Institute-wide Planning Task Force
Education Working Group

Final Report

December 16, 2009
# Report of the Education Task Force at MIT

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Introduction

This document lays out the final recommendations of the Education Task Force at MIT. It is the result of many hours of careful, thoughtful, and impartial deliberations and discussions by the faculty, staff and students of the Task Force. The members of the Education Task Force can be found in Appendix C.

Since education is such a central part of the core mission of MIT, many of the recommendations may be seen as controversial. This is unavoidable, as any change in our educational engine of sufficient size to foster significant cost savings or produce significant additional revenue is bound to have potential impact on the quality of our educational product. The Task Force set itself the charge of creating a small set of recommendations that would potentially save or raise money in the education enterprise, yet at the same time would either improve the quality of an MIT education, or at least allow alternatives that would preserve the quality of that education, while reducing costs or raising additional revenue.

In addition to actions that can be taken to achieve possible cost savings and revenue enhancements within the education enterprise at MIT, this report also suggests strategic thinking and organizational changes that the Task Force believes are of value in framing decisions. Almost all the ideas discussed here will involve potentially significant cultural change or will have impact on other aspects of MIT’s educational environment. (The ideas are summarized in the table below.) To provide a basis for assessing the impact of choices from this list on the Institute’s core educational mission, or on other aspects of MIT’s environment, such as student life, the Task Force has also focused on the fundamental theme of accountability and associated metrics to ensure that Department Heads have a strong set of measures to understand the faculty, instructional staff, and TA workload, as well as the impact of other expenses on the delivery of our educational product.

To help frame the ideas being discussed, we thus begin with a discussion of accountability recommendations, and then proceed to more specific recommendations, ordered by cost impact. We also note that several of the recommendations overlap and some are subsets of others. This allows the senior administration to make choices among the recommendations. It also means that the cumulative impact is not the sum of the individual impacts. In addition, there are some recommendations to which it is not possible to assign a cost impact at this time but which are of sufficient import to warrant further study of their impacts (both cost and cultural).
<table>
<thead>
<tr>
<th>Theme/Recommendation</th>
<th>Timeline: Short- or Long-Term</th>
<th>Cost Reduction (-) or Revenue Increase (+)</th>
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</thead>
<tbody>
<tr>
<td>Accountability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexible metrics for measuring efficiencies</td>
<td>Long Term</td>
<td>N/A</td>
</tr>
<tr>
<td>Understanding Faculty Workloads</td>
<td>Long-Term</td>
<td>N/A</td>
</tr>
<tr>
<td>Program evaluation</td>
<td>Long Term</td>
<td>N/A</td>
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<tr>
<td>Higher Impact</td>
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<td></td>
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<tr>
<td>Increasing productive faculty/student educational interactions</td>
<td>Long-Term</td>
<td>-$30.0M</td>
</tr>
<tr>
<td>Develop summer classes for GIRs &amp; other courses</td>
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</tr>
<tr>
<td>Modify faculty compensation</td>
<td>Short-Term</td>
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</tr>
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<td>Increase undergraduate enrollment</td>
<td>Short-Term</td>
<td>+$4.0M</td>
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<td>Soften faculty salaries</td>
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<td>-$2.9M</td>
</tr>
<tr>
<td>Change RA tuition subsidy</td>
<td>Short-Term</td>
<td>-$2.6M</td>
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<tr>
<td>Cap balances in faculty discretionary accounts</td>
<td>Short-Term</td>
<td>-$1.9M</td>
</tr>
<tr>
<td>Change drop/add dates</td>
<td>Short-Term</td>
<td>-$1.3M</td>
</tr>
<tr>
<td>TA Cost Abatement</td>
<td>Long-Term</td>
<td>-$1.1-7.5M</td>
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## Lower Impact

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Time Frame</th>
<th>Financial Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase number of special students</td>
<td>Short-Term</td>
<td>+$1.6M</td>
</tr>
<tr>
<td>Eliminate Athena clusters</td>
<td>Short-Term</td>
<td>-$1.0M</td>
</tr>
<tr>
<td>Limit printing in Athena</td>
<td>Short-Term</td>
<td>-$0.3M</td>
</tr>
<tr>
<td>Centralize graduate admissions</td>
<td>Short-Term</td>
<td>-$0.2M</td>
</tr>
<tr>
<td>Reduce costs for alternative freshman programs</td>
<td>Short-Term</td>
<td>-$0.2-0.5M</td>
</tr>
<tr>
<td>Enhance professional education</td>
<td>Long-Term</td>
<td>$0.0*</td>
</tr>
</tbody>
</table>

Total financial impact of all recommendations: **$25.9 - 50M**

## Other Strategic Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Time Frame</th>
<th>Financial Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Build and understand graduate education model</td>
<td>Long-Term</td>
<td>N/A</td>
</tr>
<tr>
<td>Study impacts of graduate financing plan</td>
<td>Long-Term</td>
<td>N/A</td>
</tr>
<tr>
<td>Right-sizing the graduate population</td>
<td>Long-Term</td>
<td>N/A</td>
</tr>
<tr>
<td>Study impacts of time-to-completion</td>
<td>Long-Term</td>
<td>N/A</td>
</tr>
<tr>
<td>Manage faculty positions better</td>
<td>Long-Term</td>
<td>N/A</td>
</tr>
<tr>
<td>Eliminate the PE requirement</td>
<td>Short-Term</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*Further study needed to determine financial outcomes*
The figure above shows that MIT is now a graduate dominated educational institution, as opposed to its historical image as an undergraduate institution. Over the past thirty years, we have shifted from roughly equal numbers of undergraduate and graduate students to having nearly 50% more graduate students than undergraduates. In addition, as the Provost and Chancellor pointed out in the Faculty Newsletter Vol. XX No.2 Nov/Dec 2007:

“Our undergraduate student (UG)-to-faculty ratio is one of the lowest among our peer institutions (see Chart 2). In AY2005-2006 (the most recent year for which peer data is available), our UG/faculty ratio was 4.13, higher than Caltech’s 3.48, but significantly lower than those for Harvard (5.74), Yale (6.09), Columbia (6.11), Princeton (6.87), Stanford (7.10), CMU (8.81), and Berkeley (15.93), to cite just a few. These kinds of comparisons are never perfect, but they do provide some idea of relative workload.”

The increase in graduate students can be explained as follows from the same Faculty Newsletter article by the Provost and Chancellor:

“It is important to point out that 68% of the increase in graduate students over the period 1995-2006 (i.e., 521 of the 762 additional students) occurred in Doctoral programs, with 88% (i.e., 456 out of 521) of that increase occurring in the School of Engineering. The increase in graduate students in the School of Science during this period was 6.0% (i.e., 46 out of 762), mostly in its Doctoral programs, while..."
the increase in Sloan was 17.3% (i.e., 132 out of 762), mostly in its Masters programs. The increase in graduate students in the School of Engineering was 63.4% (i.e., 483 out of 762). The remaining 13.2% increase was in SAP (9.4%), SHASS (-3.8%) and Whitaker (7.6%)

Thus, changes in educational delivery in principle should directly address the fact that we are now much more a graduate institution than an undergraduate one. This suggests that we need to look for significant reductions in graduate program costs, or significant mechanisms for enhancing income on the graduate side, as we cannot simply modify undergraduate costs and expect to fully impact the budget. Alternatively, we will need to directly address the issue of an appropriate balance between undergraduate and graduate educational needs. We note that finding this balance is a challenging issue. In addition to seeking to balance the differing educational missions and associated pedagogical styles of undergraduate and graduate education, we must also address the differing budget impacts of a graduate or undergraduate student. For example, a funded RA in principle brings in net income to MIT even after the tuition subsidy. This might suggest that reducing the graduate population would hurt our budget. However, a funded RA incurs other costs, such as space and equipment, depending on discipline and other circumstances, and this may offset some, all, or even more than the net income incurred. Moreover, this should not be just a budget discussion; a broader consideration of the impact of different ratios of graduate to undergraduate students on MIT’s educational and intellectual environment must also be undertaken.

We also note the very significant differences in student population distribution between the Schools at MIT, as can be seen from the following table:

Table 1

<table>
<thead>
<tr>
<th>Faculty Count</th>
<th>279.5</th>
<th>372</th>
<th>80</th>
<th>152.5</th>
<th>102</th>
<th>7.5</th>
<th>993.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructors &amp; Lecturers Count</td>
<td>74</td>
<td>136</td>
<td>49</td>
<td>133</td>
<td>55</td>
<td>9</td>
<td>456</td>
</tr>
<tr>
<td>Visiting Faculty Count</td>
<td>19</td>
<td>39</td>
<td>8</td>
<td>17</td>
<td>15</td>
<td>1</td>
<td>99</td>
</tr>
<tr>
<td>TA Count</td>
<td>147</td>
<td>249</td>
<td>51</td>
<td>71</td>
<td>100</td>
<td>17</td>
<td>635</td>
</tr>
<tr>
<td>Total Teaching Staff</td>
<td>519.5</td>
<td>796</td>
<td>188</td>
<td>373.5</td>
<td>272</td>
<td>34.5</td>
<td>2,183.5</td>
</tr>
</tbody>
</table>

| % UG Credit Units/ School | 52% | 35% | 19% | 74% | 15% | 0% | 41% |
| % G Credit Units/ School | 48% | 65% | 81% | 26% | 85% | 100% | 59% |

| US Maj or/ School | 868 | 1,803 | 72 | 128 | 200 | 0 | 1,101 | 4,172 |
| G Maj or/ School | 1,097 | 2,740 | 563 | 317 | 969 | 362 | 0 | 6,048 |
| Total Students | 1,965 | 4,543 | 635 | 445 | 1,169 | 362 | 1,101 | 10,220 |
These numbers clearly show that SAP, Sloan and Whitaker are primarily graduate operations, as measured by credit units offered and number of majors. The SOE is much more a graduate operation than undergraduate, under the same measures. The SOS is roughly evenly distributed between undergraduate and graduate effort, in part due to the Science GIRs. SHASS is mainly an undergraduate operation, largely due to the HASS GIRs. This table also indicates the different strategies that the Schools have taken in terms of the personnel support (instructors and teaching assistants) provided to the faculty for teaching. SHASS relies heavily on lecturers to teach while other Schools make relatively more use of TAs to help teach. The implication of these numbers is that different strategies will be necessary for the different schools. While we will suggest some policy changes for MIT as a whole, they will need to be worked out in detail in the Schools and the choices will be different for each School. We also note that all the Schools have high reputations even when they have focused primarily on undergraduates (SHASS for example). This is a testament to the quality of the faculty.

While we need to address the impact of size of graduate and undergraduate populations, unfortunately it has been very difficult to build a detailed model of the net cost of a graduate student. Even our model of the cost of an undergraduate has assumptions that may affect our analysis in significant ways. While our model suggests a net income of $21K per graduate student, this does not fully address other costs such as space needs, or other resource needs. While we believe that under most circumstances, adding an additional graduate student to the Institute provides a net income of roughly this magnitude, we were not able to perform the analysis to fully determine to what extent this is dependent on how the student is funded (external RA support, for example), or at what point additional space and resource needs, especially for research support, reduce this net effect.

A complicating factor is that there is no central control of the graduate student population. Whereas the undergraduate admissions process is centrally controlled, and the target size of each entering class is set by an Institute Committee, at the graduate level individual degree granting units are able to control their own admissions process, including the number of applicants offered a position at MIT. This may have a secondary effect on the budget, as increased graduate populations may put pressure on Institute budget items, such as expectations on TA support, or Institute GIB support, for graduate students. Hence, although we believe that the graduate student population should be carefully considered, including questions of appropriate size relative the undergraduate body, appropriate size relative to the faculty size, appropriate funding mechanisms for graduate students, and other issues, we are ultimately not yet able to build a sufficiently accurate model to be able to make specific suggestions. However, we do feel that the Dean for Graduate Education should focus on this issue with the School Deans. As we move into the 21st century, an institution like MIT should be able, with modern information tools, to strategically address these questions.

**Principles for Education**

Since any recommendation that leads to significant savings is likely to impact the quality of our educational product, the task force believes it is important to set out characteristics of an MIT education that are very important to preserve. These characteristics help set the stage for discussion and evaluation of the impact of potential changes on our core mission, including impact beyond the budget. Because any large-
scale savings will almost certainly require balancing changes in quality of educational experience with costs, it is important to keep these principles in mind when assessing that balance. These characteristics are listed in arbitrary, as opposed to ranked, order.

1. Rigorous technical and analytical training for every student at MIT
2. Constant and widespread faculty/student interaction
3. Unlimited cross-cultural student synergy
4. Extensive curricular offerings
5. Mens et manus
6. Unique balance between textbook and real-life: valuing a comprehensive network of intertwined educational and research pursuits
7. Promoting creativity while in school and beyond
8. Leadership training, fostering teamwork, and developing communication skills
9. Problem solving skills
10. Learning 'round the clock': MIT as a residential experience
11. Living at the cutting edge
12. Global perspectives
13. Maintaining the highest caliber peer groups of students and faculty
14. Valuing independence, the individual, and liberty of choice in both academic and extracurricular activities
15. Financial Aid: MIT as a Meritocracy, where opportunities are not limited by ability to pay
16. Transferable skills such as confidence in solving big problems

These characteristics capture the essence of what makes MIT an attractive place to so many students as well as much of what contributes to MIT’s brand. As much as possible, the Task Force wishes to preserve these attributes of an MIT education. The Task Force recognizes that some of them incur costs (for example, extensive curricular offerings). In the recommendations below, we will address where the cost savings or revenue enhancements may impact these principles for an MIT education.

A Vision for Education

At the same time that many institutions are considering how to offer higher education more cost effectively, the nature of higher education is evolving. In particular, the rise of online distance education (some of which, like OCW, has been enabled by MIT) leads some to believe that this will be a disruptive innovation, especially for residentially based education. As we reduce costs and raise revenues at MIT, we should do so in a way that includes and enhances our vision for the future of education, and preserves the core characteristics of an MIT education.

A recent study chartered by the Provost on the value of residentially based education predicted the future of higher education in places like MIT would evolve to a kind of blended education, with intelligent combinations of the physical and virtual merged with combinations of formal and non-formal education. While we have moved some way towards the latter, we are just beginning to explore the real impact of the former. This study also suggested that there would be a continuum of learners ranging from undergraduates in residence to alumni who might periodically sample via cyberspace
with customizable learning modules. All these suggest that development of more modular forms of learning is highly desirable in the future.

The growth of online knowledge combined with more personalized ways of organizing this knowledge and a better understanding of how people learn will enable a shifting of the frames of reference for higher education. Whereas knowledge used to be hard to find (a physical visit to a library was necessary), now it is only a search engine click away. The growth of customizable tools for learning means that demand pull learning will grow whereby students ask for and receive the knowledge modules they need to build their understanding of an area. The fact that people can find each other easily over the World Wide Web allows the development of both geographically local and non-geographically local network connections to enhance learning together. Finally, the very large amount of information available (along with large amounts of noise) will shift the emphasis to the development of value added knowledge along with the tools and techniques that will enable this. All of these factors suggest that changes in our current educational structure, made in order to address budget issues, should be undertaken with a clear sense of the role of such changes in future visions of higher education.

