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Project Motivation and Scope

The structure of the project is shaped around the following three parts:

- Methodology search – What are the significant projects happening at MIT, MIT Sloan and outside and what they teach us about the environmental footprint to measure and the appropriate methodology;
- Initial assessment try-out – Calculation of MIT Sloan’s current environmental footprint
- Conclusions and recommendations – How we can improve the MIT Sloan’s ecological footprint, the awareness of the community and confirm MIT Sloan as a leading organization for sustainability.

MIT Sloan, as well as the entire MIT community, is overwhelmed with numerous “green” initiatives. Although such a trend is an encouraging proof that “greening/sustainability” issues at MIT have reached a momentum, which will most likely not reverse, these initiatives face important challenges. The most important one may be rationality: What impacts? On which specific issues do such enthusiastic initiatives pursue? How impactful? How implementable is an initiative compared to others?

Those questions are fully legitimate and require that

- Clear, practical and adapted\(^1\) definitions of greening and sustainability be agreed upon; and
- Quantitative and/or qualitative impact assessments be performed.

The underlying idea is that MIT Sloan would increase the efficiency of its “greening” actions if it had a shared and deeper understanding of the actual environmental footprint and unsustainable behaviors of its community.

In view of the above considerations, this project aims at initiating the development of an environmental footprint assessment tool that would help guide MIT Sloan’s greening/sustainability efforts.

Eventually, such a tool should serve two purposes:

- Understand the roots of MIT Sloan environmental footprint
  i.e. its various components (types of emissions, pollutions, wastes...), their relative importance in terms of environmental impact and the types of unsustainable behaviors that amplify and/or cause such footprint.
- Establish a systematic cost-benefit analytical framework for MIT Sloan’s greening/sustainability initiatives

\(^1\) In our case, it means adapted to the MIT Sloan community specificities.
i.e. organizing/prioritizing possible actions according to various dimensions, e.g. potential impact on footprint reduction, degree of feasibility/control and financial cost.

As mentioned above, having a clear perception of (i) what should/can be assessed and (ii) which methodology should be used, is an essential prerequisite for such studies. Rather than engaging in a theoretical analysis of what this study should look at and how, we opted for a more practical approach, which consisted of researching available and implementable environmental footprint assessment methodologies and/or tools that would fit the above stated objectives.

The only limitation that was set “a priori” in the scope of this study is that it will only focus on MIT Sloan, as a standalone organization, and its community, i.e. Faculty, Staff and Students. Moreover the environmental impact of these populations will be restricted to that of their activities, which are directly related to MIT Sloan.

1. Methodology search – What environmental footprint to measure and how

1.1. Web search

Many tools are available online to calculate ecological footprints. These tools are provided by companies (BP, Ben & Jerry’s, etc.), by associations (Green Peace, WWF, etc.), by governmental agencies or departments, or by joint ventures.

The vast majority of them concern the footprint of individuals. They consist of short questionnaires and ask information on the way of living (such as the place where the person lives, the area of the house or apartment, transportation and travel habits, etc.). These calculators usually apply to the inhabitants of one country. The level of accuracy of such tools is limited by the fact that they ask estimates and use intervals (a typical question is: do you spend less than 10 hours, between 10 and 50 hours or more than 50 hours in planes each year?) rather than precise numbers. However, they provide users with a useful estimate of their ecological footprint. Please see appendix 1: links towards ecological footprint calculators.

Similar calculators focusing on some specific aspects also exist. For example, there are some calculators dedicated to transportation, commuting, water use or recycling. Please see appendix 1.

Finding more accurate or flexible tools is a challenge. Organizations interested in assessing their ecological footprint most of the time have the tool designed and built to meet their needs. Universities often build the tool internally, as is the case for MIT. Other organizations have the estimation made by consultants or specialists. The Global Footprint Network offers such services.

EPA Victoria (or Environment Protection Authority) is an Australian organization working for the Ministry for Environment and the Environment Protection Board. It has created some calculators
designed for specific businesses, activities or institutions. In particular, the one we focus on is dedicated to schools. It reaches a level of accuracy higher than other calculators available online.

1.2. Footprint assessment initiatives at MIT

1.2.1. Footprint – “Evaluating our Ecological Footprint… because nobody likes big feet”

The Footprint website is a student run initiative that started in the fall semester of 2002 as part of a class project for 11.122 “Environment and Society” at the Department of Urban Studies and Planning (DUSP). The website is now intended to act as a clearinghouse for research and initiatives about MIT and the environment.

Studies on the ecological impact of 4 areas – Energy, Transportation, Waste and Water – have been conducted throughout MIT. None of them however has focused on the integrated global footprint of MIT as a whole or any of its schools or departments. We present here below for each area a list of the major studies conducted. Contexts, conclusions and recommendations of these studies can be found in Appendix 2. Further details for each study can be found at [http://footprint.mit.edu](http://footprint.mit.edu).

<table>
<thead>
<tr>
<th>AREAS</th>
<th>STUDIES AND SCOPES</th>
<th>DATES</th>
</tr>
</thead>
</table>
| Energy   | “After hours” – Survey of electric waste in 6 academic buildings during nights, weekends and holidays  
“Athena” – Analysis of energy use of computers and printers in Athena clusters  
“Dorm energy use” – Analysis of energy consumption (refrigerators, laundry and lifelong habits) of various dormitories | Fall 2002 |
| Transportation | Survey of the MIT community on how people commute to and from campus | Fall 2002    |
| Waste    | Analysis of waste recycling practices in five campus dining facilities  
“MIT waste audit” – Analysis of waste composition | Fall 2002    |
| Water    | Assessment of water usage and conservation in various campus facilities (dorms, academics, utilities and recreation)                                                                                       | Fall 2002    |

2 A recent study conducted by DUSP on DUSP’s global greenhouse gas footprint is the first attempt of an integrated analysis. Although this study is not yet published on the Footprint website, we have been in contact with DUSP and will summarize hereafter their methodology and main results.
1.2.2. 2007 Greenhouse Gas Emissions Audit of DUSP

In the spring semester of 2007, DUSP initiated the first integrated environmental footprint audit, which aimed at assessing DUSP's greenhouse gas emissions. The audit was led by Frank Hebbert as a term project for 4.406 Ecologies of Construction. We summarize here below the methodology DUSP used as well as the main results they obtained. Further details can be found at http://web.mit.edu/dusp/green/audit/about.htm.

Following the idea that understanding and quantifying emissions at the department level would provide better guidance for identifying efficient actions and routes to reducing our environmental impact as a community, DSUP focused on analyzing the extent and sources of its greenhouse gas emissions. They specifically look at greenhouse gases rather than a wider environmental footprint analysis for two main reasons:

- Greenhouse gas emissions have become a scientifically proven and undisputable factor of the climate change phenomenon. Moreover, in 2002, the City of Cambridge has set a specific target of a 20% reduction in greenhouse gas emissions within the city from 1990 levels by 2010. Reducing MIT's greenhouse gas footprint is therefore a priority.

- Two recent MIT sponsored studies developed advanced methodologies to assess MIT's energy use and greenhouse gas emissions. In particular, those methodologies are adapted to MIT's specificity of being both an energy consumer and a producer with the cogeneration power plant.

This audit looked at emissions over which DUSP has some direct control, along 5 dimensions: long-distance travel, commuting to school, buildings, material inputs and waste disposal. It naturally bounded these dimensions to DUSP's domain of action, e.g. rooms that DUSP owns in the facilities database. Data came from various years. For instance, student enrollment figures were from 2007 whereas all other figures were from 2005 or earlier.

The analytical methodology used in this audit is summarized in a diagram presented in Appendix 3.

The results of this audit are very preliminary and necessitate a number of ameliorations. They are nonetheless quite stunning. DUSP's annual activities are responsible for the release of at least 1,100 metric tons of greenhouse gases per year. This is equivalent to approximately 5 metric tons per person.
in DUSP, or a community of 70 homes. The largest sector of emissions was travel, emitting 412 metric tons or 53% of the total. Energy consumed by DUSP’s buildings and facilities accounted for 390 metric tons or 36% of the total.

The detailed breakdown of emissions for each of the 5 dimensions is given below:

![Emissions Breakdown Graph]

According to Frank Hebbert’s own words, further work is required to create a better estimate of emissions, and make recommendations for change on the basis of the above evidence. Auditing greenhouse gas emissions should be part of regular department processes. He also emphasizes that other comparative studies with other schools and institutions are needed to improve the accuracy of both methodologies and results. For instance, Tufts University carbon audit identifies greenhouse gas emissions at Tufts at 2.18 MTCDE\(^8\) compared to 5 MTCDE for DUSP.

1.2.3. Other initiatives at MIT

The number of initiatives is constantly growing thanks to a good momentum but for the moment it is difficult to keep track of all initiatives.

Therefore as much as we would like, we cannot claim that all of the MIT footprint initiatives that we highlighted represent an exhaustive list of all what has been done at MIT since 2002 on this issue.

Therefore we wish to mention several MIT structures that should be further researched for additional information:

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other than carbon dioxide are converted into an equivalent volume of carbon dioxide on the basis of their global warming potential.

\(^8\) See Tufts University’s 2001 greenhouse gas emissions inventory for 1990 and 1998.
Three founding MIT thesis\(^9\):

- Greening MIT: Generating Indicators for Campus Environmental Management by Jonathan D. Leifer (2005) can be found at http://footprint.mit.edu/misc/jleifer-indicators.pdf

Sustainability at MIT: http://sustainability.mit.edu/Main_Page

MIT Generator: http://sustainability.mit.edu/Generator

“Walk the Talk” committee (MIT Sloan student representative: Jason Jay, MIT Sloan faculty representative: John Sterman)

“Sustainability at Sloan” committee

1.3. Footprint initiatives at other universities

The topics of environment and sustainability have now gained a huge focus across universities in the United States and worldwide. For example, you may find in the thesis\(^{10}\) by Jonathan D. Leifer mentioned in the above paragraph, highlights of 9 recent audits at other US universities.

We suggest that a possible S-Lab project for next year be an in-depth analysis of environmental footprint/sustainability initiatives and actions taking place at Boston area major universities, i.e. Tufts, Harvard, Suffolk, Boston Universities and Northeastern University.

2. Initial assessment try-out – Calculation of MIT Sloan’s current environmental footprint

2.1. Survey

2.1.1. The objectives

The objectives of the practical part of the project at Sloan are to:

- Assess Sloan ecological footprint;
- Analyze of Sloan ecological footprint;
- Analyze the Sloan community relation towards sustainability;
- Make recommendations to improve Sloan ecological footprint.

\(^9\) Abstracts of each paper can be found in Appendix 4

\(^{10}\) See pages 15 to 19
2.1.2. The ecological footprint and Global hectare

For this project, we decided to use the ecological footprint methodology and the global hectare as a unit. This methodology and this unit are very commonly used to assess the ecological impact of any human activity.

