water and electricity use and food waste. It will also influence student, parent, faculty, and staff attitudes towards sustainable dining. Through trayless dining, Colgate has the opportunity to demonstrate the feasibility and benefits of trayless dining while promoting sustainability. Our survey results showed that 47% of Colgate students support trayless dining, demonstrating a large student desire for a more sustainable dining option. This sentiment should be given serious consideration because it represents consumer demand as well as student role in administrative decisions. After an in depth investigation and careful comparison of the costs and benefits of trayless dining as they pertain to Colgate, we have found that trayless

45 M. Stagnaro, personal communication, March 10, 2011.
46 See Table 5
dining is the most sustainable option because it reduces the economic and environmental costs of water, electricity and food consumption, while addressing student desire and promoting sustainability.
Acknowledgements

We would like to thank Matthew Biette and Stephanie Piech from their respective institutions of Middlebury and Ithaca Colleges, for providing us with information about their schools’ conversions to trayless dining; George Murray, Mike Stagnaro, and Dan Fravil for allowing us to conduct our experiment in Frank Dining Hall and providing us with an abundance of help and information necessary for us to determine the different options for transitioning to trayless dining at Frank; John Collins and Roy Langworthy for providing building expense information for Frank Dining Hall; and John Pumilio and Frank Frey for guiding us throughout our project - providing us with heaps of helpful information and steering us in the right direction every step of the way.

Bibliography


Appendices

Appendix I. A Partial List of Schools That Have Gone Trayless (At one or more Major Dining Halls):

- Alfred University
- Brown University
- Columbia University
- Emory University
- Hamline University
- Dartmouth University
- Georgia Institute of Technology
- Ithaca College
- Louisiana State University
- Middlebury University
- New York University
- Princeton University
- Radford University
- Rice University
- Rochester Institute of Technology
- San Diego State University
- Skidmore College
- St. Lawrence University
- St. Norbert College
- Unity College
- University of Alaska Fairbanks
- University of Arkansas
- University of California - Berkeley
- University of California – Santa Cruz
- University of Connecticut
- University of Florida
- University of Kansas
- University of Kentucky
- University of Minnesota
- University of New Hampshire
- University of North Carolina
- University of San Diego
- Utah State University
- Virginia Tech
- West Virginia University
- Western Oregon University
Besides these Universities, several schools, such as Harvard, Colby, and the University of Maine at Farmington, have been implementing more gradual programs that feature trayless dining once a week. On one single Trayless Thursday, Colby saved 575 pounds in food waste (66% of the total normally generated) while the University of Maine at Farmington saved an estimated 46 pounds of food waste per person for year with the same program.
Appendix II. Survey

This survey is for the ENST 390 class Community Based Study of Environmental Issues, in which we are evaluating the sustainability of trayless dining. Student perceptions of trayless dining will contribute to our data so we value your input.

For each question, please check the box that represents your opinion:

1. I felt inconvenienced by not having a tray.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
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2. I think that the dining hall was more congested than usual.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
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3. I support moving to a trayless dining system at Colgate.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
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Fact Sheet provided with survey to students on day of trayless dining:

- Trayless dining is proven to reduce food waste, water, chemical, and energy usage. (Sodexo North America 2008-2009 Corporate Citizenship Report)
- On average, campuses that have gone trayless have seen a 30% reduction in food waste. (Sodexo North America 2008-2009 Corporate Citizenship Report, Aramark Higher Education Dining Styles 2008)
- Every day, Frank washes between 2,300 and 2,875 trays. That’s around 70 gallons of water a day used to wash trays.
- Emory University has saved approximately $800 a month in food costs by going trayless and is putting this money back into buying local food.
- Illinois University has found that students are making healthier food choices since going trayless.
Appendix III. Food Waste Calculations:
Based on our data, recorded over two days in March of 2011:
9.52% of 82 tons food waste per year = 7.8 tons
9.52% of 1,374,000 = $128,234 saved in food costs

Based on Mike Girard’s data, recorded over four days in November of 2009:
23.79% of 82 ton food waste per year = 19.5 tons saved
23.79% of $1,374,000 = $326,875 saved in food costs

Based on case studies that have reported an average of 30% food waste savings:
30% of 82 ton food waste per year = 24.6 tons saved
30% of $1,374,000 = $412,200 saved in food costs

Appendix IV. Water Calculations:
332 gal/hr x (1 hr/14,316 dishes per hour) = .02 gal/dish

Frank has 575 trays stocked a minimum of 4 times daily (we’ll assume 4 times minimum and 5 times maximum) (Girard 2009)

That means that every day, Frank washes between 2,300 and 2,875 trays

2300 trays/day x .02 gal/dish = 46 gal/day devoted solely to tray washing
2875 trays/day x .02 gal/dish = 57.5 gal/day devoted solely to tray washing

210 total school days x 46 gal/day = 9,660 gal/yr
210 total school days x 57.5 gal/day = 12,075 gal/yr