Heuristics from studies in Higher Education

The higher education enterprise at MIT is very complex. We are a university that mixes teaching and research at the level of faculty, of students and of staff. Since it is very hard to build detailed cost and process models for such a complex enterprise, it is useful to outline some of the heuristics that have been found at other institutions of higher education. These will be useful in assessing some of the recommendations for changes that we outline below. Like all heuristics they cannot be proven absolutely but are often found to be true when used in practice.

Heuristics for improving educational delivery:
1. Using our plant (learning spaces) more (e.g. summer) will increase efficiency
2. Identification and reduction of high-end outliers will drive down mean costs
3. Elimination of redundancy is desirable
4. Modularity generally increases efficiency and effectiveness
5. Add-on technology to education generally does not reduce cost; rather fundamental redesign is needed to reduce cost.
6. Costs can be reduced by shifting instruction to the lowest marginal cost people.
7. Programs should innovate by substitution rather than just addition and duplication
8. Incentive systems that encourage cooperation and joint ventures will likely reduce costs
9. Sometimes strategic investments are necessary to get to a lower cost state.

Cost Model

In considering potential large-scale changes to education at MIT, especially those that might lead to significant cost saving, it helps to have a clear model of costs. In response to this desire, an average cost model has been developed. Because many aspects of this model refer to specific internal financial details, we do not include the full model, but simply summarize key elements and conclusions.
We stress that this is very much an initial model. We make a number of simplifying assumptions in order to obtain a rough, order-of-magnitude model. There are a number of factors that we have not included, due to lack of initial data. While we indicate at least some of those missing factors, we urge caution in interpreting fine details in our model, until such factors can be incorporated. Thus, this model forms a basis for considering potential options, but we stress that this model should be much more carefully and formally developed.

In utilizing our cost model, we note that there is significant variation between the Schools in the use of TAs, lecturers and other instructional staff. Any changes that affect these components should carefully consider the factors that have led schools to adopt different models, in order to determine if the differences should be preserved, or if a more uniform model would benefit the Institute. We also note that some Schools focus mainly on Graduate Education (SAP for example) and some mainly on Undergraduate Education (SHASS for example). This can be seen from the data described above. This implies that proposed changes may have different impact on individual schools.

In Appendix B, we have included the NACUBO cost model that MIT undertook in 2006. This cost model includes the cost of facilities. Both models indicate the cost of the education exceeds the net income from tuition.

A Provisional Cost Model

Our current student population consists of 4172 undergraduates (UG), and 6048 graduates (G). Our calculations are based therefore on an overall student population of 10,000.

On the revenue side of the model, the “tuition sticker price” is $36,135; the net tuition per undergraduate after accounting for financial aid is $19,000, while the net tuition per graduate student after accounting for the RA subsidy and other factors is $21,000.

On the cost side, we consider the GiB associated with faculty salaries, academic staff and TAs, supplies and services, and equipment. In order to estimate the costs to allocate to education, we assume that faculty and administrative staff spent 50% of their time on educational issues while academic staff and TAs spend all of their time on education. We will also discount the equipment and supplies by 50%. The faculty percentage we assume is supported by the faculty quality of life survey.

There are costs outside of the schools that are associated with education; these include IS&T, DUE, DAPER and the Libraries. We included prorated portions of these costs into our model as well.

By combining these two sources, we determined that the average total direct cost per student within the schools was roughly $27,700, while costs per student outside the school was $8,122, yielding a total direct cost per student on average of $35,822. On top of that we have to add the indirect costs associated with services (electricity etc.), the cost of the rooms, medical services, and other services. In analogy with the research overhead rate, this instructional rate is estimated at 66%. Thus the total direct and indirect cost per student is $59,465.
As an order of magnitude check, if we include the tuition discount of approximately $15,000, then the total cost of education (putting the tuition discount on the cost side as opposed to being a negative revenue) is approximately $74,465. This process is consistent with the reporting process used by the COFHE Schools. We also note that the independent NACUBO analysis of MIT costs for education (see Appendix B) finds the total cost of education at MIT is approximately $61,000. In addition, per the NACUBO assumptions, it weights the costs of a graduate student as 125% of an undergraduate whereas the cost model above does not differentiate between undergraduates and graduate students. Between these two models, we can conclude that the cost of an MIT education is between $61,000 and $74,500 per student while the tuition is of the order of $37,000 per student. Thus we can conclude the cost of education exceeds the tuition by a factor between 1.6 and 2.

We stress caution in interpreting this cost model. Nonetheless, the model does help elucidate major elements of the cost of a student.

Implications of the cost model

It is interesting to note that on average (by head count) there is slightly more than one person per faculty member who help the faculty in the teaching enterprise (994 faculty and 1190 other people who help provide education). This leads to a very low student to generalized educational instructor ratio of 4.6. The situation is even more extreme since there are faculty members who are not teaching due to administrative service. We should also note that as measured by resources, the ratio of faculty to teaching staff is not 1:1 but rather 2:1 ($163M: $81M).

Since the faculty costs largely cannot be reduced (except by reducing the faculty size or by replacing more expensive senior faculty with less expensive junior faculty), in all that follows we shall focus mainly on other costs. However, we have some recommendations that will also look at how to reduce faculty costs.

The cost model, along with our heuristics, suggests the following implications for education:

1. We can increase revenue by increasing the real capacity for students (by increasing dorm space or by the use of summers for central rather than peripheral education delivery) or by increasing the virtual capacity (more students in the same dorm space by encouraging junior year abroad), provided the other associated costs do not increase (this comes from Heuristic #1).
2. The biggest costs are in the Schools, especially costs associated with people (faculty and staff).
3. Supplies and services per student in the Schools must be tightly controlled.
4. We can reduce costs by making the faculty/student interaction more productive (this comes from Heuristic #3 and 6).
5. We can reduce costs by reducing duplication (e.g., IT between departments and central (IS&T, admissions) as well as duplicate courses between departments) (this comes from the cost model and Heuristic #7).
6. Costs will be reduced by incentive schemes that encourage cooperation and joint ventures (this follows from Heuristic #8).

As we discuss options, we need to keep these large ticket items in mind in concert with our principles of education.
We also note that after faculty salaries, the next biggest cost is salaries for Academic Staff (see Appendix A). Many of the Academic Staff at MIT are dedicated teachers and are well regarded by students. The use of a large numbers of lecturers is how the Communications Requirement of the General Institute Requirements has been primarily staffed. It is also how MIT has chosen to teach languages, an important part of our global education outreach. Nevertheless, we note that if faculty salaries are seen as a largely fixed cost then the next largest leverage point is through reduction of the large number of academic staff at MIT. Thus changes that impact major cost components will require a rethinking of the appropriate use of faculty in the teaching enterprise relative to Academic Staff.

**General Questions about Education**

There are a number of general questions that can be considered in trying to define approaches that could significantly impact our costs, while preserving or even enhancing our educational product. These questions reappear to some extent in our specific findings and recommendations, but they are worth considering separately in order to provide a framework for potential changes. All the recommendations made below should consider these questions, in order to maintain a focus on both cost reduction and increased learning.

- **Would another mix of instructional support lead to cost reduction?**
  - Could we use undergrads as teachers (tutors, peer learners) more effectively?
  - Could we use alumni more effectively?
  - Could we use emeriti professors and retired staff more effectively?
  - Is it cost and quality effective to shift instructional staff costs to less expensive TA costs?

- **How could educational technology help support cost reduction?**
  - Could we use it for self-paced learning more effectively?
    - Note that there are pedagogical implications of utilizing technology. For example, while some students appreciate videotaped lectures, others learn better in different settings. In the 6.001 on-line lecture experiment, some students clamored for the return of live lectures, and ultimately the staff went back to this because they felt that different students learned better in different settings. Any change that utilizes self-paced online learning must directly address this issue.
  - Can IT pick up some of the load of teaching small classes in a cost effective way (or will IT costs consume any teaching cost savings)?

- **Could the curriculum be reorganized to support cost reduction?**
  - Could we eliminate redundancies in courses (e.g., fluid mechanics, thermodynamics, and control theory are taught in different departments within SoE)?
  - Would more modularity increase efficiency and effectiveness?
  - Should there be a minimum-enrollment requirement for a subject to be taught?
    - If we cancel the offering of small classes (e.g. less than 10) does this necessarily lead to easy redeployment of faculty to other teaching needs?
o Should there be a cap on the number of elective subjects?

- What measures could lead both to cost savings and to better learning?
  o What improves student learning?
  o How could we reduce the need to review concepts in downstream courses?
  o How can we measure student learning?

- Could more understanding about how faculty use their time related to teaching lead to cost reduction?
  o How much time is used for preparing lectures? Preparing homework? Preparing exams? Grading?
    ▪ How does this vary by School, discipline, class size?
  o Could the use of multi-functional teams increase efficiency and effectiveness?

- Can we unbundle the educational experience we provide to understand costs better – both present practice and alternatives?

**Task Force organization**

In light of the principles, vision, education questions and cost model, the Education Task Force decided to break into four smaller sub-groups, each assigned to focus on particular areas. They were: Faculty and Academic Structure, Undergraduate Education, Graduate and Professional Education, and Pipeline and Co-Curricular issues. The last one would include issues such as admissions, computer resources for education (Athena), Open Course Ware, etc. Each of these sub-groups discussed issues in detail, and regularly provided status reports to the entire Task Force, in order to ensure communication between the multiple groups, and to enable a broad range of perspectives on issues.

In the following sections, we outline the recommendations of the Task Force. The perspective taken by the Task Force was to consider any feasible opportunity, without prejudging the viability, both financial and cultural, of such opportunities. Nonetheless, not all recommendations are equally supported by the Task Force. Some are seen as straightforward and valuable, others are met with mixed reactions, as individuals weigh the potential impact of each recommendation against the financial benefit. Where appropriate, we indicate the significant tradeoffs to be considered before implementing a recommendation.

A common theme in the recommendations is that resources can be saved by reducing the number of options that historically have been allowed at MIT. While this love of flexible options is tied closely to Education Principle #14, there is a cost to allowing so much variation. We need to explicitly recognize this cost and decide when we wish to bear it. We also note that the education system is closely linked with the research system at MIT through both faculty and student actions and values. Thus all recommendations should be considered in light of their total impact. We have broken the recommendations into three groups: ones that can be undertaken quickly and will save or make money, ones that may take longer and may have lower impact, and then a set whose cost is hard to estimate and will have strategic implications. There is some overlap among the recommendations. Many of the recommendations imply some shift in the underlying infrastructure at MIT that supports education.
Accountability

The following set of recommendations deals with issues of accountability across the Institute. Because of the diversity of issues that schools and departments must address, workloads across faculty and staff are different, resulting in differing financial impacts to both departmental and GIB funds. These recommendations ask that each school and department measure and track their resources relative to peers and may help to provide insights into managing our complex organization. These recommendations also provide a potential mechanism for ensuring equity of resource allocation across schools and departments, while providing opportunity to account for differences in culture and common practice.

FLEXIBLE METRICS FOR MEASURING EFFICIENCIES

Finding: The wide diversity across schools, departments, labs and centers in teaching methodology, expenditures, and expectations makes it difficult to make effective comparisons, pinpoint inefficiencies, and formulate ways in which we can improve the educational experience while cutting back on costs.

For example, suggested solutions to educational delivery costs have included: cutting TA stipend budgets; cutting non-faculty, academic staff positions; or establishing minimum class size requirements. However, these kinds of ‘across-the-board’ decisions can result in unfair impacts on some schools or departments while not necessarily addressing any issues in others. Instead, MIT needs a process to help academic leadership understand where resources are being focused with optimal outcome, and to weigh equity issues in resource allocation.

Recommendation:
We recommend that academic units at different scales engage in the following sequence of actions:

1. **Develop a flexible set of metrics** to allow a dean or department to measure and understand the resources utilized to provide education to both graduate and undergraduate students.
   - **Proposed Metrics** – ways to measure cost and effectiveness of educational delivery
     - **Programmatic Ratios:**
       - Enrollment/ Subject: number of students who have enrolled and completed the term in a subject per number of subjects offered; a proxy for class size
       - TAs or Academic Staff per Subject: Number of TAs or Non-Faculty Instructors per number of subjects offered
       - Enrollment per TA or Academic Staff: Number of students who have enrolled and completed the term in a subject per number of TAs or Non-Faculty Instructors
Financial Ratios:
  - Cost of Teaching($)/Credit Unit: Calculated set of costs (see below) in dollars per number of completed credits
  - Cost of Teaching($)/Subject: Calculated set of costs in dollars per number of subjects offered

Cost of Teaching: A model must be developed to provide a basis for financial ratios.

2. Assess subjects/departments/schools: a dean or department head in any school can utilize the above metrics to assess his/her school or department compared with units of similar focus
   - Traditional metrics highlight diversity between schools and show need for flexible metrics

3. Drill down to departmental and subject level for greater granularity
   This more granular examination enables differences in choices of staff cost allocation to be examined. Note that there may be other factors (e.g. lab intensive subjects) that influence cost, but the methodology provides a basis for discussion of such choices.

4. Require assessment to be completed as a part of the budgeting cycle
   - To be a multi-level approach, one should start at the departmental level and drill down to subject level for a most thorough understanding.

5. Apply metrics and identify cost- and efficiency-outliers among those subjects/programs

6. Support deans and department heads in efforts to
   - Identify inefficiencies
   - Seize opportunities to make changes within ‘inefficient’ programs
   - Eliminate programs that no longer meet MIT’s standards, if necessary

Financial impact: By calculating the cost of providing ‘teaching support’ to the Institute (GIB & departmental funds only) we can develop a base for understanding the cost impacts of efficiency. If this metric were used across all five schools to achieve 1% greater efficiency, a $1.6M savings could be achieved; (5% = $7.9M). For example, this method could be used to identify expensive subject offerings, which could either be dropped or shifted to a less frequent schedule of offering. Or, this method could be used at a coarser scale to identify significant differences in teaching costs, due to different choices in staffing patterns, which in turn could be used to initiate more cost effective but educationally comparable funding models.

Other considerations:
  - Other ways of comparing departments, programs and subjects include:
    - **Subject understanding**
      - Fundamental subjects serve the entire undergraduate population. Are they being delivered efficiently?
      - Electives and specialty subjects should be compared to each other to assess cost effectiveness
o Lifecycle of program
  ▪ Nascent programs cost more
  ▪ Older programs with higher costs may warrant re-imagination or elimination

o Education delivery methods
  ▪ Project intensive, lab and writing-related subjects cost more
  ▪ Lectures tend to be less cost intensive

o Science & Engineering
  ▪ Classes in Science and Engineering are more comparable to each other than to other schools

• This process will require significant political capital to implement as it will impact not only the time and efforts of our already hard-working deans, department heads, AO’s and other staff, but may also identify areas needing significant change to adapt to MIT’s current budget situation and the changing world of education and research. As we have seen recently, even ‘smaller’ changes to curriculum and staffing such as cutting 8 varsity sports teams can unleash a vocal response from stakeholders. Any changes as a result of this introspective process can expect similar response. This is not to suggest that the process should be dropped; rather one needs to provide a rational basis on which to assess choices in educational delivery. We hope that these flexible metrics provide such a basis, rather than relying on history to validate expensive choices.

• Furthermore, financial and other metrics’ measures of efficiency are not the only measurement of the ‘worth’ of a program or rationale behind costs. Understanding the impact of a program on MIT’s educational curriculum will be an important aspect that must not be overlooked.

• The process at a departmental level may differ from that at the school level. For example, the departmental perception of the cost of a TA includes tuition cost. This does not exist at the Institute level.