The ecological footprint is defined as “the area required to provide the goods and services consumed by individuals, communities or organizations” (Please see http://www.steppingforward.org.uk/tech/footprint.htm). For example, in order to cook a meal of rice and fish, we need sea to fish, land to grow the rice, and land to re-absorb the CO2 produced during the cooking. Furthermore, each type of land does not have the same efficiency (one acre of desert has a nearly zero productivity). We therefore need a new unit to measure the productive of a parcel of land.

The unit commonly used for the calculation of ecological footprint is the global hectare. A global hectare (gha) is defined as “productivity weighted area used to report both the biocapacity of the Earth, and the demand on biocapacity (the Ecological Footprint). The global hectare is normalized to the area-weighted average productivity of biologically productive land and water in a given year.” (Please see: http://www.footprintnetwork.org/gfn_sub.php?content=glossary)

The surface of Earth is 51bn hectares. There are approximately 11.3 billion global hectares, is a quarter of the Earth’s surface. The remaining three-quarters of the Earth’s surface (deserts, ice caps, deep oceans, etc) have very low levels of productivity and cannot be harvested. With 6.6 billion human beings on Earth, the number of global hectares available per person is 1.7. Going beyond this limit means that we are destroying the Earth resources. In average, a person in the USA has a footprint of 9.5 global hectares.

2.1.3. Methodology

Several options were possible in order to assess Sloan ecological footprint. We could build our own tool, use an existing tool without any modifications or refine an existing tool.

We found that building our own calculator was not a feasible option. Although it would provide us with a tool that would meet all our needs and would give the most precise and accurate results, it would be a project on its own, requiring a significant amount of time and a team of specialists.

The second option was to use a ready-made online calculator. Although it would have been the easiest solution, we would not have reached the desired level of accuracy. Some of Sloan’s particularities would not have been taken into account such as the high number of airplane travels, MIT cogeneration plant providing energy for the university, etc.

The third option, which was to refine an existing tool, therefore seemed to be the best option. We took into account two categories of factors: technical and behavioral. Technical factors include elements such as energy, water consumption, buildings, etc. Behavioral factors include commuting, dietary, etc. habits of the Sloan community.
The methodology and tool developed by DUSP would have perfectly met the needs of this project for the technical factors. The team is currently working on a web-based tool that other MIT departments/schools could use to analyze their own greenhouse gas footprint. Unfortunately, the building of the tool is still on progress. It should be finished by next fall semester. Our approach for this project is therefore to use a gross approximation of the impact of the technical factors (as precise figures will be available soon) and to focus on behavioral factors. We strongly recommend that our calculations should be upgraded as soon as the DSUP tool is available.

As explained above in the “web search” section, we looked for an appropriate tool that could be the basis of our assessment. We eventually decided to use, as a basis, the tool created by EPA Victoria. This calculator uses a set of data that will give an approximation of the impact of the technical factors. The behavioral aspects are captured through a questionnaire. This tool has been designed specifically for schools, and therefore addresses many of Sloan’s specific issues. However, its flexibility is limited and it will not allow us to consider every aspect of activities at Sloan. We therefore mitigated this flexibility hurdle by including several aspects that were not taken into account at first by the tool:

- The number of times per week people have dinner at Sloan;
- The number of computers (desktops and laptops) people personally own and use for their activity at Sloan;
- The number of trips people made during the year for holidays, recruiting, treks, labs, conferences, business, etc.

In order to gather the behavioral data we needed for our calculation, we created a web-based questionnaire (please see exhibit 2: Questionnaire) based on the one provided by EPA Victoria for their original tool. A link towards the questionnaire was sent to the Sloan community by Pr. Eppinger, as we believe that his authority as Deputy Dean would increase the rate of answer. The Sloan community had two weeks to answer questionnaire (the two last weeks of April). Furthermore, Pr. Eppinger allowed us to incentivize people to answer by offering to the 200 first persons who would complete the survey coffee and bagel from the E-52 Refresher course. One week after the first mail, Pr. Eppinger and the team agreed not to send a reminder as the rate of answer was fairly satisfactory. We then analyzed the results as described in the following sections. You will find below in the “scope” section a comprehensive description of the data collected. You will find the conversion rates used to calculate Sloan Ecological footprint in Appendix 6: conversion rates.

2.1.4. Scope

This section describes all the elements taken into account in the calculation of Sloan ecological footprint.

2.1.4.1. The Sloan Community
We included in the calculation the behavioral factors of three groups of people having a regular activity within Sloan:

- MIT Sloan Faculty;
- MIT Sloan Staff;
- MIT Sloan students.

We assessed their impact on the environment by asking questions on their habits and way of living:

- Dietary habits:

  - Do people usually include meat in their meals? The agricultural processes for producing meat require significantly more energy than for vegetables. It adds one more step as vegetables are necessary to feed cattle. In addition, land must be used to grow the cattle. Therefore the ecological impact of a meal including meat is much more important than of one without.
  
  - How many times per week do people have dinner at Sloan? We decided to take these meals into account because of the unusually high number of people having dinner at Sloan compared to other educational establishments.
  
  - Where do people take their meal? The answer to this question provides information on where and how to implement actions to modify dietary habits.

- Commuting habits:

  - How far do people live from school? The answer determines the number of miles people travel per year just to go to Sloan. The environmental impact of commuting increases with distance.
  
  - How do people get to school? The ecological impact of driving is twice or three times higher than the one of using the subway, for example.

- Consumption habits:

  - How many books people buy per year (excluding course packets)? How many of these are second-hand?
  
  - How many sheets of paper people print each week? What percentage of recycled paper do people use?
  
  - How much do people spend on office supply each year?
  
  - How many computers do people personally own?

- Travelling habits: we decided to include in the calculation all the travels made by the Sloan community for personal or professional reasons. The vast majority of the community is students, who often moved to the Boston area to go to Sloan. We therefore assumed that the travels they made were a direct consequence of their activity at Sloan. For the purpose of the study, we differentiated between short distances (small, large and hybrid cars, train, bus, short flights) and long
distances (flights). In order to estimate the distance people fly each year, we divided the Earth in 15 parts. We then asked people how many flights they take each year from Boston to each of these parts. We then associated to each part an average distance corresponding to a city located in this part. You will find in appendix 7: Air travel methodology the different parts of the world we identified, the associated cities and the distance to Boston. We calculated the ecological footprint by finding the global hectare needed for 1 mile of travel for short or long distance flights.

- Recycling: In order to estimate the % of paper, bottles and cans, we used the answers given to the question: “Do you usually recycle at Sloan?”. We estimated that the percentage recycled matched the percentage of positive answers. An important remark here is that the EPA tool calculate the amount of bottles, cans, etc. recycled based only on the number of students, staff, faculty and the number or meals that include meat. Veggie meals are not a part of the calculation.

2.1.4.2. Buildings, energy, gas, water

In order to assess Sloan’s ecological footprint, we gathered information concerning the Sloan facilities:

- We included in the scope E-51, E-52, E-53, E-40 and the area where E-62 is being built. This is a rough estimate as Sloan does not occupy these buildings entirely and has space in other buildings such as E48, E60, E70, NE20, and a joint lab in E19. However, we believe that this estimate will be enough to have an idea of the ecological footprint due to these buildings. Once the tool prepared by the DSUP is available, these points should be refined.

<table>
<thead>
<tr>
<th>Building</th>
<th>Construction date</th>
<th>Nb. Floors</th>
<th>Gross area (square feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-51</td>
<td>1944</td>
<td>4</td>
<td>104,477</td>
</tr>
<tr>
<td>E-52</td>
<td>1938</td>
<td>7</td>
<td>145,143</td>
</tr>
<tr>
<td>E-53</td>
<td>1964</td>
<td>4</td>
<td>94,028</td>
</tr>
<tr>
<td>E-40</td>
<td>1930</td>
<td>5</td>
<td>106,277</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>793,573</td>
</tr>
</tbody>
</table>

Source: https://floorplans.mit.edu/

- We estimated the total surface of Sloan to be 215,000 square feet.

- You will find below the number used for electricity, gas and water consumption.

<table>
<thead>
<tr>
<th>Building</th>
<th>Electricity (kWh)</th>
<th>Gas (Mega joule)</th>
<th>Water (Mega liter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-51</td>
<td>1,015,000</td>
<td>0.00</td>
<td>77.00</td>
</tr>
<tr>
<td>E-52</td>
<td>1,433,297</td>
<td>8.12</td>
<td>402.10</td>
</tr>
<tr>
<td>E-53</td>
<td>973,200</td>
<td>0.01</td>
<td>63.30</td>
</tr>
<tr>
<td>E-40</td>
<td>1,640,953</td>
<td>0.65</td>
<td>65.70</td>
</tr>
<tr>
<td>Total</td>
<td>5,062,450</td>
<td>8.78</td>
<td>608.10</td>
</tr>
</tbody>
</table>

Source: MIT Annual Utilities Usage, SAP July 06 to June 07

2.1.5. Quantitative results
We sent a questionnaire to the entire Sloan Community. You can find below the response rate to the survey.

<table>
<thead>
<tr>
<th>Nb. of persons</th>
<th>Faculty</th>
<th>Staff</th>
<th>Students</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nb. Surveyed</td>
<td>226</td>
<td>236</td>
<td>1,500</td>
<td>1,962</td>
</tr>
<tr>
<td>% Surveyed</td>
<td>9.3%</td>
<td>25.0%</td>
<td>13.7%</td>
<td>14.6%</td>
</tr>
</tbody>
</table>

We assume the group of persons who responded to our survey is representative of the Sloan community. However, it is likely that the people who answered this survey were the ones most concerned about sustainability. We can have no certainty on representativeness of the group surveyed.

You will find in Appendix 8: numerical results the detail of the numerical results of the survey will related statistics.

2.1.5.1. The ecological footprint

In this section, we will present first the ecological footprint of the three groups inside the Sloan Community: Faculty, Staff and Students. We will then present Sloan global ecological footprint. All the tables present results in gha.

2.1.5.1.1. Faculty

Based on the questionnaire and the conversion rates (see Appendix 6), we calculated the ecological footprint for one faculty member. You will find below the numerical results and the graph associated.

**Ecological footprint of one Faculty member (in gha):**

The “Travel” section includes the trips made other than commuting and by plane. The air travel section represents alone 51% of the ecological footprint, i.e. 1.2gha. The second most significant item is goods.
with an ecological footprint of 0.5 gha, far behind the air travel part. The next most important sections are commuting and travel. Then comes the food section with 0.1 gha. It is interesting to notice than in the total average ecological footprint of an American, food represents approximately 30%. In this project, we only took into account the meals taken at Sloan, 5.6 per week for a faculty member (see the dietary habits section above). If we count 3 meals per day, a person takes 21 meals a week. This would give 0.5 gha for a faculty member. We can conclude that for Sloan faculty members, travels in general (by alls means and for any reasons) represents a much bigger part and food a much smaller part of the ecological footprint than in average for Americans. An important caveat here is that Sloan buildings are not a part of this section. Their impact is added in the Sloan Ecological Footprint section below.