• Schools should use metrics that are appropriate to the classes they teach.

• Reducing inefficiencies may impact metrics used by other organizations to assess MIT’s position vis-a-vis peer institutions. Specifically, an increase in average class size, for example, will impact MIT’s standing in the US News & World Report rankings.
Understanding Faculty Workloads

Finding: According to the “Instructional Indicators Report”, in 2008 faculty across the Institute taught on average between 0.13 undergraduate classes and 11.88 classes that year, as measured within specific units. The latter number is probably anomalous, as it refers to a unit that relies heavily on instructors, who are not counted in the denominator of this ratio. However, the general range of undergraduate classes taught per faculty among most units, excluding unusual cases like this, is still exceptionally large. While these figures must represent both professorial and other academic faculty, the discrepancies in teaching load from School to School and within departments are dramatic.

Not only are faculty workloads different across the Institute, staffing faculty and non-faculty instructors is a diverse enterprise. The table below represents the “Teaching Staff Overview” for 2009 for all 5 Schools, including Whitaker, and illustrates the distribution of professors, other academics, and TA’s in each school.

| Faculty Count | 279.5 | 372 | 80 | 152.5 | 102 | 7.5 | 993.5 |
| Instructions & Lecturers Count | 74 | 136 | 49 | 133 | 55 | 9 | 456 |
| Visiting Faculty Count | 19 | 39 | 8 | 17 | 15 | 1 | 99 |
| TA Count | 147 | 249 | 51 | 71 | 100 | 17 | 635 |
| Total Teaching Staff | 519.5 | 796 | 188 | 373.5 | 272 | 34.5 | 2,183.5 |

*TA Count by primary department; all data includes unfilled positions (per IR parameters)
Source: Institutional Research

Non-faculty teaching staff (including lecturers, instructors, visiting faculty, professors of the practice and TAs) offset additional need for faculty effort, and is often identified as a source of considerable budget growth as faculty counts have remained static.

Recommendation: The need to reduce our reliance on Other Academics and TAs should be balanced by a fair distribution of effort on the part of the faculty; therefore, faculty should be required to take on a minimum number of institutional or teaching-related responsibilities. In particular, if we are to reduce net costs of non-faculty teaching staff, this must be offset at least in part by faculty effort, especially an equitable division of teaching load amongst the faculty, in all units.

1. The Dean of each School should, in consultation with his or her School Council, develop a metric to assure even-handedness and transparency in faculty loads. The Dean of Undergraduate Education should vet this to assure excellence in undergraduate education, i.e. is every professor fit to teach undergraduate classes?

2. Faculty assignments in each School might be composed of the following:
   o Teaching*, course development, and supervision of large GIR classes
   o Service to the department
   o Service to the school
Service to the Institute
- Supervision and productivity of a lab
- Undergraduate advising
- Service to the Educational Commons

3. Faculty should be asked to account for their activities each year in order to be sure that certain members are not being asked to contribute much above and beyond the work of their colleagues.

*What is meant by teaching service? There are several ways to calculate this (number of classes taught, enrollments, etc.), but the manner of calculation should be left to the Deans of the Schools in order to preserve the educational mission of each department.

Financial implications: While requesting an 'across-the-board' cut of Other Academic Staff is not recommended, a wise distribution of faculty workload would likely yield some staff cuts and resulting savings. If an assessment and re-evaluation of faculty teaching load could lead to a 5% reduction in the costs of Other Academic Staff due to these changes, the resulting savings in compensation (from GIB & departmental funds) would be $1.8M.

Other considerations:
- The subcommittee recommends that every class with low enrollments should be carefully examined for the importance of their contribution. Small classes that do not serve a broader departmental need may need to be dropped or taught less frequently.
- Sloan has introduced a ‘points system’ wherein faculty workloads are valued and measured to hold all faculty members equally accountable. The cost/benefit analysis of this program should be examined further and offered as a strawman alternative to other Schools. Such an approach may not fit the culture of all Schools, but examination of this method will spur discussion of appropriate metrics to measure workloads.
- Decisions made with regard to measurement of any metric should allow for the general principles of excellence in education at MIT.
- Metrics adopted by each school should be vetted at Academic Council so that they pass the bar of faculty promotion and tenure.
- The missions of the Schools, and even many departments, are necessarily sui generis. If, for example, we value the acquisition of foreign language learning for undergraduates, the ratio of Professors to Other Academics will necessarily be lower in Foreign Languages and Literature (0.28) than in most departments at the Institute (average = 2.2) across the Institute.
- Added to teaching responsibilities there is the anecdotal yet universally understood impression that “the Usual Suspects” undertake the most significant effort in service to the Institute.
- Students crave faculty face time. It is possible that accountability to a certain level of service will increase that exposure and therefore student satisfaction and education.
Program Evaluation

Summary description:

Over the last several decades, numerous programs, centers, and divisions have been created to address the changing realities of research. While MIT's flexibility in creating these programs is a positive and is considered fundamental to the Institute's leadership role, not all of these programs need to continue. The deans should begin an assessment of their various programs to see which ones could or should be cut. The process should be initiated at the level of the deans and not with the higher administration since the deans can collect the relevant information more effectively and as a result make a more reasoned judgment. For similar reasons, department heads, though they should be consulted and drawn into the process, may be too close to various programs to be neutral in the decision.

The tendency is to assume that everything MIT does is world class, but the point of the review is to separate promotion from reality. The overall issue is not just past performance, but the continued relevance of the program in the future.

The emphasis should be placed not only on cost cutting per se, but on the health and vitality of MIT’s academic offering. Though small programs might seem like the easiest to remove, size should not be the sole determining factor. In fact, small programs can be sometimes much more effective than larger ones.

A related factor is how students in programs are supported. We have heard, anecdotally, that some programs guarantee five years of support to their graduate students from funds provided from GIB. This would appear to be inequitable to other programs that rely almost exclusively on external funding for RAs; indeed some units see this as a tax on richer programs, and this perception can lead to faculty discontent. Part of the evaluation of programs, in addition to quality and effectiveness, should include assessment of funding support.

Quantify the idea:

There is no fixed number of dollars that can be assigned to this process. The savings will be cumulative and depend on the outcome of the process. In some schools the savings could be more substantial than in others.

Implementation issues:

The review process should take many factors into consideration, not just size and expense. Issues of quality and importance to the over-all profile of the School should be factored in. The following types of questions, which measure impact of the output of the educational process, should be asked:
• What types of positions do graduates take upon completion of their study?
• Are graduates leaders in the field? (measured both by graduates taking academic roles and industrial leadership positions)
• What type of standing does the program have?
• What fellowships or awards are awarded to faculty in these programs?
• What is the publication and production record of the faculty?
• In what way is the program integrated or not into other aspects of MIT’s academic profile?
• Who are the university competitors for entering students?

Additional metrics that may help assess the quality of the program include selectivity, which measures the input to a program and is a partial assessment of quality of program:
• What percentage of the applicant pool is granted admission?
• What percentage of the applicants to whom admission is offered actually accept that offer?
• How do these metrics compare against peer competitors?

Though these are simply guidelines, one might expect high quality programs to have low admission rates and high acceptance rates. For example, some large departments at MIT have admission rates of roughly 5% and acceptance rates of roughly 65%, indicating a highly competitive program; conversely some departments have admission rates in the 25-50% range and acceptance rates below 50%, raising questions about the competitiveness and quality of the program.

Obviously, programs are attached to various funding streams and tenured lines and cannot be easily disentangled from the academic fabric. The Deans will have to assess which option best suits a particular circumstance in dealing with programs should a reduction be in order. But this decision should be in the left in the hands of the deans with the support of the administration.

We note that such a review is likely to have a disproportionate effect on Departments whose programs are primarily supported by the GIB, namely in SAP and SHASS. It would valuable to consider any changes for these units along with changes in tuition policy for doctoral students. For example, many peers now have a reduced tuition for doctoral students after their general examinations. We do not, and are at a competitive disadvantage for students.
Action Steps with Higher Impacts

The following set of items deals with issues that could be immediately implemented to achieve cost savings or revenue enhancement. That said, many of them also imply potentially significant impacts either to MIT’s culture, mission or operations. The total GIB cost savings if implemented is estimated at $21 - $51M in the first year of implementation. It is important, however, that potential impact is carefully evaluated before moving to implementation, as cultural impact may outweigh financial benefit and argue for considering other alternatives.

Increasing productive Faculty/Student educational interactions

SUMMARY DESCRIPTION:

One overall conclusion from our cost model and the heuristics described earlier is that the faculty/student educational interaction must be made more productive since it will probably have to occur with fewer people working in support of the faculty in delivering our educational product. This conclusion is predicated on the observation the current ratio of other teaching staff to faculty is greater than one, and that this leads to a ratio of teaching staff to students that may deliver a very productive educational environment, but does so at a cost that cannot be sustained. While there is large variation in practices across the Schools, there are a number of observations that are generally pertinent to addressing this issue of faculty/student interaction. Assuming the faculty costs are conserved, one way to reduce the costs of the instructional staff is to consider the most cost effective use of other instructional support from within the triad of instructors, graduate teaching assistants, and undergraduate learning assistants. This, however, may conflict with the principle of faculty/student interaction and of quality educational experiences (Principle #2). Alternatively, the costs may be reduced by replacing people with educational technology. There may be creative ways to use OCW, which will be explored in subsequent recommendations. However, we note that the experience from many institutions is that using educational technology only saves resources if courses are designed around the use of the technology rather than just adding it into a pre-existing course. This also may conflict with Principle #2. Thus, any decision to increase faculty/student interactions must carefully consider impact on other aspects of that experience beyond financial ones.

Since the faculty may have to teach with fewer adjuncts helping, it is desirable to free up faculty time in the educational enterprise as much as possible, as well as make the best use of the TAs that are available. In considering utilization of Teaching Assistants, we stress that teaching assistance, like research assistance, is an integral part of many graduate student’s education. It should be seen as an opportunity to provide training and experience for a graduate student while amplifying the educational experience of the students being taught, rather than simply a cost-saving measure. We found that there are a number of practices that may not effectively allocate faculty time or TA time, and which create barriers to the most effective teaching. These are:

1. Large variation in the expected standard teaching load for faculty across the Schools, with anecdotal evidence of some faculty pushing the boundaries to minimize their teaching. Sloan uses a points system to ensure that all faculty members teach appropriate size classes. The SOE has a statement that faculty are expected to teach two classes on average a year. Other Schools do not have
explicit statements of the normal teaching load for all faculty members. We believe that a more uniform policy on teaching load across the Institute will certainly lead to better morale, but also will improve the efficiency of our teaching engine.

2. A large number of small classes taught in the Schools. There are currently 221 classes in the Schools with less than 9 students per class. This excludes classes that grant credit for UROP experiences. If the faculty use these classes to fulfill their teaching obligations and lecturers thus need to be hired to teach other classes then additional costs are created. The best learning theory suggests that class sizes of 12-20 are the most optimal for student learning. Of course, we understand that one of the reasons for some small classes is the need to maintain the core curriculum in small majors. This, however, also raises a question of whether the Institute can maintain degree programs with only 1 to 3 majors per year, if that requires significant teaching of small required classes to ensure that every student in a small major has the option to finish in four years.

We note that while the best number of students in a class may be 12-20 there are many classes -- that are not crafted to complete a major -- in which 12 is the maximum number for effective teaching and learning. For example, musical composition, a class for which we have some of the most distinguished faculty in the world, and for which students have a sharp appetite. The key point is that the Departmental and School leadership should understand the reasons for different class sizes and make sure that MIT resources are effectively utilized and students are well taught.

3. Inconsistent expectations for TAs across MIT. Sloan expects TAs to work 19 weeks in a semester. In the SOE, TAs are asked to work a 16 week semester.

4. Use of TAs to create new problem sets for standard courses each year, which is a significant use of TA time in some courses.

5. Significant barriers associated with assigning teaching credit for cross-School teaching. There are resource flows associated with faculty teaching in Schools different from their home School even though the faculty members are already fully paid.

6. Appropriate size of a subject offering. Some faculty members suggest that having to provide a semester’s worth of a 12 unit class sometimes means packing in material to fill out the semester. A better model might be to consider appropriate size of subject offering and to adjust the curricular calendar to adapt to smaller size subject offerings.

We recommend that the Institute student to teacher ratio be raised from 4.6 to 7. This is simply a target: there may be other ratios to consider; and there may be a need to use different targets in different schools. Moreover, there are multiple means to accomplish this, by considering many of the factors listed above: one could increase the number of students (see later discussion), or one could decrease the number of teachers (construed to include faculty members, other instructional staff, and teaching assistants). We believe that the second option is more viable, although consideration of some combination of the two options is also recommended. Since there is significant variation between the Schools, we recommend that each School be given targets on salary dollars associated with the combination of instructors, graduate TAs and undergraduate learning assistants. Thus each School can optimize the mix as best meets their mission.

We should note that one GIR, the Communication Requirement, makes extensive use of lecturers and TAs as a means to help the faculty teach communication intensive
courses. If the number of these other academic staff is reduced relative to the faculty, the effect on GIRs like the Communication Requirement must be carefully considered. Having said this, we believe it is possible to do this in a way that maintains the quality of education consistent with the principles outlined at the beginning of the document. The two keys are: more effective use of faculty time, and more productive use of TA time. Another way to see this is that we have to be more careful about student choice, use of faculty expertise, and deployment of graduate student TAs in a way that is intentional and strategic.

In order to make more faculty time available and lower barriers between the Schools, we recommend the following:

1. The Dean of each School should, in consultation with his or her School Council, develop a metric to assure even-handedness and transparency in faculty loads. The Dean of Undergraduate Education should vet this to assure excellence in undergraduate education, i.e. is every professor fit to teach undergraduate classes? We develop this idea in much more detail later in this report. The underlying idea is that MIT needs a system by which every faculty member can be held accountable for their educational contributions.

2. Each School must have an explicit teaching policy for all faculty members, preferably one that expresses clearly the value of the School and the commitment of the faculty to MIT.

3. Faculty teaching anywhere in MIT must be counted in the teaching policies of each School and the practice of having to pay for faculty to teach outside their Departments should be ended. This follows from Heuristic #8. We understand that may cause hardship for smaller units who are not rich in faculty but it will contribute significantly to the idea of a unified faculty who can teach across MIT. We also understand that there are always special circumstances that require special arrangements, and that formally negotiated existing agreements may need to be respected. Nevertheless, this practice replaces strategic cooperation with money and should be re-examined.

4. Departments should consider creating many more learning units composed of half semester courses and 6 unit courses. This increased modularity will enable faculty to more effectively allocate their time. This follows from Heuristic #4.

5. There should be uniform expectations set across MIT for TAs and undergraduate learning assistants. We recommend adopting the Sloan expectation for all TAs in terms of a 19 week expectation per semester. We also note that some departments treat a TA appointment as entailing 100% support, while others allow for partial TA assignments. We recommend that departments consider making TA appointments to more directly reflect the educational requirements of the position, rather than using TA funds to support a doctoral student who is primarily conducting research but spending a small amount of time in TA work. In other words, if the teaching experience is a half-time requirement, the appointment should be for a half-time position. This would allow departments to better distribute their TA resources, while ensuring that those resources are supporting the educational mission. Such a decision would need to account for special circumstances, as some disciplines of necessity rely on TA support for their students, due to a general lack of funding in that discipline.

6. All courses that use TAs should assess whether standard problem sets can be used and whether an expectation can be set such that students complete the problem sets without looking at the answers from previous versions. The role of the problem set as a learning tool versus an evaluation tool should also be
examined within the context of each department. In addition, the use of peer grading approaches, especially in senior undergraduate and graduate course offerings, should be considered.

7. Departments should consider replacing TAs used for grading purposes as much as possible with undergraduate assistants, who are often equally as effective in this role. This would allow departments to focus their TA resources on cases that enhance the educational experience of the TA, while also amplifying the educational impact on students.

8. Departments should consider including teaching degree requirements in their PhD programs (we note that many departments already do this). Such a requirement provides a way to have graduate students serve as TAs without the associated cost (see later discussion).

**QUANTIFICATION:**

The choice of the ratio of students to people in the teaching enterprise of 7 is arbitrary. If the ratio is raised to this level, by decreasing the number of people who help the faculty teach, the number of people needed to support the faculty becomes 435. This amounts to approximately half an additional person per faculty member in the teaching enterprise as compared to the current situation where there is more then one additional person per faculty member in the classroom. A simple scaling of the salary resources indicates that this would require $30 million in salaries and associated costs, assuming the relative mix of people stayed the same. This would provide a $50 million saving. Another way to do this is to choose a specific salary savings from the non-faculty salaries in the education enterprise. If the savings were set to $30 million across MIT, then the Schools would be free to plan on how to accomplish this savings. For the same relative mix of people, this would amount to a student to teacher ratio between 5 and 7. Thus, this model provides a range of options, with tradeoffs between cost savings and educational experience. We believe it thus provides a framework to allow rational discussion of these tradeoffs, leading to choices of savings.

**IMPLEMENTATION CONSIDERATIONS:**

The recommendations will have profound impacts on the current MIT culture. They will change the “Problem Set” culture of many classes and establish a culture of self enforced academic honesty. They will create many additional small-learning options for students and possibly reduce the number of very small classes that are taught at MIT. It may have a differentially larger impact on departments with a very small number of majors. If achieved, these effects could significantly improve the quality of the educational experience; however, there are many factors to consider before implementing this recommendation, including the human impact on reducing the number of instructors, the impact on the graduate program of reducing the number of TA positions, and the impact on small programs.

These recommendations have the potential for hurting the quality of the education, however, if done well, these recommendations also have the potential for improving the effectiveness of the faculty at MIT. Some of the offices of the DUE (TLL, the Teaching and Learning Lab; OEIT, the Office of Educational Innovation and Technology; and OFS, the Office of Faculty Support) can also be called upon to help address the impacts as outlined in Appendix D.
Develop summer classes for GIRs and other courses

Summary Description:

There is a perception that much of our educational plant sits idle during the summer, as well as during IAP. Our classrooms sit empty, except for use by external conferences (which we acknowledge do raise some funds for the Institute, although not in substantial amounts) and our supporting educational infrastructure similarly sits idle; in short, we believe we are not fully utilizing our plant. If we can find effective ways to employ these resources, without significantly increasing other costs, we have the potential to impact the cost model.

There are many factors to consider here, as this is a complex situation. One possibility is to offer a broad range of courses during the summer. This would require instructional staff, however, and the cost of that staff may undo any benefits by offering courses to our normal cohort of students and charging appropriate tuition. Moreover, if the effect of adding summer courses simply improves the throughput of students (i.e., more MIT students complete their degree in less than 4 full calendar years), it is not clear that there is a particular financial benefit to the Institute. A second possibility is to use the summer to attract other students, particularly high school students preparing for college, and seeking to obtain college credit either to improve their application or to get a head start on their future college career; or college students from other institutions seeking to augment their curricular experience. This could include newly admitted MIT students who wish to get started on GIR requirements. If a summer program is targeted at high school students, it is important to manage expectations – taking one or more summer session classes at MIT should not be seen as a back-door entry into the standard MIT admissions process.

It is important, before embarking on changes that would utilize our educational plant during the summer, that we understand the current usage of the Institute’s resources, and whether the net income generated by such usage would be improved by shifting to more traditional educational activities.

Classrooms in the summer

To assess the opportunities, we focus on what physical plant is actually available. The Registrar has a total of 149 classrooms available in the summer, of which 12 are not currently air-conditioned. There are additional classrooms at the Institute, but those are assigned to departments for their own activities, and thus any use of those spaces would require agreements with the departments. For the purposes of this discussion, we focus only on the classrooms controlled by the Registrar.

Between June 9 and August 19 (which is the currently defined MIT summer session period), there are numerous events that make use of the 149 classrooms. These include academic meetings and symposia, student groups, conferences, professional courses, MIT classes, and numerous outreach programs such as MITES, Interphase, RSI, Oxford Studies, and ID computer camp. In spite of the common lore, the fact is that the classroom spaces are heavily used.
For example, during the summer of 2008, these events consumed 50% of the assignable classroom hours. This comes by assuming that the potential available hours are determined by 51 days x 8 hours a day x 149 classrooms = 60,792 hours. During the 2008 summer other approved activities used 30,000 hours, or nearly 50% of the available hours.

This does not necessarily mean that there are 30,000 classroom hours suitable for summer classes. In order to run classes we would need regularly scheduled blocks of time on a weekly basis.

Given the distribution of planned activities scheduled as of April 10 for summer 2009, it appears that there are 20 classrooms that could be available for classes in the June-August period, presuming that other summer activities continue as normal. Thus, one fundamental question is whether renting out our academic space to other activities generates sufficient revenue that they should not be replaced by academic efforts. Examples would include outside summer schools, academic conferences, and other external events. Clearly some activities need to be judged by factors other than dollars (e.g. outreach efforts such as MITES, RSI, Interphase).

Thus we recommend that the Institute should establish a summer teaching program, during which period basic courses, such as GIR requirements, introductory courses to departmental majors, and widely used foundational courses (such as 18.03 and 18.06, 6.041, 6.00, and others) are offered for credit and at pro-rated tuition rates. OCW should be used as much as possible with TAs to minimize the cost of delivery.

**Quantification**

The question to consider is whether there is an opportunity to increase revenue by using our educational plant during the summer session. For sake of argument, we assume no changes in MIT’s academic calendar. Assume we run a 10-week summer session (starting June 8 and running to August 19). Classes meet for 2 hours, twice a week, for 10 weeks. We also assume there is open admission (no applications required) and we do not pay any financial aid for summer session courses (though for outreach reasons we may want to consider some financial aid). We assume that courses could potentially be offered for undergraduate credit, graduate credit, and/or noncredit.

**Revenues per class:** Assume we charge $2750 per student for a 10-week lecture course (for comparison, Tufts charges $1750 and Harvard charges $2500 for 3-4 credit courses during the summer). If each class has 30 students, then total tuition per class would be $82,000.

**Costs per class:** We would need an instructor and TA for each course. Assume a TA is paid $1200 per week and an instructor is paid $2400 per week, including EB. One way to justify this number is the following: Assume an average 9 month faculty salary of 120K. Most departments allocate 30-35% of the faculty member’s time to teaching, which implies 40K for teaching. This implies that salary for a term’s teaching assignment is typically 20K, hence a ten-week assignment would imply 2K/week. With EB this becomes $2400. Total teaching costs for a 10-week course would be $36,000. An
alternative mode is to use a flat rate. Assuming a $500 rate per hour of teaching, if a 10-week session offered 2 one-hour sessions per week, the faculty cost would be $10,000 plus EB.

**Number of courses:** Assume we have 20 classrooms available for our summer session. Assume each course meets for 2 hours twice a week for 10 weeks, consistent with MIT’s summer session which starts on June 8 and runs to August 19. Assume we use Mon/Wed and Tues/Thurs teaching schedules. Assuming each class is 2 hours long, each classroom should be able to handle 3 subjects each day. With 20 classrooms, we should be able to handle 60 classes on the Mon/Wed schedule and 60 classes on the Tues/Thurs schedule, for a total of 120 courses.

**Net Revenues:** 120 courses x $46K net per class = $5.5M. This does not include revenues and expenses that might be gained from a dining/housing component if we chose to add that option. This also does not include additional instructional costs, such as lab supplies, computer resources, and other elements that are likely to be needed, especially for science and engineering subjects. Nonetheless, there is the potential (assuming we can fill the capacity with students) for $4-5M in additional revenue under this model. This model does assume that the interest would be present to fill 120 classes; clearly a market study should be undertaken to assess this likelihood, before fully embarking on this recommendation.

Note that additional revenues might be brought in if we add the concept of on-line students. For this we would need videos of the classes, we would offer a lower tuition structure and we would need to work out mechanisms for interactions with TAs, for submission of homework, and for taking exams.

**Implementation considerations:**

If this is to be pursued, there are a number of factors that will need to be explored:

- Will these courses need access to Stellar?
- Will these courses need access to Libraries?
- Does it make sense to consider night classes in summer?
- How much existing revenue does this cannibalize?
- What will be the costs for lab courses in summer?
- Does this impact our ability to rejuvenate teaching facilities over the summer?
- If the summer session could start two weeks earlier (by shortening IAP) then we might teach two shorter summer sessions, as Tufts does. This could probably increase the number of courses to 160, thus increasing revenue an additional 33% (to roughly $7.4M before instructional expenses, or roughly $5.5M). This would require careful consideration of the impact on other educational factors due to the reduction in IAP.
- Who will staff these courses? If courses are taught by faculty, is this treated as summer salary or as a replacement for a regular teaching assignment. If the latter, then this proposal may simply shift teaching needs, but not actually benefit the budget. If courses are taught by other instructors, including graduate students, then how do we ensure a level of quality commensurate with an MIT offering, even if to students other than those in the regular MIT cohort?
Clearly the financial impact of this recommendation will require additional study. As noted, adding such courses will require teaching staff, either faculty or other instructional staff. If faculty members teach these courses, there will be costs: either such faculty will be remunerated for summer months of activity, or they will be released from other teaching duties during regular terms, which would then require other instructional staff to cover necessary courses. Thus there must be sufficient generation of new income to cover these costs, as well as generating additional income in order to benefit the Institute.

The best cost model is one in which students taking summer courses come from beyond our normal cohort, such as high school students get a head start on their college career. To fully estimate the financial impact, we need a model of the number of students likely to be included in this cohort. We recommend investigating other institutions that run such programs, such as Harvard, Stanford, Wellesley, Tufts, and others, to assess likely financial models.

Nonetheless, the cost model above suggests that there is potentially on the order of $5M in additional net revenue for the Institute. This, however, makes a number of assumptions:

- This set of offerings would be primarily aimed at students other than our current cohort. If our own students take these courses, then issues of financial aid arise, as well as the question of what effect allowing a student to move through the system more quickly has on our financial model.
- This set of offerings can be staffed by faculty members or other instructors without impacting regular course offerings. If a summer teaching assignment simply serves to replace a regular term teaching assignment, no savings on faculty costs are incurred. The model assumes that there will be sufficient faculty or other qualified instructors interested in using this opportunity as a summer supplement to their salary, which may not be true for many faculty who use the summer for major research efforts.

*Note:* There are many other factors that need to be carefully examined. As noted, there may be an impact on faculty teaching assignments, or the use of other instructional staff. There will also be an impact on other parts of the Institute that use the plant during the summer, such as conference offerings and other rentals of our space. If students are able to register for several courses during the summer, there is a need to provide housing, which will have an impact on the dormitories, in terms of shortening times available for maintenance, the need to provide air conditioning if it is not already available, and other physical impacts. However, it should be possible to create a cost model for summer usage that determines if in fact one can create a new income for the Institute. Note that one potential side benefit of this approach is that we may be able to subsume much of the cost of Interphase into this approach, particularly the cost of the instructors in Interphase.
INCREASE UNDERGRADUATE ENROLLMENT

Finding: For the coming year the estimated net revenue to MIT per undergraduate student is $19,000. Each student pays tuition of about $38K, and has room & board expenses of around $11K, plus another $3K for books, supplies, and travel; thus, the total cost for each student is roughly $52K. The average grant from MIT is about $19K per student (80 million in financial aid for 4200 students). Thus, each student has an average net cost of $33K, which pays for $11K of R&B, $3K for other expenses, and a net tuition of $19K to MIT.

What would be the impact on costs?

The key question to consider is the potential increase in net income to the Institute that would accrue by increasing the number of undergraduate students, weighed against both the financial costs of increasing the class size, but also the impact on the quality of the educational experience, both inside and outside of the classroom.

The precise incremental cost incurred by MIT for each additional undergraduate student is unknown. In the following we discuss how we might think about the effect on costs of a 10% increase in enrollment. A key factor in considering this proposal is to determine how much additional capacity is available without significantly increasing costs, or impacting the quality of the educational product. Because each additional student in principle affects a range of educational and student life parameters, a careful study is needed to fully analyze the effects of increasing the undergraduate student body.

Teaching Costs

We expect that for many subjects and for many departments, the incremental teaching cost from additional students is very low. For example, an increase in a class of 20 to 22 students has minimal effect on the classroom experience. Certainly some class sizes would increase, possibly requiring more support costs. But we tout that “63% of undergraduate subjects have less than 20 students,” so possibly we can add more students without great harm or cost.

However, there are clearly some subjects for which a 10% increase in students would not be costless. For instance, we expect that we would need proportionately more sections of the science/math GIRs. Similarly there would be a need for more recitation sections for the large lecture classes, e.g., 6.041. More specifically, a class of 250 students would see potentially an increase of 25 students, which has impact on TA and recitation instructor staffing. The impact of this increase in cohort size on the GIRs would need to be carefully considered. For example, can such an increase be absorbed in the TEAL teaching style? One way to possibly ameliorate these bottlenecks is to increase the number of transfer students who might already have satisfied some of the core GIRs. In addition, we might target transfer students who want to enter Departments where there is capacity.

We estimate that the incremental teaching cost is on the order of $5K per year per student. See appendix E for an explanation of this estimate.

Other Costs

Our medical costs are probably variable in the number of students – so this cost might increase. Student life costs might also increase –but we are uncertain how best to
assess this. Both of these factors should be carefully examined if this proposal is further considered.

How would we house additional students?

We do not have enough housing for more undergraduates, at least until the new undergrad dorm opens. We list some possibilities for accommodating an increase in undergraduate population:

1. Place undergraduates in graduate housing.
2. Encourage more students to live in fraternities or ILGs
3. Do more overcrowding in current dorms
4. Encourage more upper-class students to live off campus
5. Encourage more upper-class students to take a term abroad (this would help our global education efforts)
6. Rent space in nearby hotel
7. Put temporary dorms on (say) Briggs field

None of these are great options. Many of the latter choices are very unrealistic, and we expect that only some combination of 1 and 2 are really viable to allow for MIT to increase enrollment by 10%. Clearly a careful examination of the consequence of shifting housing needs must be undertaken: on the current undergraduate experience, and on the graduate student population.

Who would we admit and what might be the impact on the quality of the student body?

We have a large pool of qualified students that we currently can’t admit; so we expect minimal impact on the quality of the class from increasing the size of the class. Furthermore, we might actually increase the overall quality if we were to increase the percent of international students and/or the number of transfer students. In both cases, we currently turn down some exceptional students, and the acceptance rate in both categories is much lower than among domestic students.

Indeed targeting both international students and transfer students has other advantages.