The US Census Bureau (http://www.census.gov/ipc/www/popclockworld.html) estimates that the total population on Earth on Monday, May 05, 2008 is 6,665,794,195 persons. There are 11.3 billion global hectares available on Earth. Therefore, the ecological footprint of faculty members related to the total number of persons living on Earth represents 1.42 Earth. In other words, if all human beings had the same activity than Sloan Faculty (taking into account only the scope of this calculation), 1.42 Earth would be needed to sustain this way of living. We should emphasize here the fact that the scope of the project is limited. Activities outside of Sloan are not taken into account in this calculation.

2.1.5.1.2. Staff

You will find below the same table and graphs than in the section devoted to the ecological footprint of faculty members.

Ecological footprint of one Staff member in gha:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Ecological Footprint in gha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>0.1274</td>
</tr>
<tr>
<td>Commuting</td>
<td>0.4469</td>
</tr>
<tr>
<td>Travel</td>
<td>0.2865</td>
</tr>
<tr>
<td>Air travel</td>
<td>0.2537</td>
</tr>
<tr>
<td>Goods</td>
<td>0.5613</td>
</tr>
<tr>
<td>Recycling</td>
<td>(0.0016)</td>
</tr>
<tr>
<td>Total</td>
<td>1.6741</td>
</tr>
</tbody>
</table>
The ecological footprint of staff members is much lower than the one of faculty members. It represents 69% of the Faculty ecological footprint. The difference in the three sections related to travel, in particular, is remarkable: a total of 0.99gha for staff vs. a total of 1.82gha for faculty (staff impact is 54% of faculty impact). Air travel was, by far, the most important section for the professors whereas, here, it is only the fourth one. The “goods” section is here, the most important one and differs a lot from what we found for the Faculty. Inside this section, the main difference is the amount of money spent each year on office supplies: staffs spend in average 750$ whereas faculty members spend 166$.

If we had taken into account the 21 meals per week, the ecological footprint of food would be 0.53gha. This is closer but yet still below the average impact of food for an American.

By making the same calculation than in the section devoted to the ecological footprint of faculty members, we find that, if all human beings had the same activity than Sloan Staffs, 0.99 Earth would be needed to sustain this way of living.

### 2.1.5.1.3. Students

You will find below the same table and graphs than in the section devoted to the ecological footprint of Faculty and Staff members.

**Ecological footprint of one Student in gha:**

![Ecological Footprint for 1 Student](image)

<table>
<thead>
<tr>
<th>Ecological Footprint in gha</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>0.1770</td>
</tr>
<tr>
<td>Commuting</td>
<td>0.1107</td>
</tr>
<tr>
<td>Travel</td>
<td>0.2876</td>
</tr>
<tr>
<td>Air travel</td>
<td>1.3682</td>
</tr>
<tr>
<td>Goods</td>
<td>0.2442</td>
</tr>
<tr>
<td>Recycling</td>
<td>(0.0013)</td>
</tr>
<tr>
<td>Total</td>
<td>2.1865</td>
</tr>
</tbody>
</table>

The ecological footprint of a student is 2.2gha, compared to 1.7 for Staff and 2.4 for Faculty members.

In general, the ecological footprint of a Sloan student is similar to the one of a Faculty member. The main difference is air travel: 51% of a Faculty member ecological footprint and 63% for a student. This
may be explained by the higher number of long term flights made by students (3.8 per student vs. 3.6 per professor).

By making the same calculation as in the previous sections, we find that if all human beings had the same activity than Sloan students, 1.29 Earth would be needed to sustain this way of living.

### 2.1.5.1.4. Sloan Ecological Footprint

In order to calculate Sloan global ecological footprint, we included the ecological footprint of the 226 Faculty members, 236 Staffs and approximately 1500 Students. We also included the ecological impact of the buildings and of the 26,000 meals served annually (with an assumed 20% of veggie meals) for the executive programs.

**Sloan ecological footprint in gha:**

<table>
<thead>
<tr>
<th>Component</th>
<th>Ecological Footprint in gha</th>
</tr>
</thead>
<tbody>
<tr>
<td>School Building</td>
<td>2,110.4</td>
</tr>
<tr>
<td>Food</td>
<td>338.4</td>
</tr>
<tr>
<td>Commuting</td>
<td>365.7</td>
</tr>
<tr>
<td>Travel</td>
<td>544.2</td>
</tr>
<tr>
<td>Air travel</td>
<td>2,402.4</td>
</tr>
<tr>
<td>Goods</td>
<td>608.0</td>
</tr>
<tr>
<td>Recycling</td>
<td>(2.8)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6,366.3</strong></td>
</tr>
</tbody>
</table>

The total ecological footprint of Sloan is 6,366gha.

As we can see, air travel is still the most important part of this footprint, as it represents 38% of it. This percentage is lower compared to the ones found in the sections above because of the very significant ecological impact of the buildings (this section includes electricity, water, gas, etc.): 33% of the total footprint. In total, in order to sustain the way of living at Sloan, if all human beings shared our way of living, 1.99 Earth would be required.

You can see below two graphs showing the breakdown of the Sloan Community and the groups/items’ impact on Sloan ecological footprint.
The students are accountable for 52% of the footprint. This high number makes sense as they represent 76% of the Sloan Community. The Faculty represents 9% and the Staff 6%. If the impact of each group of the community was the same, Students would represent 51%, Faculty and Staff each 8%. This is consistent with the sections above that enlightened the lower impact the Staff on the environment compared to Faculty members and students.

A part of the questionnaire asked the people taking the survey to assess the sustainability of their behavior. We asked them to evaluate themselves and to assign notes to their behavior, 1 being very poor and 10 excellent. The table below shows the results.

<table>
<thead>
<tr>
<th>Ecological self assessment</th>
<th>Faculty</th>
<th>Staff</th>
<th>Students</th>
<th>Global</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecological self assessment</td>
<td>5.43</td>
<td>6.12</td>
<td>5.96</td>
<td>5.92</td>
</tr>
<tr>
<td>Ecological footprint (in gha)</td>
<td>2.41</td>
<td>1.67</td>
<td>2.19</td>
<td></td>
</tr>
</tbody>
</table>

The results show that the Sloan Community members evaluate themselves well compared to their peers. The staffs have the lower ecological footprint and grade themselves better than the other two groups. In the same way, Faculty members have a higher ecological footprint and assign lower grades to themselves.

2.1.5.2. Sensitivity analysis

For factors that seemed to us important and relevant (where some actions could be taken – for example, we did not perform any analysis concerning the distance between homes and Sloan assuming that no measures implementable at Sloan could make people live closer from school), we performed a simplified sensitivity analysis to assess the potential impact of actions.

2.1.5.2.1. Dietary habits

The first area we investigated was dietary habits. As we have seen in the previous sections, the presence of meat in a meal has an important effect on the ecological footprint of this meal: it multiplies it by a 2 or 3 factor. (See exhibit 3: conversion rates). At Sloan, 72% of people eat meat in their meals. The table below shows the difference in total food ecological footprint, should this percentage decrease till 60%.
Impact of the % of veggie meals going from 28% to 40% in gha:

<table>
<thead>
<tr>
<th></th>
<th>Ecological Footprint in gha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food (40% veggie)</td>
<td>303.6</td>
</tr>
<tr>
<td>Food</td>
<td>338.4</td>
</tr>
<tr>
<td>Difference</td>
<td>(34.76)</td>
</tr>
<tr>
<td>%</td>
<td>-10%</td>
</tr>
</tbody>
</table>

As you can see, if 40% of the meals eaten and served at Sloan were veggie meals, the ecological footprint of the food at Sloan would decrease by 10%. This represents on average no more than 2 lunches per week without meat. However, as food represents no more than 6% of the total ecological footprint of Sloan, such an action would have a very limited impact on the global ecological footprint.

2.1.5.2.2. Commuting

A factor that can be easily modified is the mean of transportation to go to Sloan every day. We therefore estimated the impact of a drastic change of behavior: we assumed that each member of the Sloan community previously using their cars would use public transportation.

Impact of a general use of public transportation:

<table>
<thead>
<tr>
<th></th>
<th>Ecological Footprint in gha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commuting(No car)</td>
<td>156.2</td>
</tr>
<tr>
<td>Commuting</td>
<td>365.7</td>
</tr>
<tr>
<td>Difference</td>
<td>(209.5)</td>
</tr>
<tr>
<td>%</td>
<td>-57%</td>
</tr>
</tbody>
</table>

If the members of the Sloan Community stopped using their cars to go to Sloan, the ecological footprint of commuting would decrease by 57%. Some measures are going to be implemented at MIT next year in order to favor such a change. According to these calculations, they are likely to have a positive impact on Sloan and MIT footprint.

2.1.5.2.3. Air travel

Convincing the Sloan Community to reduce the amount of flights taken may prove to be impossible. Some travels are mandatory for business reasons. It is also unlikely that students will be willing to travel less as travelling a lot is considered to be one of the main advantages of Business School. However, as air travel represents 38% of the total ecological footprint of Sloan, it is interesting to know what would be the impact of a 10% decrease in air travels.

Impact of a 10% decrease of air travel in gha:
The analysis shows that a 10% in air travel would decrease the total ecological footprint by 3.8%. Implementing measures that would decrease the number of mandatory flights for the community could therefore have a significant impact on the ecological footprint.

2.1.6. Qualitative results

You will find in this part answers to qualitative questions that have been asked during the survey.

### 2.1.6.1. Interest and involvement of the Sloan Community

We wanted to know how people felt about sustainability, assuming that it would give clues on how to provoke a change.

<table>
<thead>
<tr>
<th>Are you interested in sustainability issues?</th>
<th>Faculty</th>
<th>Staff</th>
<th>Students</th>
<th>Global</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>90%</td>
<td>100%</td>
<td>90%</td>
<td>92%</td>
</tr>
<tr>
<td>No</td>
<td>10%</td>
<td>0%</td>
<td>10%</td>
<td>7%</td>
</tr>
</tbody>
</table>

In average the Sloan community is very concerned about environmental issues as 92% of surveyed people answered that they were interested in these issues.

There were many types of positive answers. Among these ones, many expressed a strong concern about the environment and the need to change, to go back to what is seen as older, healthier and more traditional practices. Some answers concerned the necessity to include sustainability in business and other even expressed some fears about the future. In general, answers are enthusiastic; denote a strong will to change, to improve along with the consciousness that there are very easy steps to be made. According to the answers, it is likely that people will modify their behaviors of they are provided with guidelines.

On the contrary, we found only one type of explanations for the negative answers: lack of quality information. Some people seem to be overwhelmed with contrary and not convincing information. The result is distrust. Sustainability is seen as a mere fashionable word without strong, qualitative and scientific roots.