For transfer students, we have a better idea of their academic interests, and might admit to under-utilized departments (to the extent possible, which would need to be studied), so as to not incur additional costs or hit any capacity constraints. Furthermore, transfer students are less likely to burden the science/math GIRs as they typically will have satisfied these requirements before entering MIT.

International students, depending on home country, also tend to have more extensive preparation in math/science that allows them to skip some or all of the GIRs. Furthermore, given the challenges we face, we might consider changing our need-blind admissions policy for international students. We recognize that this option was taken off the table in one of the overarching principles guiding the work of the Task Force, and is generally met with reluctance or skepticism by the working group. However, this issue was discussed in the working group, and therefore we include the discussion here. Currently, while our overall policy setting the number of international students in the student body (8%) was guided in part by financial considerations (international students are on average more needy than domestic students), we currently select international students in a need-blind fashion and meet their full financial need. (Note: there are other reasons we limit the international student population, most notably in deference to the demographic makeup of the undergraduate student body, as MIT is a national as well as international institution.)
As an alternative to the current cap, we might limit the financial aid for international students. For instance, one suggestion would be admit (say) another 50 international students each year, but with no aid. If we did this, then the net revenue for each student is now $38K rather than $19K. Another suggestion would be to replace the cap of 8% with a limit on the total financial aid that is available for international students. Then we might admit as many international students as are qualified, including an increased number of full-pay students, but the total amount of financial aid available for international students would be constrained by a preset budget. Each of these scenarios causes us to lose our ability to say that we admit international students without regard to their ability to pay, and there is reputational risk associated with this, as meritocracy is a central element of MIT’s brand. A third alternative is to reduce the number of international students in order to meet an estimated financial aid expenditure, while still admitting international students in a need-blind fashion. In effect, this lowers the 8% cap on international students, and the decrease in global diversity in the student body that would result is not one we endorse.

We must note that doing all of these except for the last would violate Educational Principle #15 on financial aid.

**Recommendation:** Increase the number of undergraduates by 10% from about 4200 to 4600.

**Financial impact:** We estimate that this would net MIT about $4 million per year. The net revenue per student is $19,000. We need to reduce this by our estimate of teaching cost of at most $5K; we estimate there is another $4K in increased cost due to medical cost subsidy and increased student life costs. Thus the total incremental costs are at most $9000, leaving us with the average net revenue from each student of at least $10,000. The details of our calculations are explained in Appendix E.

The impact would be greater if we changed our financial aid policies for international students.

**Other impact:** An increased student body would increase the absolute number of underrepresented minorities on campus, but would probably decrease the percentage. An increased student body might provide critical mass for activities and/or curricula that currently are not viable, and hence enrich our overall offerings. But we might also hit some capacity constraints with oversubscribed departments and subjects. One suggestion is to do this for a four year pilot period and critically assess what are the limiting factors. One of the things that must be considered is the effect on our “crown jewel” programs. This includes UROP but also includes classes like 2.07, which draws national attention to MIT, or overloading of already crowded top-ranked departments such as EECS. Finally, the quality and faculty/student contact in our UG program must be maintained if we try this change.

Clearly this proposal needs very careful examination before implementation. A study of the impact of increasing the class size on all aspects of student life should be conducted; a more thorough model of the financial benefit of increasing the class size should be developed; the impact of changing our admissions policies on our brand, and with our faculty and alumni needs to be carefully examined; the impact of increased class size on different departments must be considered.
SOFTENING OF FACULTY SALARIES

1. FACULTY SALARY DISTRIBUTION AND RESEARCH VOLUME

A. Increase academic year salary distribution to research funds

Most faculty academic year salaries (9-month) are paid by the General Institute Budget (GIB) allocated to departments. Given the current robust research volume at MIT and sponsors’ reported willingness to have grants pay some portion of faculty academic year salaries, we propose that faculty be allowed to shift some of their AY salary to research if they are able to do so.

As an incentive for faculty, the gross savings to a department’s GIB resulting from a shift of salaries to research funds could be split, with 50% of the savings used to reduce the GIB and 50% given as discretionary research funds to the faculty member.

We stress, however, that this would not be solely a decision for MIT to make. MIT’s current policy of “hardened” faculty salaries reflects an arrangement approved by ONR as part of MIT’s F&A negotiation process. This arrangement includes an acknowledgement that faculty work on research projects throughout the academic year but their salaries are not charged to research awards, and hence their efforts are considered as “cost sharing”. Any change to this process could in principle mean additional costs to the federal government, and would need to be approved. Thus, we recommend that if this suggestion is considered further, evaluation be carefully coordinated with the Office of the Vice President for Research.

Quantifying the outcome:

We assume that, in general, faculty outside the Schools of Engineering and Science will be unlikely to have this capability of shifting some salary to research grants, given their sources of support for scholarly activities. Perhaps half, or 325, of the ~650 faculty in Engineering and Science might be expected to participate. If we conservatively assume that the average amount of AY salary distribution to research funds could be 1 month (11% of AY salary), then the expected savings to GIB is calculated as follows:

$163M (total faculty salaries now charged to GIB) / 9 months = $18M per month

$18M X 325 participants/1000 total faculty X .50 returned to GIB = $2.9M per year
Other impact:
This proposed action would, to some degree, reverse the “hardening” of faculty academic year salaries that has been in place for roughly the past two decades. This is a significant cultural shift. Any shift in this direction also has the potential to create pressure on faculty to participate (e.g. a department head expecting faculty to raise portions of their salary from outside funds, with negative repercussions at salary review time). It also has the potential to create tension within the faculty ranks, if some schools are seen as expecting faculty members to raise outside funds to cover salaries, and others are not. This tension was evident during the period when salaries were being hardened, as faculty in Engineering, for example, were still expected to raise 50% of their salary at a time when faculty in other schools were fully hardened. It will also exacerbate inequities between those who are seen as the “haves” and the “have nots”. This may also expose our faculty to raiding, if a fully hardened salary at a peer institution is seen as more attractive. At a minimum, this may lead to unhelpful comparisons with peer institutions.

As a consequence, we recommend that the rationale behind the faculty salary hardening process of the early 1990’s be revisited to ensure that this proposal does not take us in a backward step. We further recommend that groups of faculty be engaged in discussion of the impact of such a change on their quality of life.

We also stress that this proposal, if pursued, will require careful analysis and planning to ensure compliance with federal research administration policies, as well as to ensure compliance with conditions and expectations from other, non-federal, funding sources.

Caveat: Departments would need to be prepared to absorb (by using GIB) any declines in research revenues that support faculty AY salaries.

B. Shift January salary to research funds

Given that faculty normally do not teach during January IAP, it might be possible to shift some portion of January faculty salaries from the General Institute Budget (GIB) to research support. In principle, the annual GIB support would therefore be reduced from 9 months to 8 months. As above, this action would depend on the capacity of research funds raised by individual faculty members.

Similar to the proposed shift of some portion of AY salary to research funds, an incentive should be identified to induce faculty to charge January salary to research. This could again take the form of returning some of the savings to the faculty member as discretionary research funds. Another possible incentive might involve paying the participating faculty member some “differential”, slightly more than 8 months salary for 8 months effort (e.g., 8.5 months), which, combined with a full month of January salary from research funds (at 1/9 of AY salary, as during the summer), would result in increased earning potential over the academic year.

We stress that this proposal, if pursued, will require careful analysis and planning to ensure compliance with federal research administration policies, as well as to ensure compliance with conditions and expectations from other, non-federal, funding sources.
Other impact:
This would incur the same risks as those discussed above. In addition, while faculty do not typically teach during IAP, many faculty members use the time to prepare for the upcoming term, and hence can legitimately argue that salary for this period should come from GIB. Additionally, if faculty are opting to pay for their January salary from research, this may lead to arguments that faculty need additional TA support during January to prepare for the coming term, thus undermining the potential savings. In addition, such a move would remove the argument that IAP is part of the Academic Year and would make it even harder to get faculty to be present during IAP. On the other hand, such an expectation of bringing in research funds for IAP may enhance faculty renewal.

Quantifying the outcome:
$18M \times 325 \text{ participants/1000 total faculty} \times .50 \text{ returned to GIB} = \$2.9M$

Caveat:
This proposal needs to be discussed with the Office of Sponsored Programs to determine whether structuring the academic year with a duration of either 9 months or 8 months is acceptable under federal grant administration guidelines. There may be other factors that will require careful analysis and planning to ensure compliance with federal research administration policies, as well as to ensure compliance with conditions and expectations from other, non-federal, funding sources. Also, as above, the risk of declining research revenues would need to be managed.

C. Overhead-related incentives connected with faculty research volume
We should explore the possibility of the Institute “returning” to faculty some portion of overhead funds collected on research funds beyond a certain volume threshold (which could vary by school/department). The amount returned could be calculated as a percentage (25%? 50%?) of marginal overhead collected, and provided as discretionary funds to the faculty member.

Caveat:
This would need to apply to incremental research volume only, assuming the current F&A pool is already fully utilized. I.e., this proposal would result in additional costs to the Institute, and those costs would need to be covered by marginal F&A revenue.

In addition, we note that distribution of marginal future revenues to operating units only makes sense if it is paired with freezing of current budgets. If pursued, an alternative is to redistribute funds to DLC’s with each DLC further redistributing to individual faculty, if desired.
**Reduction of the Subsidy for Graduate Research Assistants**

**Findings:** Currently MIT subsidizes 50% of the academic year tuition and 100% of summer tuition of Graduate Research Assistants (RAs) from the General Institute Budget (GIB). In FY08, there were 2,376 graduate RAs across the Institute (see “Students by Major; Academic Years 1998-2008,” Office of the Provost, Institutional Research, p. 35), and thus the amount of the academic year tuition subsidy in the GIB was approximately $42,000,000.

**Recommendation:** Consider a reduction in the academic year tuition subsidy to 45% (i.e., 55% paid from grants).

**Financial Impacts:** Assuming the Graduate RA population remains level in FY10, the net savings to the GIB would range from $2.6 million to $4.4 million. This comes from our earlier analysis: FY10 tuition and RA stipend projected to be $37,510 (45% subsidy = $16,880; 55% from grants = $20,630) and $28,200, respectively. Savings in RA subsidy would equal $4.4 million, but the attendant loss of F&A is likely to be as much as $1.8 million. For example, a PI may consequently cut back on Materials and Services (M&S), Travel, or other F&A-bearing expenditures. For every $1 of increased tuition burden that is paid for by what is currently used for F&A-bearing expenses, then the GIB would be reduced not by the full $1, but by $0.595 (= $1 x (1/1.68), using F&A rate of 68%); thus, the F&A income lost from the GIB per $1 increased tuition burden on the PI would be $1 x [1 – (1/1.68)] = 40.5¢. In this limiting scenario, the GIB would be reduced by the $2.6M figure above. In another limiting scenario, where the PI does not reduce F&A-bearing expenses but rather those that do not bear F&A (e.g., Equipment items of $5,000 or more), then every $1 of reduced subsidy reduces the GIB $1, amounting to $4.4M annually.

**Other Impacts and Considerations:**
- Reducing the subsidy shifts more of the financial burden to research grants.

Possible impacts that require serious consideration include:

1. Large research groups with many graduate students will be hit hardest, and some PIs may necessarily reduce the size of their research groups.

2. The reduction in funds available to each PI for research expenditures may be putting the brakes on the research engine of MIT.

3. As the cost difference between supporting a postdoc and an RA decreases, the frequency with which PIs hire a postdoc in lieu of an RA will likely increase.

4. As the cost of doing research at MIT increases relative to that at peer institutions (see FOGS Report, Figure 12.), the rate at which faculty leave MIT will also likely increase. Thus we need to stay competitive with peers (who are also changing).

- The tuition subsidy has been adjusted several times over the past decade. In particular, the subsidy was: 65% from FY99-FY04; 45% from FY05-FY08; 50% from FY09-present. These and other financial impacts have been analyzed in detail by Sarah Brady, Senior Financial Analyst, office of the Vice President for Finance at MIT. (We would also like to thank Stephanie Richardson and Lydia Snover for helpful discussions and information.) She has generously allowed us to include her report as an attachment to this report. The attached memo (dated March 12, 2003) from former Provost Bob...
Brown also speaks to some of these issues and is provided as further background on the history of the tuition subsidy at MIT. The impacts of these previous adjustments may be useful in evaluating reduction of the subsidy to 45%.

- **The NIH caps the amount of “graduate student compensation”** (defined as the sum of stipend + tuition, direct costs) that can be charged to an NIH grant (e.g., R01) at an amount equal to the minimum postdoc salary (currently $36,996 per year; $37,368 beginning FY10). (The NSF does not have a similar cap.) Therefore, with the 50% subsidy, the FY10 graduate compensation would be $28,200 stipend + $18,755 tuition = $46,955, i.e., $9,587 over the cap. However, the NIH has always allowed MIT to rebudget (i.e., there really isn’t an NIH cap as far as the PI is concerned), and the number within MIT used as the “hard cap” is currently: minimum postdoc salary + Employee Benefits + Vacation Accrual = PD salary x 1.305 = $48,765 (FY10). (These numbers are from Bill Barrett in OSP). Thus, a 45% tuition subsidy would correspond to $28,200 + $20,630 = $48,830 per RA per year. The $65 differential (RA cost – NIH cap) would either come from another source of funding, e.g., unrestricted funds, or be addressed by some other mechanism.

- **Educational and Research Missions of MIT and the RA Population**

  Should the number of graduate students at MIT be regulated more directly, e.g., capped by the Administration, Deans of each School, Heads of each Department, etc.?

We ran into this question in various forms throughout the preparation of this report. Its relationship to the RA Tuition Subsidy merits mentioning. This issue was addressed at length in the Funding of Graduate Students (FOGS) Report (pp. 21-24), and we encountered many different opinions and perspectives in our own investigations. The lack of any explicit policy regulating RA population growth is clearly an important component of the MIT culture and likely has a very large financial impact. Of our peer institutions, only Stanford also lacks a similar policy of population control, as far as we are aware. Worth investigating are the factors that led to our peer institutions’ decisions to control or not control the number of graduate students. However, unclear are both the extent of the financial impacts of this current practice and whether it should be changed.

The number of graduate students at MIT has increased significantly over the past several decades. That the number of undergraduates has changed only marginally during the same time would suggest that the driver for the increase in graduate student population is not an increased need for TA support. Rather, this increase has been caused largely by the growth of research at MIT and has not been subject to any policy regulating the number of graduate students. Rather, the faculty, at the level of the individual PI (i.e., not DLC, School, Institute, etc.), has had the greatest direct influence on the number of graduate students at MIT, within certain constraints, in particular:

- A. Grant support that the PI is able to secure.
- B. Space.
- C. Nature of the research.
- D. Personal assessment of “ideal” group size, which varies over the PI’s career.

The increase in average number of graduate students and postdocs per PI over the past several decades (1940: 2.5 and 0, respectively; 2006: 6.2 and 2.4) would suggest that the faculty have become increasingly better at A (above), that MIT has continued to increase B, and that the size of a research group is highly customizable by the individual PI (C and D).
One can make very good and convincing arguments that the number of research personnel should not be subject to any cap, but rather be determined ultimately the impact, nature, and sustainability of the research. In fact, there are some recent indications that the total graduate student population may be leveling (suggesting that further regulation may not be necessary), but we are of the opinion that it is not clear whether this is a short-term phenomenon (FOGS Report, Figures 14). However, unfettered growth in the graduate population, while increasing research production, may have impact on faculty time for other endeavors, such as undergraduate teaching and mentoring. Hence, a more careful consideration of appropriate balance of faculty effort should be included in this discussion.