The role of the Sloan in raising awareness is not clear. Some answers suggested that Sloan had increased awareness, allowed people to understand their impact better and helped them change their behavior.
Other answers indicated that sustainability at Sloan was reduced to renewable energies, that this subject was not enough or even not at all talked about at Sloan.

The second question was whether people were as “green” as they wished to be.

Are you as Green as you want to be?

<table>
<thead>
<tr>
<th></th>
<th>Faculty</th>
<th>Staff</th>
<th>Students</th>
<th>Global</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>33%</td>
<td>12%</td>
<td>14%</td>
<td>15%</td>
</tr>
<tr>
<td>No</td>
<td>67%</td>
<td>88%</td>
<td>86%</td>
<td>84%</td>
</tr>
</tbody>
</table>

In general, the Sloan Community is not satisfied with its level of sustainability. There are very diverse reasons. The most common ones are:

- It is too expensive;
- Green behaviors are often contrary to social norms;
- People confess the difficulty to change their habits and to stay motivated;
- People must choose between time and convenience.

Many members of the community regret that too much does not depend on them, such as too much air conditioning, heating, lights on too often, or too much paper required. They have the feeling that they cannot be green, even if they wish too. They would certainly welcome any initiative from Sloan to improve its ecological footprint or any commitment towards sustainability. It would reinforce their involvement and their motivation.

As a conclusion, there is a need for education and commitment: education to teach to willing people how to change their behaviors and, when appropriate, to convince people of the validity of the process and commitment to lead the community.

2.1.6.2. Dietary Habits

We asked people where they usually have lunch. The table below shows the results:

As you can see, the E-52 Refresher course and the Sloan events are most frequent answers. In the category “other”, we found that many people brought their lunches from home. This means that there is here some room for improvement as Sloan can have some influence either by selecting their suppliers, either by giving sustainable guidelines. Sloan could promote for example food grown locally, veggie food, recycled/recyclable packaging, etc.
2.1.7. Next Steps and improvements

Some steps may be taken and improvements made in order to better assess Sloan ecological footprint. We listed below the ones we considered to be the major ones.

As explained in the methodology section, the calculation for the impact of buildings, electricity, gas and water are rough estimates. Once the tool currently designed by the DSUP is available, a more precise calculation will be easily doable and should be included in this calculation.

The refresher course in E-52 building has not been taken into account for this project. A study of the activity, of the supply process and of the management of waste could usefully complete this study.

We took into account computers owned and used by the Sloan Community but not other devices such as printers, photocopiers, etc.

The recycling processes at Sloan and more generally in MIT are, so far, not well understood. We understand that MIT does not match the recycled items with a building or a department but manages them in a centralized way. Understanding better this process and have figures would be useful to correct the calculation. Furthermore, we assumed that no electronic device was being recycled at the end of their life. This subject should also be investigated in a next step.

As described above, we assumed that the breakdown of the footprint of air travel was the same than the one of large cars. Should more accurate numbers made available (or found), the breakdown should be corrected.

Most of the calculation explained above relies on the calculator developed by the EPA Victoria. We assumed that this calculator was a quality tool and that their estimations were correct. However, having access to the methodology that was used to create that tool would allow assessing better the accuracy of the calculation we made, and perhaps correct and/or complete it.

3. Conclusions and Recommendations

3.1. Conclusions

As already mentioned, the study we conducted is greatly imperfect. Many refinements, some of which we have suggested throughout this document, can be imagined to improve this analysis. Nonetheless we feel that 2 major conclusions should be drawn from this preliminary work.

(A) The sensitivity analysis that we performed on the survey data as well as qualitative data collected corroborate 2 important points that have been discussed at length in many S-Lab classes this semester:

20/51
i. Shifts in habits and behaviors of members of the Sloan community must be huge and systematic to induce substantial improvements on Sloan’s environmental footprint. The natural or even incentivized occurrence of such shifts is therefore a very important question, which is the source of heated debates. Tackling this question goes beyond the scope of this study.

ii. Beyond shifts in personal habits and behaviors, systemic/policy level actions seem to bear much greater potential for meaningful impacts on a community’s environmental footprint. The draft list\(^\text{11}\) of possible actions, policies or guidelines that Sloan could pursue to induce meaningful impacts is a good illustration of this reality. However, it is crucial to recognize that public/community awareness is one of the most, if not the most important driver of systemic/policy level actions as it pressures organizations and governing body to act. Qualitative data of survey points also to another fact that is often overlooked: the positive feedback loop that systemic/policy level actions create on individual habits and behaviors. Indeed many of the persons surveyed indicated that a strong commitment and clear actions from Sloan would reinforce their commitment and involvement towards sustainability.

(B) We started this project with the usual research process in order to get familiar with the matter at hand. After a lot of bouncing here and there, we were surprised to discover the extent of initiatives and projects that the MIT community has developed to better understanding and assess its environmental footprint. We have tried to relate the gist of the information we found in the first part of this study. However, in doing so, we have realized that our hope of presenting an exhaustive panorama of these initiatives and projects was an impossible task. We found ourselves trapped in some sort of inextricable maze. Even if a dedicated study addressed this issue, we are afraid that a substantial amount of interesting work is lost for good. Moreover, despite an undisputable increase in the average momentum around “green”/sustainable issues, the trend pattern of this momentum seems to suffer from huge swings. For instance, most of MIT footprint assessment initiatives detailed herein took place in 2002. Although very few projects seem to have taken place since then, we hope that this initiative as well DUSP’s one will reinvigorate the much needed energy of our community on this issue.

Good intentions clearly exist on all sides of the MIT community. Nevertheless it is important to stress that so far the MIT community has not been very effective at implementing processes that foster the creation of building blocks. Such building blocks constitute however essential cornerstones to the development of efficient long-term actions.

Reasons for such a phenomenon are numerous and complex. Yet experiences of unsuccessful coordination attempts we read about, almost always refer to 2 main root causes that can be summarized as follows:

\(^{11}\) See Recommendations below.
i. MIT often present a rather unwieldy network of departments, offices, committees, subcommittees etc…; and

ii. The lines of communication and coordination between these various groups are often leaky.

We can only re-emphasize here the importance of coordinated integration where by an appropriate structure organizes and channels effectively questions, concerns, suggestions and actions.

### 3.2. Recommendations

On the basis of the above conclusions, we wish to make the following recommendations:

**A) Bringing Sloan best management and leadership practices to the handling of these issues**

We think that the highest added value that MIT Sloan can bring to the handling of these issues is to apply what it knows best, i.e. management and leadership techniques, to promote coordinated efficient actions. Priority but not exclusivity should be given at first to initiatives targeted towards the MIT Sloan community.

We recommend in particular the implementation of the following initiatives:

- Continue over the coming years the footprint analysis work initiated by this project so as to create the monitoring and valuation tool, which ultimately motivated this study. This involves for instance:
  - The design of data tracking systems, which would improve and systematize environmental footprint data collection
  - Working with DUSP to develop, improve and implement the methodology they have started to create
  - The design of the appropriate MIT Sloan academic and administrative structure in order to ensure continuity and coordination
  - The design of community objectives around observable and publicized metrics so as to maintain and grow the involvement of the MIT Sloan community

- Create over the next years more projects (within S-Lab or not) focused on the analysis and improvements of the sustainability of Sloan processes

- Lead the organization and coordination of initiatives and projects within the MIT community and push for their implementation

- Promote the development coordinated partnerships with other universities, local universities at first. Such partnerships could cover for instance research, education, communication or program implementations
(B) Draft list of possible systemic/policy level actions at MIT Sloan

As discussed in the conclusion, systemic/policy level actions are of utmost importance. We therefore present here below a very preliminary draft list of such actions. We recommend that the input of MIT Sloan Faculty, Staff and Students be solicited.

The first purpose of such a list should be to identify on a regular basis as many “green”/sustainable actions as possible. Naturally the list should be limited to actions over which MIT Sloan has a large degree of control. Then the listed actions should be analyzed and prioritized according to selected dimensions such as the 3 following ones: potential impact on footprint reduction/process sustainability, degree of feasibility/control and financial cost. Eventually, the above-mentioned assessment tool should facilitate this prioritization process.

Finally, it seems essential to us that for the positive feedback loop reason referred to in our conclusion, such a list and subsequent actions be highly publicized within as well as outside the MIT Sloan community.

Proposed initial list:

- Provide continued information on more environmentally friendly transport programs
- Provide recycling bins next to all regular trash
- Improve signaling and information for trash recycling
- Participate in take-back programs for IT equipment
- Implement a clear and systematic purchasing policy based on the preference for environmentally items. For instance,
  - Purchase Energy-Star labeled IT products and Eco-PCs
  - Purchase paper items with a minimum percentage of recycled paper
- Implement systematic double-sided printing: all printers should have that capability, which should be set as default
- Implement document margin and font size policies that will optimize paper use
- Set computer to automatically enter low-power mode after a certain period of inactivity
- Off-peak lab computers shutdown
- Maximize online content (e.g. course packets, exams, papers via electronic format)
- Include reusable mug and a reusable flatware packet in orientation freebees
- Promote/facilitate the purchase of used books
- Organize an university wide contest for the design of one-stop sorting recycling bins
- Organize a challenge within dormitories used by the MIT Sloan community to identify ways to save energy
- Installation of more efficient lighting, e.g. low-pressure sodium light bulbs
- In partnership with the E52 refresher course,
  - Promote bulk serve items
  - Promote the use reusable/washable dishware – disposable for take-away only
  - Incentivize people to bring their own mug (e.g. price reductions, i.e. some proportion of the cost of disposable packaging, on beverages)
  - Switch to the greatest extent possible to fully biodegradable dishware
  - Donate food surpluses that meet standards to local homeless shelters and food banks
  - Implement composting of all post-consumer organic waste
  - Develop vegetarian meal options
  - Inform customers on the environmental impacts of the various types of food
  - Promote local supply chains
- Off-peak monitoring and minimization of air conditioning while preserving good working conditions
- Installation of automatic lighting controllers, e.g. timers/sensors
- Find and promote ways to develop alternative energy sources such as direct sunlight or solar energy (e.g. window panes with solar cells)
- Study possible ways to subsidize nearby housing for the workforce
- Push for the installation of high energy efficient washers, dryers and refrigerators for common use in dormitories used by the MIT Sloan community
- Improve sustainability in academic life (e.g. set optimal number of work hours per person and per week, incorporate sustainability issues in core curriculum, develop cross-department courses related to sustainability)

(C) MIT Sloan Sustainability Charter

As discussed in the conclusion, public awareness is, may be unfortunately, the main force driving systemic/policy level action. Therefore, in order to raise even more public awareness in our community, we came up with the idea of putting together the MIT Sloan Sustainability Charter. Signatories of this charter would not only personally commit to a number of actions and attitudes, but also acknowledge certain facts about sustainability.
We present here below a first draft proposal of the content of such charter. If this idea is pursued, a number of details in the functioning of such charter will have to be addressed. For instance, shall we have this charter signed by the entire MIT Sloan community or shall we let the community endorse it on a voluntary basis? Shall we let signatories the option to select their own selection of commitments within a proposed list?

One thing is certain. Such a charter should be highly publicized and a number of posters throughout MIT Sloan should echo its content.

**Proposed charter content:**

**I commit to**

- Switch off the lights whenever I am the last one to leave a room
- Switch off electronic appliances when not in use
- Purchase used books as much as possible when purchasing books
- Purchase paper with the highest content of recycled paper possible
- Use as much as possible a reusable mug and dishware
- Take the stairs as much as possible
- Print wisely if printing out cannot be avoided
- Use electronic documents as much as possible
- Recycle my garbage
- Not to overload myself or others with too much work and/or activities
- Keep myself informed about issues/actions related to Sustainability

**I understand that**

- The environmentally friendly ranking of commuting modes is, from best to worse: Human powered means / Public transportation / Car pooling / Motorcycle / Car
- The environmentally friendly ranking of food consumption is, from best to worse: Vegetarian food / White meat / Red meat
- Trips by plane, in particular repetitive short-haul trips, are extremely damaging for the environment
- Consuming seasonal products outside of the appropriate season is not environmentally friendly
- My way of living and consuming is not sustainable
Appendices

Appendix 1: links towards ecological footprint calculators

Link toward BP individual footprint calculator; this calculator is designed for inhabitants of twelve countries, including USA, UK, China, Canada, etc.:

http://www.bp.com/extendedsectiongenericarticle.do?categoryId=9015627&contentId=7029058

Link toward EPA Victoria footprint calculators; this include personal (designed for Australia), home, office, retail tenants, retail center, school and event calculators:


Link toward WWF footprint calculator:

http://footprint.wwf.org.uk/

Global ecological footprint calculator:

http://www.ecologicalfootprint.org/Global%20Footprint%20Calculator/GFPCalc.html

Link toward Path to Freedom calculators; this include a personal, commute, water use, recycling, transportation, etc. calculators:

http://www.pathtofreedom.com/calculators.shtml

Link toward Global Footprint Network;

http://www.footprintnetwork.org/
Appendix 2: Studies referred to in the Footprint website

Energy

In 2001, it was computed that MIT used 160 gigawatt hours of electricity—enough to power New York City for 32 hours—hence generating approximately 6,560 kilotons of CO₂. Following this statement, 3 studies tracked in the fall semester of 2002 the electricity waste respectively in MIT buildings after business hours¹², Athena computing clusters and campus housing.

The “After hours” study surveyed six academic buildings¹³ out of the 140 academic, residential and service buildings MIT owns. A bit more that 900 rooms were visited twice, once on a weeknight and another during the weekend, so as to identify unoccupied rooms with lights on. The following results were collected:

Despite the numerous sources of errors, the survey intended to be a measure of public awareness of energy conservation. According to the surveyors, individuals appeared to feel a lack of responsibility for institutional energy use.

Energy conservation solutions fall into 2 categories, social and technical.

- On the social front, the surveyors stress the importance of a greater emphasis on awareness actions in order to convince people to think about energy differently, and to be conscientious in its use.

- On the technical front, the surveyors identify 4 classes of technical solutions, which can be used concomitantly to conserve energy with lighting:

¹² i.e. nights, weekends and holidays.
¹³ Buildings 3, 14N, 16, 34, 35, 54 and E51.
- Automatic lighting controllers, e.g. timers or sensors;  
- Alternative energy sources such as wind and solar energies;  
- Increased direct sunlight; and  
- More efficient lighting such as low-pressure sodium light bulbs.

The “Athena” survey was initiated on the belief that a large portion of MIT’s power was used and wasted to maintain the 24 hours-a-day, 7 days-a-week Athena cluster availability. The 15 main Athena clusters holding 406 workstations and 29 printers and located throughout the MIT campus were analyzed both in terms of the amount of energy used to power the Athena workstations and the actual use of these workstations. The following results were compiled by the authors:
The authors conclude that the majority of wasted energy associated with computers comes from the fact that they are left on, in full power mode, when not in use. The authors also note that computer parts were quicker from long uptime than from regular switch-offs.

According to the authors, MIT would significantly produce less heat, use less energy and even save money if it were to implement the following policies:

- **Energy Efficient Purchasing:** MIT should purchase more energy-efficient computers and workstations accessories such as Energy-Star labeled products or Eco-PCs;

- **Enter Low-power Mode:** Computers should enter a low-power mode after a period of inactivity, which can be tailor-made to be synchronized with periods of peak activity. Contrary to common belief, this does not shorten a computer’s life and while in low-power mode, systems still retain network awareness. According to the authors, the primary reason why MIT does not allow workstations to enter a “sleep” mode after a period of inactivity is because “students assume the computer is out-of-service”. The authors surveyed 150 students asking them if they would assume a workstation was not working if it was in sleep mode. 88% of students said they would not assume the machine is down while 7% would make that assumption. The remaining 5% said they would only make that assumption if unaware of a low-power mode policy;

- **Off-peak Shutdown:** During periods of peak inactivity all but the most popular clusters should be closed;

- **Double-sided Printing:** Priority should be given to the purchase of printers with double-sided printing capability. The standard estimate is that it takes 10 times as much energy to produce a piece of paper than to print onto it;

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15 The default setting of printers should be set to double-sided printing.
Participate in Take-back Programs: According to the authors, MIT does not participate in any type of computer “take-back” program or recycling/reusing program. Old computers\textsuperscript{16} are disposed of by the MIT Property Office, then picked up by a disposal company and most likely sent to a landfill. Dell, IBM, Sun and Apple have some type of take back program that MIT should participate in. MIT should also research and participate in any Boston or Cambridge recycling program or curbside pickup.

The “Dorm Energy Use” study analyzed the yearly energy consumption of different dormitories on the premise that many aspects of their energy use are no different from those of other types of buildings on campus. Similar energy efficient technical and administrative changes could be applied on lighting and heating for instance. Moreover, the authors believed that these buildings were better candidates for encouraging student awareness and social efforts to keep energy use down.

The following results\textsuperscript{17} have been compiled:

According to the authors, significant improvements in energy conservation could be made if students were properly informed and incentivized. As dormitories energy costs are directly billed to residents, incentives to make such efforts are low.

The authors suggest the following social and technical solutions to foster improvements:

- **Residence Challenge:** MIT could organize competitions where dormitories compete with one another to find and implement new and innovative ways to reduce their energy bill. The authors mention several examples of such competitors in various universities such as Ohio University, the University

\textsuperscript{16} 4 years old in average.

\textsuperscript{17} The study excludes Sydney & Pacific and Simmons Hall due to the unavailability of data, as well as Eastgate and Westgate, which are more apartment-like.
of Montana or Furman University. For instance, in 2001 Ohio University saved $76,000 on its
dormitory energy bill, distributing roughly $7,000 in prizes in a competition where many dormitories
reached reductions over 25%.

- **Washing Drying and Refrigeration:** In addition to the technical solutions already discussed in the
  “Afterhours” and “Athena” studies, the authors advocate for the installation of high energy efficient
  washers and dryers. Such machines can save as much as 90 kilowatt-hours each week, which roughly
  represent a yearly reduction of the dormitory energy bill of $45,000. They also advocate for an
  increased availability of public refrigerator space. They estimate that personal refrigerators most
  students use, require 4 times as much energy per volume as full size, high efficiency refrigerators do.

- **Retrofitting:** Although more structural renovations of current dormitory buildings such as the
  installation of double pane/insulated glass windows would also greatly improve energy savings, the
  authors acknowledge that the financial cost of such works would most likely outweigh the energy
  savings benefit. Nonetheless they relate the example of Northland College in Wisconsin, which built
  a new self sustainable dormitory using the latest available technologies from low-tech composting
toilets to solar paneled roofing. This dormitory is said to use 50% less energy than others of its size
  on the campus.

According to information found on the MIT Generator website, a “Dorm Electricity Competition”
was organized over 8 weeks in the spring semester of 2007. We have not found any document reporting
the outcome of such competition.

**Transportation**

In the fall of 2002, the Planning Office conducted a survey of the MIT community about how people
commute to and from campus.

The survey was designed to collect data on the MIT community with regard to 3 main areas of interest:
Ways and distance of commuting (including a breakdown by respondents’ affiliation with MIT:
Undergraduate, Graduate, Academic workforce and Non-academic workforce), Reasons for choice
of commute mode and Degree of awareness of commuting programs provided by MIT.

The surveyors drew two main conclusions from their analysis:

- Most students have already chosen environmentally friendly transportation methods. However,
  some graduate students still have room to reduce their ecological impact of commuting.

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18 The authors mention that MIT has started to install such machines.
19 See [http://sustainability.mit.edu/Dorm_Competition](http://sustainability.mit.edu/Dorm_Competition)
20 Distance from campus was computed by town, and thus contains some inaccuracies.
21 i.e. faculty, and research and other academic staff
22 i.e. other workers, including medical and cleaning staff
Both academic and non-academic workforces prefer driving alone for their commuting methods far more than students, while a considerable number of them do not know services that MIT provides to make carpooling or transit use easier.

The main data findings of this survey are summarized in the charts below:

**Weekday Commute** – MIT Community as a whole

![Weekday Commute Chart]

**Weekday Commute** – Undergraduates

![Weekday Commute Chart]

**Weekday Commute** – Graduates

![Weekday Commute Chart]

**Weekday Commute** – Academic Workforce

![Weekday Commute Chart]
Weekday Commute – Non-academic Workforce

Rationale for Commute Mode – In general / For Public Transportation

Rationale for Commute Mode – Why Car pooling / Public Transportation are not used

Awareness of programs provided by MIT
In terms of recommendations about what MIT can do to improve the footprint of its community in terms of transportation, the surveyors identified the possible following actions:

- Provide students with more dormitories options as well as additional services nearby campus;
- Study possible ways to subsidize nearby housing for the workforce;
- Pressure authorities to have public transportation more accessible and more frequent;
- Develop environmentally friendly transportation programs, e.g. increasing subsidy on T-Passes or negotiating a special deal with the MBTA in which all MIT community members ride for free, and then MIT reimburses the MBTA at the end of each month based on usage23;
- Provide more and better information about available programs and find ways to convince people to use these programs, e.g. ways to promote car pooling.

Building on the idea of new transportation programs, a recent MIT initiative led by DUSP students is developing “A Sustainable Transportation Plan for MIT”, including for instance a proposal for a universal “Mobility Pass” that will allow all members of the community to choose to take the MBTA for no additional cost, or park anywhere on campus for a range of different below-commercial daily parking fees. Additional information can be found at http://sustainability.mit.edu/Sustainable_Transportation_Presentation.

**Waste**

Waste in campus dining facilities

In the fall of 2002, a group of students decided to assess the environmental impacts of MIT’s dining services. How much waste was being produced? What were some of the earth-friendly practices and not-so-friendly practices that dining halls were employing? What improvements could be made? were the key questions they tried to address.