The observed increase in research space per faculty member is one of the largest financial impacts of this philosophy, i.e., the capital investments of building/renovating space and the facilities costs of maintaining it. The latter should, in principle, be recoverable from overhead. Funds for the former are often provided by targeted donations, but in some notable cases, by the MIT endowment.

Thus, the significant impacts of the lack of a regulated growth policy on the GIB include increased revenues in the form of tuition and F&A income from grants and increased costs in the form of the RA tuition subsidy. In effect, the RA tuition subsidy is one of the investments that MIT makes in order to stimulate research, and the revenues generated by research are the return. Perhaps a return on investment (ROI) model would assist the analysis of the purpose and effects of the subsidy.

In closing, since reducing the subsidy to 45% would likely reduce the number of RAs (vide supra), then, stated another way, one means by which MIT could regulate the number of RAs would be adjustment of the subsidy. Alternatively, if MIT decides that tighter, more direct control over the number of graduate students of MIT is necessary (space considerations, etc.), then a cap would be a possible means to this end. Each of these paths would likely have large financial and cultural impacts on the Institute. We also note that such a large change would have to be phased in gradually since faculty have grants with the current rates built in. In addition, there would have to be consideration of RAs on discretionary funds.

What is clear from this discussion is that MIT does not have a good sense of the elasticity of the demand for graduate students or postdocs. There is a large policy question that MIT should address as to the desirable size of both populations (graduate students and postdocs) as well as what are the levers to change both. We recommend that such a policy review be undertaken. Since UROP is such a key part of the education at MIT, such a policy review should look at any effect on the willingness of faculty to fund a UROP.

Finally, we note that on many awards (awards already issued, new awards with budget limitations, for example), funding cannot be increased to compensate for changes in MIT policy. Reducing the RA tuition subsidy requires that a greater percentage of full tuition costs be charged to research awards. Tuition charged to research awards is not subject to F&A assessment and is not part of the Modified Total Direct Cost (MTDC) base used to calculate F&A rates. Therefore, reducing RA tuition subsidies will create a shift from MTDC to non-MTDC costs, reducing MIT’s research MTDC base and increasing F&A rates. Thus, any consideration of this proposal should carefully examine such secondary effects.
CAP ENDOWED PROFESSOR FUNDS

PROFESSORSHIP FUNDS

There are approximately 375 endowed faculty chairs at MIT (some controlled centrally by the Provost and others controlled at the department or school level). We suggest that the funds provided to chair holders as annual scholarly allowances could be more tightly managed, by 1) enforcing a rule that no more than two years of allowance funds can be accumulated in a discretionary account, and any resulting unspent balance be returned to the Institute; 2) considering a reduction in the annual allowance. Funds saved in this way could potentially be re-directed to paying expenses now covered by the GIB.

Financial impact: It is difficult to assess the impact of the first suggestion without a detailed examination of the current chair holder accounts. Moreover, imposing this rule may simply encourage chair holders to expend their funds in manners that do not directly impact the GIB.

The second suggestion could provide significant savings. Currently most chairs provide a $15,000 or $20,000 allowance; a $5K reduction would save $1.875M; a $10K reduction would save $3.75M.

Other impact: While this may save the Institute several million dollars, there are some secondary effects. To the extent that chair holders use their scholarly allowance to support graduate students, limiting these funds may simply deflect costs to external funding sources, and thus indirectly contribute to a reduction in the number of graduate students.

Secondly, limiting accumulated scholarly allowances or annual scholarly allowances may lead to faculty dissatisfaction, as many chair holders use these funds to augment their group expenses.

The aim is reduce and redirect excessive buffers. It may be more appropriate to allow some waiver to the idea if a faculty member presents a good argument as to why they should be allowed to keep a large amount of resources.

Note: MIT should redouble its efforts to raise endowment for professorships in order to continually reduce the dependence on GIB for the support of faculty salaries.
DROP/ADD DATE CHANGE

Finding: MIT’s late and separate add date and drop dates allow for considerable fluctuation in class size during the term, which incurs additional and unnecessary costs. While there is a clear educational benefit for students to have an add and drop date beyond the first week of classes, in allowing them to manage their educational experience and to explore subjects in areas outside their core interest, it is unclear that these benefits require such late dates for adding and dropping a subject. In addition to financial impact, the late drop date also has implications on how students allocate time during the term, on GPA-protecting behaviors, and on other educational elements.

To get a sense of the impact of a late add and drop date, consider the following. It is very common to see reductions in class enrolment between the fifth week counts and the end of the term counts of between 10 and 15%, and between first day counts and end of term counts of between 20 and 25%, especially in large subjects. For subjects (both GIRs and subjects in large majors) with enrolments on the order of 150 students in a term, even the drop from fifth week to end of term translates into roughly 25 students – the size of a recitation section. Of course for larger courses, the numbers increase. Thus, by staffing a subject based on initial enrolment, a department may have to allocate a half FTE recitation instructor and a half to full FTE Teaching Assistant beyond what is actually needed at the end of the term, and what is actually needed as measured by credit hours earned. Even for smaller subjects, other resources need to be allocated based on initial enrolment counts, which may change considerably by the end of the term. Another way to understand this is to note that with the current very late drop date, MIT bears all the costs (wasted financial resources) and the students bear none of the cost of allowing this high degree of flexibility.

Recommendation: Move Add and Drop Date earlier in the term or have them coincide on the same day. While there are many variations, perhaps the most straightforward proposal would move Drop Date to coincide with Add Date, during the fifth week of classes.

Financial impact: Minimize waste of educational resources:
1. Minimize spending on additional instructional staff members (TAs, lecturers, writing instructors, technicians) who are not needed at the end of the term when the class drops considerably in size. Allows for planning of subject staffing based on realistic expected enrolments by the end of the first few weeks of the subject.
2. Minimize waste of space allowing Professors to plan appropriately in reserving adequate classroom/lab space/recitation time.
3. Minimize waste of equipment by enabling Professors to secure an exact amount of needed supplies.

Although it is unclear exactly how much could be saved with this change, the following rough analysis provides some guidelines. It is very common in large subjects (e.g., more than 150) to see a 10 to 15% drop rate between Add Date and Drop Date, and a 20 to 25% drop rate between start of term and Drop Date. For a class of 150, this means that roughly 30-40 students may drop between first class and drop date, and roughly 15-25 students may drop between fifth week and drop date. If this were controlled much earlier in the term, this could imply staffing with perhaps one or two fewer TAs and with one-half of an FTE recitation instructor for each such course. While
we have not done a specific count of classes of this size, between Science and Math GIRs and core courses in large majors, there are probably at least 20 such courses at the Institute. Thus, this would imply a need for 20 fewer TAs, which yields a savings of $1.3 million. If in addition on the order of 10 faculty (or other instructors) can be redeployed to other teaching needs, this further increases the potential savings.

**Other impacts:**
**Pedagogical**
1. Improve classroom dynamic by minimizing the amount of student inflow and outflow, thereby enabling the students and professor(s) to develop cohesive work ethics and methods from the outset.
2. Improve student integrity by mandating a high commitment from the onset.
3. Without the option of dropping classes at the end of the term due to dissatisfaction with non-A grades, students will be encouraged to focus less on grades and more on comprehending and mastering material.
4. Foster the development of foresight by encouraging the student body to plan in advance: students will need to peruse syllabi and course options more thoroughly in the beginning of the term to determine what classes are appropriate for them, and to make sure they have the pre-requisites.
5. Make the MIT experience more holistic.
6. Encourage students to take more responsibility for their own learning.

**Cultural**
1. Students may feel that such regulations impinge on the freedom of choice. This is a potentially serious cultural impact. We encourage our students to explore, we encourage our students to take risks; thus we need to ensure that we are not removing a valuable safety net that will end up discouraging students from such behaviors.
2. Students cannot get a flavor of the course before committing to it; such a change may reduce student exploration of new areas. As with the previous point, this is a potentially serious cultural impact.
3. Grading policies may be opaque in a class; students do not have a way of gauging their performance to decide whether to commit to the class.

**MIT takes pride in its student body's achievements and ambitions. Without the possibility of bail-out, this level of risk taking may be seriously affected.** Thus, a careful consideration of alternative ways of encouraging exploration should be conducted as part of this question. Similar to the introduction of “exploratory subjects” as part of the process of reducing freshman “pass-no-record” from two terms to one, it is worth exploring ways to continue to encourage exploration if the drop date is moved to much earlier in the term.
MODIFY FACULTY COMPENSATION

A. Salary freeze

Substantial savings could be realized if the Institute were to implement a salary freeze or a lower than usual annual increase rate for one or more years. Each year of freezing faculty salaries, assuming a typical salary increase factor of 4%, saves the GIB approximately $6.5M. Each 1% increase represents a cost of approximately $1.6M; thus for example freezing raises at 2% would represent a budget reduction of $3.2M.

B. Retirement benefits

Currently, all MIT employees continue to accrue retirement benefits in both the Basic Plan and the Supplemental (401k) Plan until they retire. The Institute could consider discontinuing its contributions to these retirement accounts after a certain age, perhaps in the range of 65 to 70, or pegged to the current age for Social Security eligibility. We understand that this is the practice in some universities.

Financial impact:

Currently there are approximately 150 faculty members over age 65. Assuming MIT contributes 5% (the maximum available match) of each faculty member’s salary to Supplemental Plans, this is an annual cost of approximately $1.2M.

Similar savings may be obtainable by limiting accrual of funds in the Basic Retirement Plan, but this needs further consultation with the Benefits Office. (We believe that basic Retirement Plan benefits are funded through the employee benefits pool.)

Other impacts:

MIT needs to stay competitive with peer universities in faculty retention and recruitment and would need to assess the impact of any actions related to salaries or retirement benefits on our competitive standing. One possible benefit is to encourage faculty renewal.

This idea would need to be examined by legal counsel to ensure that it passes legal muster.

Note:
We have addressed the impact of these proposed changes only on faculty salaries, but we recognize that MIT could choose to include any or all categories of employees in any actions directed at salary or retirement programs.
MATCH APPOINTMENT AND PAY TO ACTUAL TA EFFORT

Finding: TA appointments and utilization vary widely among departments with regards to roles, responsibilities, expectations and reimbursement methods of TAs, highlighting the different methods of using teaching staff across the Institute. Among the issues that identify the diverse way MIT uses TAs are:

• Work hours per week and weeks per term
• Hiring standards — how many TAs per subject and per number of undergraduate students taught
• Stipend rates
• Work performed — homework grading, report grading, classroom teaching & one-on-one tutorials each require different levels of effort and interaction

Recommendation:
1. Consider providing every MIT doctoral student with at least one semester of teaching experience while at MIT. For this teaching experience students would receive course credit, rather than pay.
2. Manage the need for diversity of TA appointments across departments and schools by reorganizing TA appointments. Ideas for reorganization include:
   i. Differentiate Teaching vs. Teacher’s Assistant
      a. Teaching Assistant: Direct student contact is highly regarded; requires greater expertise & higher pay
      b. Teacher’s Assistant: No direct student contact; activities performed include grading homework, setting up labs, etc. Requires training but no particular expertise.
   ii. Student Alternative TAs — Hire graduate OR undergraduate TAs for teaching support
      a. GTAs: Graduate student TAs to do the work of teaching and report grading
      b. UGTAs: Undergraduates to grade problem sets or other homework
   iii. Work Hour Structure — Structure TAs in 12 hour/unit blocks
      a. Part time TA: 12 hour/credit work week
      b. Full time TA: 24 hour/credit work week
   iv. Support Type — Offer all types of TAs an opportunity to be compensated for their work either through stipends or credit, similar to UROP positions, in order to provide the best possible experience for the individual student
      i. UG- or GTAs for credit: students desiring teaching experience could earn credit; roles and responsibilities could be better tailored to help them learn how to teach better
      ii. UG- or GTAs for pay: students working to support their education need financial support; their roles and responsibilities could reflect that need
      iii. Part time GTAs might receive tuition support but no stipend
   v. Compensation Type — Consider structuring compensation hourly versus salaried to enforce hours worked
   vi. TA Salary & SEIP Budgeting — Decouple TA salaries and SEIP budgets from departments’ GIB funds for operations to provide transparency
3. **Develop managerial tools to navigate choices:**
   
i. **Matrix could be utilized to understand departments' needs:** see below

<table>
<thead>
<tr>
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<th>UGTA</th>
<th>GTA</th>
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<tr>
<td><strong>Hours of Work</strong></td>
<td><strong>For credit or pay</strong></td>
<td><strong>For credit or pay</strong></td>
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<td><strong>Full time</strong></td>
<td><strong>Full time</strong></td>
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<td></td>
<td><strong>Ex: Additional teaching assistant, homework grading</strong></td>
<td><strong>Ex: Classroom teaching, 1 on 1 tutorials</strong></td>
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<td><strong>Pay Rate</strong></td>
<td><strong>For pay</strong></td>
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<td><strong>Part time</strong></td>
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<td></td>
<td><strong>Ex: Homework grading, lab set up</strong></td>
<td><strong>Ex: 1 on 1 tutorials, report grading</strong></td>
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</table>

**Financial impact:** Reduction of 10% of TA stipends through reorganization could be an annual salary savings of $1.1M across internal funding sources (this comes from $1.1M is 10% of the FY08 TA salary base of $11.1M in GIB funds). This amounts to institutionalizing multiple categories (full-time, half-time, 1/6-time, etc.) of TAs across all schools and departments (currently it varies by department): full-time TA vs. half-time TA. Adjust pay for TAs depending on the category of TA, based on the number of hours they spend on TA duties. By allowing fractional TAs such as 1/3-time TA, 1/6-time TA we can assure that the pay accurately reflects the percentage of full time the TA works. While we cannot accurately estimate how much this would save, anecdotally it seems that some very large departments consider all TAs full time positions, regardless of actual time spent on TA duties.

We recognize that the idea of requiring all doctoral students to be a TA can likely not be implemented across all of the schools/departments. We estimate implementation of this idea for 1/3 of all possible TA positions. If each of the 6000 graduate students serves as a TA once during the ~10-12 semesters of their graduate career, that means that 600 TAs per semester would receive credit rather than pay. Conservatively assuming only 1/3 of those positions will receive credit each semester yields cost savings of $12M per year.

If a student does not receive credit for serving as a TA, an alternative is that while serving as a TA, his/her pay should be divided between TA and RA responsibilities. The fraction of salary covered by TA money should reflect the amount of time student is spending as a TA versus the amount of time they are spending as an RA.
Assuming that we need ~500 TAs per semester and that for 250 of them half of the student salary can be shifted to RAships, we would remove $7.5M from the GIB.