---

23 About 60 universities in North America offer universal bus passes. For example, the University of Victoria (Canada) has the U-Pass program. In 1999, students voted overwhelmingly to add a mandatory fee of $12.50 per month, which would go to providing free city bus service for all students. This is 1/4 of the price of a normal monthly bus pass. However this kind of program works best when students do not live on campus. MIT is a special case in that almost all undergraduates and many graduate students live within walking distance of campus, and thus a mandatory transit pass would be useless for most students.
As of 2002/2003, MIT had contracts with three food service companies: Sodexho, Bon Appétit, and Aramark. **Sodexho** operated the multiple food court and café-style venues including Walker Dining Hall, Lobdell Food Court, Pritchett Grill, Pritchett Convenience, Building 4 Coffee Shop, Dome Café, Bio Café/ Subvisions, Bosworth’s, and East Side Café. **Bon Appétit** operated the three main residential dining facilities: Baker House Dining, Simmons Dining, and Next House Dining. Finally, **Aramark** provided campus catering services.

The group decided to focus the analysis on the 3 Bon Appétit venues and the 2 largest Sodexho eateries, Lobdell and Walker. It also chose to narrow the assessment to 3 major concerns in waste stream management: composting, packaging, and recycling.

As a result of their analysis, the group made the following recommendations:

- Provide recycling bins next to all regular trash receptacles
- Hold a contest for students to design a one-stop sorting station for recycling/garbage/compost. The winning design will then be made into a prototype station and tested in a cafeteria to monitor its accessibility, ease of use and effectiveness in preventing contamination among waste categories
- Make bulk serve items (condiments, salad dressings, dessert items) available and more convenient to access than the individually packaged/wrapped items
- Encourage the use of reusable/washable dishware. Expand the range of reusable items to include utensils, plates, bowls, glasses and cups.
- Until a wider variety of reusables becomes available, offer incentives to individuals who bring their own mugs (or even plates and glasses).
- Publicize the current reusable mug incentive program and any future incentives for reusables.
- Phase out of individually packaged beverages in favor of fountain-style drinks.
- One way of discouraging disposables might be to place them all in a separate location marked with a sign "Please Use Disposable Dishware For Take-Out Only".
- Actively pursue the possibility of switching to fully biodegradable items such as plates, utensils, cups, take-out boxes, etc.
- Communicate with universities that have successfully integrated biodegradable dishware into their dining programs.
- Implement a pilot program to assess the feasibility of using these biodegradable materials in dining venues
- Recruit other universities to participate in the pilot program in order to drive down the current high prices of "earth-friendly” packaging
- Donate all surplus food that meets OSHA standards to local homeless shelters and food banks
- Implement composting of all post-consumer organic waste: kitchen scraps, left-over tray waste, biodegradable packaging and all left-over food that cannot be donated
  - Communicate with universities that have successfully implemented food waste composting programs.
  - Train staff in proper sorting of pre-consumer kitchen waste and post-consumer tray waste.
  - Campaign to inform public on proper sorting practices.
  - User-friendly signs near the sorting station indicating exactly what left-over tray waste can be composted.
  - Place signs in the dining halls informing diners of the post-consumer composting program. These signs should encourage individuals not to throw away any compostable tray waste.
- Dining Services and EPTF should consider contracting an outside agency to conduct a waste-stream audit at least once per year.
- The EPTF should publicize its existence, make efforts to gather students' opinions, and actively solicit participation from food service provider including the staff on campus ie; head chefs and dining hall managers.
- MIT has policies dealing with many environmental initiatives, however, not many people are aware of these programs and therefore don't realize when stated goals are not being met. MIT should publicize these policies in order to create awareness that will drive people to comply with the stated goals.
- Dining Services should implement a waste monitoring program to encourage the individual dining venues to reduce output. It could offer incentives by giving the dining facility a percentage of the money MIT saves in hauling costs.
- MIT should include as part of freshman orientation freebees a reusable mug and a reusable flatware packet (Dartmouth has done this with great success).

**Water**

Annually MIT consumes hundreds of millions of gallons of water, but it was only until the 1990's that water conservation programs began to be implemented. As the MIT campus evolved over the past century, each new building that was added would have its impact assessed and approved. Individually most buildings do not appear grossly inefficient, but when these minor inefficiencies are aggregated over the entire campus they translate into millions of gallons of wasted water. It was not until the 1990's that MIT began its current battery of water conservation programs.
MIT's water conservation group has two aims, the first of which is to track down and quantify water usage. The second aim of the group is to implement a series of programs that will first target inefficiencies with immediate short-term gains, and then to implement programs with long term benefits. One example of a program with immediate short-term gains is the installation of low flow devices in all institute bathrooms. An example of long-term project would involve renovating the plumbing in older buildings. Overall the water conservation group has implemented programs that have saved over 70,000,000 gal./year.

Water usage at MIT covers a broad spectrum of activities, ranging from everyday drinking water to microchip fabrication. Despite this broad range, a large percentage of water usage can be accounted for by a relatively small list of activities, including but not limited to cooling, drinking, and cleaning water.

Here is a map of the Annual Water Use at MIT on campus.

Although water conservation efforts are actively underway at MIT, there is always room for more improvement. Below are some ideas that can help the institute save more water.

- **Student Involvement**

  Students in dormitories make up a lot of the water usage that occurs on campus. Unfortunately, they do not appear to be aware of the water conservation efforts that are taking place. If there is more publicity about the conservation efforts, students may care more and actively partake in more water reducing activities.
One easy method to spread awareness is to have a little signs on mirrors various bathrooms across campus encouraging students to save water. If there's a friendly reminder when people use water, they may just take the effort to conserve.

Also, a dorm wide competition can take place in which the dorm that conserves the most water (and perhaps energy) will win a certain prize. As water is prices based on the rate of usage, a savings in water may result in a much lower water bill. A possible incentive would be to use part of these savings to reward dorms with good percentages.

Here are some simple water conservation techniques for the dorm:

- Take shorter showers.
- Don't run the water when brushing your teeth.
- Don't run the water excessively when doing the dishes.

- Half-flush Toilets

While all 6 gallon toilets have been replaced with 1.6 gallon low flush toilets, there exists an even more efficient toilet that only uses .8 gallons of water per flush for liquid waste. These half flush toilets are used in Australia, although it is starting to infiltrate American markets. Unfortunately, this method is more expensive than the low-flush toilets and may not be a good investment currently, as the toilets have just recently been changed.

Another bathroom option would be to use compost toilets. These toilets use composting instead of water to dispose of human waste. This is very water efficient, as no water is needed. However, this system is not yet designed for large buildings.

- EPA WAVE

WAVE (Water Alliances for Voluntary Efficiency) is an EPA program aimed at conserving water while at the same time increasing profitability. WAVE provides software that tracks water use in laundry, irrigation, and cooling towers. This software also performs cost-analysis and budgeting of various conservation methods. Once a member of WAVE, members agree to use the surveying equipment and switch to the water saving alternatives if feasible. While MIT may not experience the amount of savings other have, it may still benefit from this program.

- Grey Water

One way of improving MIT's water efficiency is to implement grey water systems. Grey water is domestic waste water produced by sinks, showers, baths, washing machines, and dishwashers. Grey water is characterized by low organic and chemical content. Because MIT must not only pay for its water, but it must also pay to dispose of it, it is beneficial to recycle water as much as possible. Grey water involved down cycling the water to lower uses such as using it for toilet water or underground irrigation systems.
Appendix 3: DUSP Audit Methodology
Appendix 4: MIT Thesis Abstracts


This MIT campus emission assessment has been written in response to the City of Cambridge Climate Protection Plan, which calls for a 20% decrease in greenhouse gas emissions from 1990 levels by the year 2010. This greenhouse gas inventory includes all emissions of carbon dioxide, methane, and nitrous oxide due to utility use from fiscal years 1990 to 2003, as well as estimates of transportation and solid waste emissions. It accounts for utilities purchased and utilities produced from the MIT Cogeneration Power Plant. A methodology has been developed to allocate MIT utility plant emissions based on produced electricity, steam, and chilled water. This allows facilities to develop programs that will directly impact the source of highest emissions. In addition, the assessment includes carbon dioxide emissions due to the MIT commuting population from fiscal years 1999 to 2003, and accounts for equivalent carbon dioxide emissions from campus solid waste incineration from fiscal years 2000 to 2003. The 20% reduction target from 1990 emission levels sets a cap on campus emissions of 161,150 equivalent metric tons of carbon dioxide per year. At current levels, a 22% decrease in emissions would be required to achieve this target. Emissions released from utility use account for 90% of the campus emissions, with 9.5% attributed to commuters, and 0.5% due to campus solid waste. Therefore, reducing the amount of emissions caused by utility production and purchasing would have the largest effect on reducing the total campus greenhouse gas emission rate.

A thermodynamic availability flow analysis has also been conducted on the gas turbine and heat recovery steam generator system of the MIT cogeneration power plant. Availability losses within the system were targeted, and therefore appropriate actions can be made to decrease losses and increase component and plant efficiencies. As production efficiencies are maximized, fuel use, and thus emissions are minimized. From fiscal years 1998 to 2003, the gas turbine efficiency, based on the higher heating value, remained approximately constant at 24%. The heat recovery steam generator effectiveness has decreased 11% from 42% to 37%. It has been shown that the decrease in the heat recovery steam generator’s performance can be attributed to fouling effects on the heat transfer surfaces between the hot exhaust gases and the water stream.

An accurate inventory of MIT’s greenhouse gas emissions is a necessary first step in reducing campus emissions. This assessment targets emissions generated by the utility, transportation, and solid waste sectors, and identifies areas with the greatest potential for reducing campus emissions. This inventory will also continue to allow MIT to evaluate its greenhouse gas emission trends and establish goals that will contribute to the emission reduction target set by the city of Cambridge.
Greening MIT: Generating Indicators for Campus Environmental Management by Jonathan D. Leifer (2005)

To reduce environmental impacts, organizations must first gain a sense of how their activities affect their surroundings. Operations that impact the environment include purchasing, production, waste disposal, and material processing. Environmental management systems help organizations consider the unique consequences of these activities and control the ecological impacts associated with them. Colleges and universities have a special role to play in modeling environmental management’s best practices. By implementing carefully crafted management systems that consider the use, reuse, and recycling of resources, universities such as MIT can practice what their environmental curricula teach. When practice and teaching are consonant, universities serve as a model that tomorrow’s leaders can follow to affect further institutional change. This thesis considers the topic of campus environmental management, examining in particular the question of how MIT might audit the ecological impacts associated with its operations.

The document begins by surveying auditing tools and exploring environmental indicator design. Its penultimate discussion proposes a set of indicators that support the Environmental Program Office’s current information management efforts. After considering the value and feasibility of implementing the recommended indicator suite as an environmental management tool, the document concludes with a discussion as to how future indicators might approximate campus sustainability. Appendices catalogue cross institutional indicator information, indicator calculation procedures and student projects that will facilitate indicator calculations, and campus impact data sources that may be useful for informing the suggested projects.