Other impacts/considerations:

- This proposal may well affect the total graduate population at the Institute. Currently roughly 600 graduate students receive financial support as a TA each term. If this support is dropped, the support for those students must come from somewhere: from research grants, from fellowships or from personal resources. Since the bulk of the graduate students at MIT do not self-support, the obvious conclusion is that cutting the financial support for TAs could in fact lead to a reduction in the graduate population of a similar amount (e.g. 600 fewer students). The impact of this may be differentially distributed among departments, and that impact needs to be carefully examined.
- TA appointments may be used by some departments as graduate financial aid as well as teaching support.
- International students have a restriction on number of hours per week that they can work. Restructuring appointments may impact them adversely.
- Departmental policies will need further investigation as some may require TA appointments during a graduate student’s education at MIT.
- TAs receive full tuition support; net tuition revenue per TA = $0.
- Reduction of graduate student enrollment may be the only way to offset costs borne by GIB.
- Graduate student support & appointment process may need to be entirely reconsidered, for example:
  - RA levels to be driven by research volume
  - TA levels to be driven by need for teaching support
  - Graduate Fellowships offered as appropriate
  - Result may increase net graduate tuition revenue and reduce costs across all funding types
Action Steps with Lower Impacts

The following set of items deal with issues that could be immediately implemented to achieve cost savings or revenue enhancement. These issues are less likely to have as significant an impact on MIT as they largely represent revenue enhancement ideas and leverage of campus resources that do not significantly impact students or faculty. They also may yield less cost savings than more difficult options.

Increase the number of Special Students

Many of our class offerings do not fully utilize available resources. This could be better handled by offering excess capacity in existing undergraduate subjects to the general public. Before registration, each section would disclose seat capacity with existing teaching resources. After Registration, we could offer remaining capacity to special students for non credit.

**Recommendation**

Increase the number of Special Students admitted to the Institute on a term-by-term basis.

**Financial Impact**

We estimate that this could create $1.6 million per year in new revenue. This is based on doubling the current special student number from 150 - 300 and charging $5,335 per seat.

**Other Impacts**

- Will require good estimates of class enrollment, or to move Registration Day to earlier in the calendar
- Will require promotion to general public
- Could have impact on classroom experience for other students, both positive and negative. Would be a significant negative if the pace or experience of the class were significant changed by the presence of special students. This can be exacerbated if special students feel entitled to a classroom experience geared to their needs, given that they (or their company) are paying significant funds to take a class.

A significant policy issue is to treat all visiting students fairly and appropriately. Visiting students who take classes should be asked to pay, although many current visiting students do not pay and simply attend classes.
Eliminate Athena Clusters
Reduce cost by reducing or eliminating Athena public clusters based on the fact that 95% of students have laptops. There is a commonly held belief that use and importance of Athena clusters has decreased as student use of laptops has increased. Certain clusters have very low levels of usage and should clearly be closed. However, other Athena clusters such as at the Student Center are still heavily used during peak hours and peak times of semester. Unfortunately, there is no recent data on how students and faculty actually use the Athena clusters and this should be further studied before any drastic action is taken to close any of the heavily used clusters.

Recommendation
Close Athena Clusters

Financial Impact
Cost of Athena hardware and operations is estimated at close to $900K; software licenses are another $400K. Energy savings (electricity, heating, and cooling) from closing clusters estimated at $130k/year. However, there are financial aid implications that will need to be resolved.

Other Impacts
- Financial aid issues need to be resolved if students are required to have laptops. In particular, if programs are available to provide laptops to students unable to afford them, this expectation needs to be carefully managed so that students do not simply come to expect MIT to provide a laptop.
- Must solve centrally managed software license agreements and develop alternative cost-effective mechanisms to provide educationally important third party software such as Matlab.
- Athena space also used for collaborative student working environment. If the clusters are closed, appropriate utilization of the space needs to be carefully considered. This could be significant cost savings if the space is well utilized to release leased space. This is not accounted for in the cost estimate above.
- Need to better understand how faculty and students use the Athena clusters. Impact on education that requires additional review/contingency plans: a) a few classes are currently highly dependent on availability of Athena clusters, b) some classes rely on older software that is uniquely available on Athena, c) some faculty and students rely on software that is licensed for Athena and not otherwise available to students, and d) some classes reference Athena or Athena software in course materials because it is "lowest common denominator" although the software is also available on personal machines
- Significant issues with availability of printing would have to be resolved.
Limit printing in Athena
A great deal of paper is used in students printing at the Athena Clusters

**Recommendation**
Limit or control the printing in Athena Clusters. This could be accomplished, for example, by providing utility programs, establishing limits, and possibly charging a per page fee for printed materials. One needs to ensure that the cost of enforcement of such a program does not exceed the savings incurred.

**Financial Impact**
Athena printing cost is about $300K/year

**Other Impact**
A significant benefit is the perception of being “green” and the reduction of obvious waste. This may help reduce other waste.
Centralize Graduate Admissions

By moving all academic departments to a central Graduate Admissions System, MIT maintains a consistent presence, streamlines IT support, and reduces overall cost of maintenance. This may also increase faculty productivity, which will have secondary benefits. The subgroup performed a high level comparison between EECS’ system and CollegeNet's, and determined that EECS’ system has a more robust feature set. If adopted, the subgroup believes departments would receive better service at a lower overall cost.

**Recommendation**

We recommend that MIT move to the graduate admissions system that is currently owned and maintained by EECS.

**Financial Impact**

We estimate about $0.2 million in savings between the departments. This savings comes in two elements: direct and indirect. The direct savings are the fees currently paid to CollegeNet and ApplyYourself to process applications. Some of those savings will have to be redirected to MIT sources for maintenance of the system. The indirect savings are in personnel. Many departments use temporary help or portions of an administrative assistant’s time to deal with the paperwork volume associated with graduate admissions. The automation of the system should significantly reduce the need for such help. A more careful study would be required to determine the actual savings in personnel support costs.

Short term savings are offset by the cost to implement in academic departments. After the transition, we will save significant funds by limiting changes to one system instead of the 3 we currently maintain.

**Other Impacts**

- Will need to be phased in over time
- Would like to redirect 15% funds collected by CollegeNet to EECS
- Would require support from Senior Administration to further streamline processes. Additional cost savings can be harvested if Senior Administration supports standardizing graduate admissions processing across all the schools” (our estimate of savings is based on standardizing technology but not process). This would stress Educational Principle#14 but is consistent with Heuristic #3.
- Greater cost savings realized if we use student labor through employment or UROP
- Significant change for Sloan to migrate from ApplyYourself system.
- This will likely get rid of the need for shadow systems in the Departments.
- We would also have a more robust feature set at lower cost.
- A central system would also allow more ability to plan and allocate TAs.
Reduce costs for the Freshman Alternative programs:

Findings
We currently provide three alternative teaching models for freshmen: the Experimental Study Group (ESG), Concourse, and Terrascope. These programs serve approximately 15-20% of the freshman class. The total budget for FY09 for all three programs is approximately $1.5M. This will drop to roughly $1.4 in FY10 due to budget cuts. Instructors are the primary teachers in these programs.

Recommendations
- Decrease the number of Science instructors associated with ESG and Concourse, by 3 FTEs, an approximately 50% reduction. Substitute with faculty, making teaching in ESG/Concourse part of the normal departmental assignments. Faculty could also come from departments not currently engaged in teaching Science GIRs.
- Consider disbanding Terrascope or integrating it into the other alternate freshman programs, or departments (EAPS or CEE).

Financial Impacts
- ESG presently has 4.75 FTEs and Concourse has 2.5 FTEs, reflecting the different teaching group sizes in the two programs. Instructors often overlap between the two programs. With reduction of 3 FTEs, at a salary/benefits of approximately $80,000 per FTE, a yearly savings of $240,000 would be obtained.
- The Terrascope FY10 budget is $290,000. A significant amount of this would be released if Terrascope was incorporated into other programs or disbanded.

Other impacts
Alternate freshman programs provide pedagogical advantages for many students. For example, students who have been through Terrascope report that the leadership, problem solving, and teamwork skills acquired stay with them in the long term. ESG and Concourse provide a clear advantage for students who learn better in small-group or structured settings that are different from the normal delivery of the freshman year. Preliminary data (that should be examined further) suggest that URM students in Concourse and ESG have greater academic success than their peers in the regular curriculum.

These programs should be retained in a way that sustains and even improves the benefits they offer. This will be achieved most effectively by considering the programs as part of a connected and coordinated system, which includes freshman advising, the programs of the Office of Minority Education (including Interphase), and the freshman learning communities.

The staffing of these programs with faculty will require Science, Engineering and HASS to adopt a different attitude to these programs. In particular, they would have to adopt the recommendation made earlier that faculty teaching anyway at MIT should count as part of the teaching expectation for a faculty member.
**Enhance professional education**

**Summary description:** MIT offers relatively few educational programs that unequivocally bring in revenue. There are some professional masters programs and a small boutique program of short professional courses. There is a significant opportunity to expand these offerings and leverage the MIT brand. We could envision the full gamut running from OCW-based certificate programs to paid professional Masters degree programs to specially designed short courses for professionals.

**Quantify the idea:**

1. We have no data to assess the amount of money raised by Masters’ programs at MIT. Nevertheless, the Deans of the five schools should be urged to investigate the potential costs and benefits of establishing new one or two year masters programs targeted at students who would pay full tuition.

2. The 2008 Treasurer’s Report states that revenue from “executive and continuing education” was $33.4 million in 2008 (up from $21.4 million in 2007; we do not know to what this significant increase was due). In comparison, according to their annual report, Harvard in 2007/8 had revenues of $214 million from “continuing education and executive programs”.

The executive director of MIT’s Professional Education program, Bhaskar Pant, stated that currently, the main beneficiaries of the revenue coming in from the program are the faculty instructors. He sketched a wholesale revamping and expansion of the program, which would bring in significantly more revenue to the institute. Note that additional revenues might be brought in if we add the concept of on-line students.

One obvious target for expansion would be larger offering of professional courses related to energy, which could be devised by the MIT Energy Initiative.

**Implementation issues:**

The main factors that need to be considered are resource issues: faculty and staff time, classroom availability, short term housing referrals (since presumably, MIT’s dorms are not adequate for housing professionals). One issue is whether these programs would be offered during the summer (in which case the discussion on summer courses would apply here, and there would be a potential collision between needs for regular summer courses and professional summer courses); or whether these programs would be offered during the academic year, in which case there are issues of conflict on resources that would need to be addressed. Another issue that will require significant faculty adjustment is the possibility of the creation of non-thesis MIT degrees. This would likely make such offerings much more attractive. Finally, the growth in such professional education will provide a home for academic staff that may have to leave MIT as the faculty/student interaction is made more effective.

While there is probably some headroom in existing operations, a serious expansion of continuing and professional education would require time, effort, and capital investment. If the Institute decides that this is a worthy investment, a more sustained analysis would be in order, as well as a study of how such education programs are used by our peers.
Strategic Thinking and Organization with Higher Impacts

The following set of items deal with issues that need to be studied or reorganized in order to achieve cost savings or revenue enhancement. They may, if implemented, also imply significant impacts either to MIT’s culture, mission or to operations.

Study and Understand Graduate Education Model

General Thoughts

The economic downturn and corresponding change in valuation of MIT’s endowment provided the impetus to charge an Institute-wide Planning Task Force with finding ways for the Institute to operate within its adjusted financial envelope. The work of the Task Force has shed new light on the activities of the Institute and generated insights for how new efficiencies can be realized. However, at least in our experience, this process has also raised new questions about how the Institute operates that we weren’t able to answer, such as the marginal cost of a graduate student, or what some of the second-order or unintended consequences of our recommendations will be. To us, these are research problems, and should be studied by those with more time and expertise than members of the task force can bring to bear.

We recommend that, based on the experiences of the task force, the administration undertake an effort to research and model the finances and processes of the Institute to gain a better systems-level understanding of how MIT actually works. From this vantage point, we believe administrators would be better equipped to make future decisions about fundamental parameters of the Institute (such as adjusting the size of the graduate population), as well as understanding what the non-obvious effects of such decisions will be.
Graduate Programs Financial Support Plan

Findings: Based on discussions with Steven Lerman, Dean for Graduate Education, we have learned that often (most?) graduate students are admitted to departments for doctoral study with offers of funding that are only for their first year. While the vast majority of such students get support throughout their doctoral studies, the year-to-year nature of their commitment is often stressful. In addition, many of our peer institutions are guaranteeing multi-year funding, making our offers less competitive. If future funding becomes less certain, we may find more students in late stages of their doctoral work, while admitted during better financial times, who cannot be supported.

Recommendation: There should be an Institute-wide norm that departments need to have a plan for supporting their doctoral students over a longer period (four or five years). This plan would be contingent on the student's making good progress. Some elements of this plan might be uncertain at the time of admission, but the plan would at least represent the best estimate the department could make.

Financial impact: This is difficult to estimate. A possible benefit of this recommendation would be that our graduate admission offers would be more competitive, the departments would be inclined to admit a smaller number of stronger and better supported students.

Other impacts: There is a general sense at the moment that the graduate student population is too large and possibly too expensive. We could not find an objective metric to assess this statement. But assuming that one agrees that a reduction of the graduate student body is necessary, the recommendation above would be one way to implement the reduction.

One possible beneficial impact is on faculty interactions with UG students. As the number of graduate students goes down, the faculty will have more time to spend with UGs. One of the issues in the highly successful UROP program is that UGs often are not mentored by faculty in research groups. Rather they see G students. A shift to a smaller graduate population may allow more UROP based student/faculty interaction. Finally, a shift to a smaller graduate population coupled with an intentional increase in postdocs will have broader coupled consequences that we cannot currently appreciate.
Right-sizing of the graduate Population
In the subgroup meetings on graduate students, as well as through discussion with Dean Lerman and others, it was often expressed that it would be desirable to understand the marginal cost of a graduate student at MIT, but such figures are not available to the best of our knowledge. Thus, we find it a difficult task to make macroeconomic recommendations about the size of the graduate school when it is unknown whether an additional student (or what type of additional student) brings in more revenue than expenses, or vice versa. Further, the graduate population is not homogeneous, but rather composed of several classes of students (e.g. Ph.Ds, S.M.s, M.Engs, and MBAs) that have different costs and revenues associated with them.

According to Steve Lerman, MIT and Stanford are the only members of the Ivy-Plus group with an uncontrolled (i.e. free to grow with research volume) graduate student population. Indeed, this is quite clear in data published in the January 2007 MIT Faculty Newsletter, where research volume per graduate student has remained roughly constant since 1967. This is consistent with Dean Lerman's point that MIT is the most dependent on externally-funded research assistantships (RAs) of the Ivy-Plus Group.

Figure from January 2007 MIT Faculty Newsletter (re: grad student population and research volume)

Illustration 1: “...shows research expenditures (in constant dollars) normalized by the number of faculty, and separately by the number of graduate students. While there has been a slow, continual increase in the research volume per faculty member, the expenditures per graduate student have remained fairly constant since the mid 1960s. During the same period of time the number of graduate students per faculty has increased from 2.5 in 1940 to 6.2 in 2006, and the number of research staff per faculty grew from ~ 0 to 2.4. Clearly the makeup of the average research group has changed considerably over the last half-century.” [http://web.mit.edu/fnl/volume/193/canizares.html]
Without a more detailed understanding of the cost dynamics of graduate education as a function of the student population, or the secondary effects of reducing the graduate population, we recommend further research to understand the true costs of providing graduate education. A better understanding of costs of providing graduate education would allow the development of informed policies to allow MIT's graduate school to operate sustainably, or to achieve other Institute objectives related to the graduate school.