The MIT community and the City of Cambridge embarked on initiatives to reduce energy consumption and Greenhouse Gas emissions in accordance with the Kyoto Protocol which calls for a 20% reduction in 1990 levels of GHG emissions by 2010. This thesis seeks to expand our understanding of how the MIT campus consumes energy and with that knowledge recommend methods of reducing energy consumption by eliminating irresponsible energy use. Based on the GHG emission map created by Tiffany Groode in her 2004 thesis A Methodology for Assessing MIT’s Energy Use and Greenhouse Gas Emissions, the second largest energy consuming building per square foot, Building 18, was selected and analyzed in detail. This thesis proves the high hood density, lack of an exhaust heat recovery system, and irresponsible fume hood use necessitate Building 18’s wasteful consumption of energy. Research revealed that, on average, 67 hoods were left open at night, and 88 were open during daytime use. Of those open hoods, only 5 were in use during the night, and 48 were in use during the day. If the unused hoods were closed the consumption of electricity, steam, and chilled water could be decreased by approximately 17% and save the Institute $350,000 a year in utility costs.
Appendix 5: Survey

Dear MIT Sloan Community,

This request comes as part of our effort to raise awareness of -- and then reduce -- our community's impact on the environment. As part of this year's Sustainable Business Lab class, we have begun an analysis of MIT Sloan's environmental footprint.

We are writing to invite you to participate in a survey about your actions and behaviors, which are essential input for our analysis. This survey will take approximately 5-7 minutes to complete. Please click on your personal web link below to enter the survey.

Your answers will be kept strictly confidential, and data will be reported only in summary form. The deadline is April 30th.

Participation is entirely voluntary. However, if you do complete the survey and are amongst the first 200 to do so, we will reward you with a gift certificate for a "Hot drink plus bagel and cream cheese" at the E52 refresher course (or any equivalent $3 purchase).

Thank you very much for your participation. We look forward to learning from you how we can make MIT Sloan a greener place to work and study.

Sincerely,

Prof. Steven Eppinger, Deputy Dean
Alexandra Prioux, MBA Class of 2009
David Gadmer, MBA Class of 2009

* denotes a required question

1 - Where do you go for lunch during school time? Please select the 3 places you go to most often.

* ==> 1st most often: 

* ==> 2nd most often: 

* ==> 3rd most often: 

1.1 - If you selected "Other" to any of the above questions, please tell us the name(s) of the place(s) in the following order 1st/2nd/3rd.

1.2 - On average, how many times per week do you have dinner at Sloan or on campus because of Sloan related work?

Never
1 time a week
2 times a week
3 times a week
4 times a week
5 times a week
6 times a week
All week

1.3 - Do you usually have meat in your meals at Sloan?

Yes
No

*2 - EXCLUDING course packets, How many books do you typically buy in a year for your activity at Sloan? (Integers only please.)

*2.1 - How many of these books are second hand? (Integers only please)

*2.2 - EXCLUDING course packets, handouts, etc., How many sheets of paper do you usually use or print on personal printers each week related to your activity at Sloan? (Integers only please.)

*2.3 - Out of these sheets of paper, what % of recycled paper do you use? (Integer between 0 and 100 please.)

*3 - How much do you spend on office supplies per year? (In US$, integers only please.)

*4 - How many computers (laptops and desktops) do you personally own and use for your activities at Sloan? (Integers only please.)

*5 - How do you usually get to school in the morning?

- Hybrid Vehicle
- Small Car
- Large car
- Motorcycle
- Tram
- Train
- Bus
- Walk / bicycle

*5.1 - How many miles is your home from school? (Take your best guess! Integers only please.)

6 - How many miles have you traveled this year or do you typically travel each year for your activities at Sloan (e.g. Recruiting, Treks, Labs, Conferences, Business etc.) for each of these transportation means? (Take your best guess! Integers only please.)

* ==> Hybrid car (Type in 0 if you do not use this mean):

* ==> Small car (Type in 0 if you do not use this mean):

* ==> Large car (Type in 0 if you do not use this mean):
6.1 - EXCLUDING flight tickets expensed to MIT Sloan, How many plane return trips (from Boston) to each of the destinations below have you done this year or do you typically do each year for your activities at Sloan (e.g. Recruiting, Treks, Labs, Conferences, Business etc.)? (Take your best guess! Integers only please.)

* ==> Train (Type in 0 if you do not use this mean): [ ]

* ==> Bus (Type in 0 if you do not use this mean): [ ]

* ==> North America - East Coast (1 = 1 return trip; Type in 0 if this destination does not apply.): [ ]

* ==> North America - West Coast (1 = 1 return trip; Type in 0 if this destination does not apply.): [ ]

* ==> North America - Central (1 = 1 return trip; Type in 0 if this destination does not apply.): [ ]

* ==> Central America (1 = 1 return trip; Type in 0 if this destination does not apply.): [ ]

* ==> South America (1 = 1 return trip; Type in 0 if this destination does not apply.): [ ]

* ==> Western Europe (1 = 1 return trip; Type in 0 if this destination does not apply.): [ ]

* ==> Eastern Europe (1 = 1 return trip; Type in 0 if this destination does not apply.): [ ]

* ==> Middle East (1 = 1 return trip; Type in 0 if this destination does not apply.): [ ]

* ==> North Africa (1 = 1 return trip; Type in 0 if this destination does not apply.): [ ]

* ==> Africa - Sub-Saharan (1 = 1 return trip; Type in 0 if this destination does not apply.): [ ]

* ==> Oceania (1 = 1 return trip; Type in 0 if this destination does not apply.): [ ]

* ==> South East Asia (1 = 1 return trip; Type in 0 if this destination does not apply.): [ ]

* ==> North East Asia (1 = 1 return trip; Type in 0 if this destination does not apply.): [ ]

* ==> South West Asia (1 = 1 return trip; Type in 0 if this destination does not apply.): [ ]

* ==> North West Asia (1 = 1 return trip; Type in 0 if this destination does not apply.): [ ]

7 - Do you usually recycle your trash at Sloan?

☐ Yes
☐ No

7.1 - If you do not usually recycle, can you tell us why?
8 - Are you interested in/aware of sustainability issues?

☐ Yes
☐ No

8.1 - Can you tell us why or why not?

9 - How “green”/sustainable do you think your behavior is? (1= very poor; 10= excellent)

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

9.1 - Are you as “green”/sustainable as you want to be?

☐ Yes
☐ No

9.2 - Can you tell us why or why not?

9.3 - What would you need to become “greener”?
10 - What actions/ideas would you suggest our community pursue to improve Sloan’s green impact?

*11 - To which part of the MIT Sloan community do you belong?

- MIT Sloan Faculty
- MIT Sloan Staff
- MIT Sloan Student
### Appendix 6: Conversion rates

<table>
<thead>
<tr>
<th>Item</th>
<th>Category</th>
<th>Ecological Footprint in gha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persons</td>
<td>Recycling</td>
<td>0.000016</td>
</tr>
<tr>
<td>Meals with meat (Students)*</td>
<td>Food</td>
<td>0.03</td>
</tr>
<tr>
<td>Meals without meat (Students)*</td>
<td>Food</td>
<td>0.01</td>
</tr>
<tr>
<td>Meals with meat (Others)*</td>
<td>Food</td>
<td>0.02</td>
</tr>
<tr>
<td>Meals without meat (Others)*</td>
<td>Food</td>
<td>0.03</td>
</tr>
<tr>
<td>Large car**</td>
<td>Travel</td>
<td>0.000308</td>
</tr>
<tr>
<td>Small car**</td>
<td>Travel</td>
<td>0.000161</td>
</tr>
<tr>
<td>Hybrid car**</td>
<td>Travel</td>
<td>0.000107</td>
</tr>
<tr>
<td>Train**</td>
<td>Travel</td>
<td>0.000058</td>
</tr>
<tr>
<td>Tram**</td>
<td>Travel</td>
<td>0.000044</td>
</tr>
<tr>
<td>Bus**</td>
<td>Travel</td>
<td>0.000095</td>
</tr>
<tr>
<td>Walk/bicycle**</td>
<td>Travel</td>
<td>-</td>
</tr>
<tr>
<td>Aeroplane (short distance)**</td>
<td>Travel</td>
<td>0.000076</td>
</tr>
<tr>
<td>Aeroplane (long distance)**</td>
<td>Travel</td>
<td>0.000047</td>
</tr>
<tr>
<td>New books</td>
<td>Goods</td>
<td>0.017705</td>
</tr>
<tr>
<td>Second hand book</td>
<td>Goods</td>
<td>-</td>
</tr>
<tr>
<td>1 sheet of paper</td>
<td>Goods</td>
<td>0.000004</td>
</tr>
<tr>
<td>1 sheet of recycled paper</td>
<td>Goods</td>
<td>0.000003</td>
</tr>
<tr>
<td>Office supply (1$ expense per year)</td>
<td>Goods</td>
<td>0.000040</td>
</tr>
<tr>
<td>Computer</td>
<td>Goods</td>
<td>0.103313</td>
</tr>
<tr>
<td>1 sheet sent for recycling</td>
<td>Recycling</td>
<td>(0.000001)</td>
</tr>
<tr>
<td>Packaging of 1 meal with meat sent for recycling (student)</td>
<td>Recycling</td>
<td>(0.000000)</td>
</tr>
<tr>
<td>Packaging of 1 meal with meat sent for recycling (other)</td>
<td>Recycling</td>
<td>(0.000000)</td>
</tr>
</tbody>
</table>

* 1 meal per week
** per mile per passenger
### Appendix 7: Air travel methodology

<table>
<thead>
<tr>
<th>Destination</th>
<th>Identified City</th>
<th>Distance (miles)</th>
<th>Round trip distance (miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America - East Coast</td>
<td>North Carolina - Raleigh</td>
<td>607</td>
<td>1,214</td>
</tr>
<tr>
<td>North America - West Coast</td>
<td>Oregon - Salem</td>
<td>2,567</td>
<td>5,134</td>
</tr>
<tr>
<td>North America - Central</td>
<td>Kansas - Topeka</td>
<td>1,307</td>
<td>2,614</td>
</tr>
<tr>
<td>Central America</td>
<td>Guatemala - Guatemala</td>
<td>2,227</td>
<td>4,454</td>
</tr>
<tr>
<td>South America</td>
<td>Bolivia - La Paz</td>
<td>4,051</td>
<td>8,102</td>
</tr>
<tr>
<td>Western Europe</td>
<td>Switzerland - Geneva</td>
<td>3,681</td>
<td>7,362</td>
</tr>
<tr>
<td>Eastern Europe</td>
<td>Belarus - Minsk</td>
<td>4,255</td>
<td>8,510</td>
</tr>
<tr>
<td>Middle East</td>
<td>Iraq - Baghdad</td>
<td>5,822</td>
<td>11,644</td>
</tr>
<tr>
<td>North Africa</td>
<td>Libya - Tripoli</td>
<td>4,477</td>
<td>8,954</td>
</tr>
<tr>
<td>Africa - Sub-Saharan</td>
<td>Zambia - Lusaka</td>
<td>7,396</td>
<td>14,792</td>
</tr>
<tr>
<td>Oceania</td>
<td>Australia - Sydney</td>
<td>10,087</td>
<td>20,174</td>
</tr>
<tr>
<td>South East Asia</td>
<td>China - Hong Kong</td>
<td>7,973</td>
<td>15,946</td>
</tr>
<tr>
<td>North East Asia</td>
<td>China - Beijing</td>
<td>6,752</td>
<td>13,504</td>
</tr>
<tr>
<td>South West Asia</td>
<td>India - Indore</td>
<td>7,488</td>
<td>14,976</td>
</tr>
<tr>
<td>North West Asia</td>
<td>Tajikistan - Dushanbe</td>
<td>6,319</td>
<td>12,638</td>
</tr>
</tbody>
</table>
Appendix 8: Numerical Results

Dietary habits:

The first significant aspect of dietary habits is the amount of meat people eat.

<table>
<thead>
<tr>
<th></th>
<th>Faculty</th>
<th>Staff</th>
<th>Students</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat in meals</td>
<td>67%</td>
<td>59%</td>
<td>79%</td>
<td>72%</td>
</tr>
<tr>
<td>No meat in meals</td>
<td>33%</td>
<td>41%</td>
<td>21%</td>
<td>28%</td>
</tr>
</tbody>
</table>

As we can see, 72% of the Sloan community members usually include meat in their meals taken at Sloan. The students especially tend to increase this percentage with 79% including meat in their meals.

The second factor is the number of dinners eaten at Sloan each week. Even though this has no influence on each person’s ecological footprint (as people would have dinner at home instead of at School), this increases the part of the footprint related to Sloan.

<table>
<thead>
<tr>
<th>Number of dinners at Sloan per week</th>
<th>Faculty</th>
<th>Staff</th>
<th>Students</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.6</td>
<td>0.3</td>
<td>1.4</td>
<td>1.0</td>
</tr>
</tbody>
</table>

In average, members of the Sloan community have dinner at Sloan once a week. Students, once again, have results much higher than staff and professors, which is certainly due to different life styles. Among the students surveyed, more than half had dinner once or twice a week at Sloan and only three had dinner five times a week there.

Commuting:

The impact of commuting on the ecological footprint is due to the distance travelled and the mean used.

<table>
<thead>
<tr>
<th></th>
<th>Faculty</th>
<th>Staff</th>
<th>Students</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of people</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large car</td>
<td>19%</td>
<td>10%</td>
<td>6%</td>
<td>9%</td>
</tr>
<tr>
<td>Small Car</td>
<td>24%</td>
<td>34%</td>
<td>8%</td>
<td>17%</td>
</tr>
<tr>
<td>Hybrid Vehicle</td>
<td>10%</td>
<td>3%</td>
<td>0%</td>
<td>2%</td>
</tr>
<tr>
<td>Train</td>
<td>19%</td>
<td>37%</td>
<td>29%</td>
<td>30%</td>
</tr>
<tr>
<td>Tram</td>
<td>0%</td>
<td>n.a.</td>
<td>2%</td>
<td>1%</td>
</tr>
<tr>
<td>Bus</td>
<td>5%</td>
<td>8%</td>
<td>13%</td>
<td>11%</td>
</tr>
<tr>
<td>Walk / bicycle</td>
<td>24%</td>
<td>7%</td>
<td>41%</td>
<td>30%</td>
</tr>
<tr>
<td>AVR. distance from home (miles)</td>
<td>14.3</td>
<td>13.8</td>
<td>7.4</td>
<td>9.9</td>
</tr>
<tr>
<td>Fractions (miles)</td>
<td>9.4</td>
<td>14.1</td>
<td>10.7</td>
<td>11.5</td>
</tr>
<tr>
<td>Fractions (miles)</td>
<td>14.1</td>
<td>7.5</td>
<td>0%</td>
<td>3.5</td>
</tr>
<tr>
<td>Fractions (miles)</td>
<td>11.7</td>
<td>3.4</td>
<td>30%</td>
<td>6.4</td>
</tr>
<tr>
<td>Fractions (miles)</td>
<td>4.2</td>
<td>2.0</td>
<td>1%</td>
<td>1.2</td>
</tr>
<tr>
<td>Fractions (miles)</td>
<td>2.5</td>
<td>2.4</td>
<td>11%</td>
<td>3.1</td>
</tr>
<tr>
<td>Fractions (miles)</td>
<td>4.6</td>
<td>1.1</td>
<td>30%</td>
<td>1.8</td>
</tr>
</tbody>
</table>

In general Faculty and Staff mostly use cars (53% of Faculty and 47% of staff). The second most frequent mean of going to Sloan is walking and cycling for faculty and train for staff, who, in average, live further from school. Students mainly walk/cycle and live at very short distances from Sloan, which is certainly due to the high percentage of students living on campus.

Consumption:

Please find below the results of the survey for goods bought, owned or used by the Sloan community.
<table>
<thead>
<tr>
<th></th>
<th>Faculty</th>
<th>Staff</th>
<th>Students</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Nb. of books bought per year*</td>
<td>12.0</td>
<td>7.1</td>
<td>6.4</td>
<td>7.1</td>
</tr>
<tr>
<td>Of which second hand</td>
<td>1.4</td>
<td>0.2</td>
<td></td>
<td>2.1</td>
</tr>
<tr>
<td>Sheets of paper printed per week</td>
<td>120.7</td>
<td>69.1</td>
<td>53.0</td>
<td>64.2</td>
</tr>
<tr>
<td>Of which recycled paper</td>
<td>21.5</td>
<td>46.3</td>
<td>14.8</td>
<td>24.3</td>
</tr>
<tr>
<td>Office supplies expenditures per year</td>
<td>$165.71</td>
<td>$750.25</td>
<td>$118.28</td>
<td>300.5</td>
</tr>
<tr>
<td>Nb. of computers</td>
<td>1.8</td>
<td>1.2</td>
<td>1.3</td>
<td>1.3</td>
</tr>
</tbody>
</table>

* excluding course packets

Faculty members buy in average 40% more books than staff and students and print 45% more sheets of paper each week. On the other side, 50% of books bought by students are second-hand, certainly for financial reasons. Staffs tend to use more recycled paper and spend several times as much as faculty and students on office supplies.

**Travels:**

For this section we present the results for air travel apart from other means of travelling.

<table>
<thead>
<tr>
<th></th>
<th>Faculty</th>
<th>Staff</th>
<th>Students</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travels, average distance per person per year (miles)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large car</td>
<td>271</td>
<td>58</td>
<td>441</td>
<td>314</td>
</tr>
<tr>
<td>Small car</td>
<td>383</td>
<td>1,407</td>
<td>597</td>
<td>801</td>
</tr>
<tr>
<td>Hybrid car</td>
<td>143</td>
<td>2</td>
<td>16</td>
<td>25</td>
</tr>
<tr>
<td>Train</td>
<td>476</td>
<td>652</td>
<td>391</td>
<td>471</td>
</tr>
<tr>
<td>Bus</td>
<td>33</td>
<td>44</td>
<td>328</td>
<td>216</td>
</tr>
<tr>
<td>Total</td>
<td>1,307</td>
<td>2,163</td>
<td>1,774</td>
<td>1,827</td>
</tr>
</tbody>
</table>

Staffs travel significantly more miles than students and faculty using these means of transportation. They especially favor small car that they use for 65% of the distances. However, as you can see below, the distance they travel by plane is also much lower than for the two other groups. Faculty members’ breakdown is fairly balanced. We can notice that they are the only group which commonly uses hybrid cars. Another interesting point is that students favor more bus than the other group. As we already have seen in the previous sections, financial reasons may explain this.

**Air travel by destination - from Boston**

<table>
<thead>
<tr>
<th></th>
<th>Faculty</th>
<th>Staff</th>
<th>Students</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nb. round trips / person</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North America - East Coast</td>
<td>2.1</td>
<td>2,601</td>
<td>0.3</td>
<td>1.359</td>
</tr>
<tr>
<td>North America - West Coast</td>
<td>1.2</td>
<td>6,356</td>
<td>0.2</td>
<td>5,093</td>
</tr>
<tr>
<td>North America – Central</td>
<td>0.8</td>
<td>1,992</td>
<td>0.1</td>
<td>1,369</td>
</tr>
<tr>
<td>Central America</td>
<td>0.0</td>
<td>212</td>
<td>0.0</td>
<td>848</td>
</tr>
<tr>
<td>South America</td>
<td>0.3</td>
<td>2,315</td>
<td>0.0</td>
<td>1,415</td>
</tr>
<tr>
<td>Western Europe</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<p>| Nb. round trips / person     |         |       |          |       |
| North America - East Coast   | 2.1     | 2,601 | 0.3      | 1.359 |
| North America - West Coast   | 1.2     | 6,356 | 0.2      | 5,093 |
| North America – Central      | 0.8     | 1,992 | 0.1      | 1,369 |
| Central America              | 0.0     | 212   | 0.0      | 848   |
| South America                | 0.3     | 2,315 | 0.0      | 1,415 |
| Western Europe               |         |       |          |       |</p>
<table>
<thead>
<tr>
<th>Region</th>
<th>Short Distance</th>
<th>Long Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern Europe</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Middle East</td>
<td>0.3</td>
<td>0.2</td>
</tr>
<tr>
<td>North Africa</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Africa - Sub-Saharan</td>
<td>-</td>
<td>0.1</td>
</tr>
<tr>
<td>Oceania</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>South East Asia</td>
<td>0.3</td>
<td>1.1</td>
</tr>
<tr>
<td>North East Asia</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>South West Asia</td>
<td>-</td>
<td>0.0</td>
</tr>
<tr>
<td>North West Asia</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Total short distance: 2.1
Total long distance: 3.6

Students tend to travel in very diverse countries, which is consistent with the diversity of this community. However, the average number of long distance trips is similar to the one of faculty members. Staffs, in average, travel by plane far less than the other two groups (0.7 trips compared to 3.6 or 3.8 for long distance trips). The distance per person is significantly lower for both short and long distance flights.

Recycling:

<table>
<thead>
<tr>
<th></th>
<th>Faculty</th>
<th>Staff</th>
<th>Students</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>81%</td>
<td>95%</td>
<td>97%</td>
<td>95%</td>
</tr>
<tr>
<td>No</td>
<td>19%</td>
<td>5%</td>
<td>3%</td>
<td>5%</td>
</tr>
</tbody>
</table>

The percentage of people claiming that they recycle is very high as it represents 95% of the community. We can notice that this percentage is 14 points below average from the faculty.