We are making two recommendations that will likely reduce the size of the graduate population at least somewhat, but these recommendations are made with the intent of reducing costs and increasing sustainability and quality, rather than simply reducing the graduate population.
Study impacts of reduction of time to Degree completion

It would seem that reducing the time-to-completion of Ph.D degrees would not save the Institute resources, as newly-admitted students would typically take the place of graduating students, keeping the Ph.D component of the graduate school size and its corresponding level of resource consumption roughly constant. If it was determined that the graduate student population should be reduced, then reducing the time-to-completion could possibly allow the Institute to produce the same number of graduates in a given amount of time, despite the smaller graduate population. It should be noted that not all graduate programs at MIT have experienced increasing time-to-completion—some have kept this figure relatively steady, and within peer group averages. If this approach is considered, further research should be done to determine the feasibility of reducing Ph.D time-to-completion, as well as mechanisms/incentives for achieving this reduction.

In the case of outlying students (13-14 year Ph.Ds, etc.) and outlying programs, concerns about time-to-completion may be better addressed generally in the context of student and program quality. We make recommendations about both of these issues.
Better Management of Faculty Positions

MANAGING FACULTY POSITIONS

A. Improved management of unfilled faculty positions and associated funds

Roughly 60 to 70 faculty positions remain unfilled in a given year. In general, these TBA slots, and the GIB budget allocations associated with them, are allowed to remain in departments. "TBA funds" are then applied to replacement teaching costs or to general operating costs in the departments.

We propose that the School Deans take a more active approach to managing both the TBA slots themselves and the funds associated with these positions. This could involve the Dean "holding" the TBA slot and allocating it within the School based on academic priorities which might include, for example, a comparison of the number of credits taught per faculty member in different departments. At the Dean’s discretion, departments could be allowed to retain 50% of the TBA funds for replacement teaching if needed, and be required to return the other 50% to the GIB as savings on a year-to-year basis, while the position remains unfilled. (We understand that the School of Engineering already has a policy of controlling open positions at the school level, which should be explored as a model.) This allows Schools to evolve strategically rather than with just local optimization.

Other impact:

This might be a tool to allow the Institute and School Deans to better match faculty positions to student demands, enabling more effective utilization of faculty teaching and a potential reduction of Other Academic positions. It could be used to increase resources allocated to more active departments while correspondingly reducing those allocated to less active departments. At the same time, this action might remove some funds now counted on by departments to support graduate students or to fill other departmental needs.

As a general policy, allowing the reallocation of resources that are being held open is just good management practice and should be practiced aggressively.

Caveat:

Judging which departments are allowed to fill TBAs, based on various levels of activity, would be a sensitive matter. In addition, the knowledge that a less active department might lose a slot to a more active one could deter faculty retirements in a department deemed less active.

B. Reduce the number of unfilled positions

A related action could involve the reduction of a certain number of faculty positions by eliminating unfilled positions. This would result in a loss of potential numbers of faculty but would likely not result in a decrease of actual numbers, because of the continual existence of open faculty positions described above. School Deans could exercise the authority to determine which positions would be eliminated. Approximately 15 faculty retire each year. If 10 of these positions are eliminated over the next 3 years, the savings is ~$2M. Moreover, for every $1 saved on faculty salary, $0.5~$1 is saved on other salaries.
Caveat:
Some percentage of open faculty positions are “unfunded”, that is, the funds supporting these positions have been eroded over time through the channeling of these funds to other uses, such as graduate student support or general operating expenses (as an effective proxy for inflation in these areas). Therefore, Deans would need to exercise discretion in deciding where to capture funds associated with open positions or to eliminate such positions.
PE Requirement

Finding: The PE requirement adds additional costs to the academic degree program; however, it could perhaps be met in a more cost-effective manner that enhances the independence and leadership skills of students while maintaining, if not improving upon, the rigor of the fitness classes.

Recommendation:

1. In the same fashion that undergraduates are used as TAs in departments, use exemplary undergraduate athletes as PE instructors. For example, a semi-professional track runner could organize a jogging group that meets thrice weekly at the Z center. The Z center staff member manning the desk would sign off on students’ cards to verify activity. The same system could be implemented for other sports, such as soccer, swimming, biking, basketball, where more experienced students instruct others. The instructors would also earn their PE points by instructing.

2. Implement a system by which students fulfill the time requirement of 480 mins/2 PE points by working out on a cardio machine/ swimming laps 4 times/week at the Z center, and has a fitness staff/lifeguard sign off on a time card to validate that the student did his/her time.

3. Authorize intra-fraternity and dormitory intramural competition as PE legitimate.

4. Abolish IAP offerings and long-weekend (Veteran’s day, November; Patriot’s day, April) hiking/climbing trip offerings

5. Swimming instruction should be taught by life-guard/CPR certified experienced swimmer students who have spent previous summers earning money this way. As in situation one listed above, the instructors would also earn their PE points by instructing.

Financial impact:
These recommendations have the potential to: save money spent on instructors and PE administrators; save space, as more students could satisfy the requirement individually, or if in a group setting, could do so in general areas rather than special fitness studios or courts, save equipment, as many students have their own basketballs, soccer balls, bikes, and save money spent on classes during IAP and on long weekends

Other impact:

1. Enhances student leadership/management skills
2. Provides teaching experience
3. Encourages independence and self-help
4. Increases rigor of PE classes and fitness of student body

Other factors:
The Physical Education requirement is more than a simple mechanism for encouraging physical activity; it also provides an opportunity for training both in individual activities and more generally in active lifestyles that can last a lifetime. It provides learning opportunities for understanding the relationship between regular physical activity and overall productivity. Since MIT is training future leaders, it is important that this educational experience not be diminished through small-scale budget savings.
Appendix A; People from whom the Group heard

The whole group heard from the MIT Council on Educational Technology and Steve Graves on the Sloan points model. The graduate and professional subgroup heard from Steve Lerman as Dean for Graduate Education, Frank Field, the Executive Director of TPP and Bhaskar Pant, the SoE director of Professional Education.

The pipeline and co-curricular issues group heard from Robert Morris and Frans Kaashoek of EECS, Duncan Kincaid of DUSP regarding Graduate Admissions; the IT Task Force regarding Athena Clusters and Athena Printing. The group used the document entitled, “Classroom Committee Recommendations – Report of the Subcommittee on Athena Clusters to the Classroom Committee”. The group also heard from Mary Callahan, the Registrar, regarding scheduling, online registration. Finally, the group heard from Carrie Sampson Moore and Peter Cummings in DSL regarding the PE Requirement.

Significant details of the cost model were developed by Deb Leitch and Lydia Snover and more generally the data analysis group was helpful and responsive.
APPENDIX B: NACUBO COST MODEL

NACUBO Cost of College Study
Annual Undergraduate Educational Costs Per Student Reporting Template

<table>
<thead>
<tr>
<th>Category</th>
<th>Cost per Undergraduate FY 06</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. General Institution Information</td>
<td></td>
</tr>
<tr>
<td>Institution Name and Carnegie Class: Massachusetts Institute of Technology Research 1</td>
<td></td>
</tr>
<tr>
<td>Contact Name: Gillian Emmons</td>
<td></td>
</tr>
<tr>
<td>Contact Title: Assistant Controller</td>
<td></td>
</tr>
<tr>
<td>Contact Phone: 617-253-2777</td>
<td></td>
</tr>
<tr>
<td>Contact e-mail: <a href="mailto:gemmons@mit.edu">gemmons@mit.edu</a></td>
<td></td>
</tr>
<tr>
<td>Institution Type: Private</td>
<td></td>
</tr>
<tr>
<td>Fiscal Year Reported: 9/30/2006</td>
<td></td>
</tr>
<tr>
<td>Price Per Student: 32,100</td>
<td></td>
</tr>
</tbody>
</table>

| FTE used in this report: |
| Basis of FTE count: preferred method |
| Number of FTE undergraduate students: 4,031 |
| Number of FTE graduate students (weighted by 1.25, see below): 7,443 |
| Did you weight graduate students in this FTE count?: yes |
| If yes, indicate weighting factor used: 25% |

<table>
<thead>
<tr>
<th>Category</th>
<th>Cost per Undergraduate FY 06</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Instructional and Student Services</td>
<td></td>
</tr>
<tr>
<td>a. Instruction</td>
<td>$ 27,232</td>
</tr>
<tr>
<td>b. Departmental Administration</td>
<td>2,951</td>
</tr>
<tr>
<td>c. Student Services</td>
<td>7,859</td>
</tr>
<tr>
<td>d. Library</td>
<td>1,619</td>
</tr>
<tr>
<td>e. Allocated O. and M. Expenses</td>
<td>2,723</td>
</tr>
<tr>
<td>f. Allocated Depreciation: Facilities</td>
<td>995</td>
</tr>
<tr>
<td>g. Allocated Depreciation: Equipment</td>
<td>555</td>
</tr>
<tr>
<td>h. Allocated Administration (G&amp;A)</td>
<td>3,367</td>
</tr>
<tr>
<td>i. Subtotal: Instruction and Student Services Costs</td>
<td>$ 47,212</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Category</th>
<th>Cost per Undergraduate FY 06</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Institutional and Community Costs</td>
<td></td>
</tr>
<tr>
<td>a. Cultural, Religious Life and Recreation</td>
<td>270</td>
</tr>
<tr>
<td>b. Museums, Gardens, etc.</td>
<td>162</td>
</tr>
<tr>
<td>c. Net Cost of Intercollegiate Athletics</td>
<td>297</td>
</tr>
<tr>
<td>d. Net Cost of Other Auxiliary Operations</td>
<td>(995)</td>
</tr>
<tr>
<td>e. Other (Specify)</td>
<td></td>
</tr>
<tr>
<td>f. Allocated Facilities O. and M. Expenses</td>
<td>490</td>
</tr>
<tr>
<td>g. Allocated Depreciation: Facilities</td>
<td>263</td>
</tr>
<tr>
<td>h. Allocated Depreciation: Equipment</td>
<td>51</td>
</tr>
<tr>
<td>i. Allocated Administration (G&amp;A)</td>
<td>62</td>
</tr>
<tr>
<td>j. Subtotal: Institutional and Community Costs</td>
<td>$ 602</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Category</th>
<th>Cost per Undergraduate FY 06</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Undergraduate Financial Aid Costs</td>
<td></td>
</tr>
<tr>
<td>Institutional Resources</td>
<td>$ 13,516</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Category</th>
<th>Cost per Undergraduate FY 06</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Total and Recap of Costs by Component</td>
<td></td>
</tr>
<tr>
<td>a. Instruction and Student Services Costs</td>
<td>$ 47,212</td>
</tr>
<tr>
<td>b. Institutional and Community Costs</td>
<td>$ 602</td>
</tr>
<tr>
<td>c. Financial Aid Costs</td>
<td>$ 13,516</td>
</tr>
<tr>
<td>d. Total Costs:</td>
<td>$ 61,329</td>
</tr>
</tbody>
</table>

Addendum: Facilities Capital Costs:
A. Book value of all facilities | $ 2,073,692,000 |
B. Estimated replacement value of all facilities | 1,552,363,500 |
C. Portion of line B applicable to education | 32% |
D. Portion of line C applicable to undergraduates | 35.13% |
E. Divide line D result by number of undergraduates reported above | 42,815 |
APPENDIX C: Members of the MIT Task Force on Education

Eric Grimson, EECS co-chair
Daniel Hastings, DUE, Aeronautics and Astronautics & Engineering Systems

Undergraduate Education

- Nicole Bucala
- Denny Freeman, Convener
- Steve Graves
- Steven Hall
- Caroline Ross
- Hazel Sive
- Janet Sonenberg
- Stephanie Toews-Moeling

Graduate and Professional Education

- Tim Jamison
- Mark Jarzombeck
- Gigliola Staffilani
- Kai von Fintel, Convener
- Stephen Woodrow

Faculty and Academic Structure

- Sherene Aram
- Cindy Barnhart
- Vladmir Bulovic, Convener
- Young Lee
- Doug Pfeiffer
- Phil Thompson
- JoAnne Yates

Curricular Support and Pipeline Issues

- Arne Abramson
- Cecilia D'Oliviera
- Mark Damian, Convener
- Stu Schmill
- Karen Yegian
### Appendix D: Additional resources for strategic support

<table>
<thead>
<tr>
<th>Problem/Perceived Need</th>
<th>Project/Strategy to address need</th>
<th>DUE Efforts/offices that can help address this need</th>
<th>Comments/Anticipated Outcomes</th>
</tr>
</thead>
</table>
| Reduction in TA appointments may strain a wide range of undergraduate subjects | **TA Training Programs** Pre-semester, semester and year-long programs to help TAs work more efficiently and effectively  
**Undergraduate Teaching Opportunities (UTOP)** Undergraduates assume some of the responsibilities that are traditionally assumed by graduate TAs  
**E-tutors (Cybertutor)** Asynchronous/OLTA (Online Teaching Assistant) | TLL  
- Train, support (non-$$) TAs & UTAs  
- Develop and provide appropriate cohort experiences & Institute wide seminars & workshops  
- (selection and vetting, by individual depts. of UTAs)  
- Potential partnership with Gordon ELP  
OEIT | • Improved Teaching skills for TAs  
• Better learning experiences for undergrads  
• Substitution of some graduate TA slots with UTA slots will lead to cost savings  
• Course credit for UGs may lead to cost savings  
• Technology opportunities to scale |
| **Leverage Co-curricular Opportunities** Develop means by which students can utilize co-curricular activities (with potential external funding) for hands-on experiences (e.g. capstone subjects). For capstone replacements, students would submit proposals and present work for department approval/credit. | Office of Experimental Learning  
- D-labs  
- Edgerton Center  
Global & Careers Office  
- Prototype/developmental projects at MIT, only)  
SAE, solar capstone, other student groups | • Some departments may be able to “offload” capstone experience, which would free up faculty teaching time  
• Potentially better fit between students concentration and project |
| **Alternative Authentic Learning Options**  
- Changes in lab materials (e.g. bacteria v. animals)  
- Simulations v. real-space construction  
- Development of Museum Exhibits  
- iLabs | Funding to develop and implement modifications to existing subjects.  
TLL (preserving desired learning outcomes amidst “platform” changes)  
OEIT (iLabs, simulations)  
OES (museum exhibits) | • Materials cost savings (for departments)  
• Authentic experiences in cases where they previously did not exist  
• Redistribution of faculty awards (modifications v. creation) at an overall cost savings |
| **Industry partnerships for labs (iLabs?)** | OEIT  
Opportunities to share labs? |  |
| Faculty and TAs in downstream science and engineering subjects spend large amounts of time reviewing (re-teaching) math concepts taught in 18.02, 18.03 | **Survey and map overlapping concepts in math and in Science and Engineering subjects**  
- Math -> Mech E; Chem E, EECS, Aero-Astro  
- Develop/utilize e-tutors  
- Make digital video segments available for asynchronous learning  
- OCW | TLL  
- HRM material  
OEIT  
- Flash-forward/back  
- Cybertutor; Interactive Math Tutorial/Portals  
- Spoken Lecture Browser using OCW | Reduction in faculty and TA time needed to cover downstream subjects  
Facilities |
<table>
<thead>
<tr>
<th>Problem/Perceived Need</th>
<th>Project/Strategy to address need</th>
<th>DUE Efforts/offices that can help address this need</th>
<th>Comments/Anticipated Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Several topics (e.g. fluids, statistics, thermodynamics) are taught in introductory subjects across the Institute. This redundancy can be costly in terms of redundant faculty and TA effort.</td>
<td><em>Address (topic/concept) redundancy through modularization of subjects. Core material can be taught in one subject with specializations addressed in smaller classes</em></td>
<td>TLL, OEIT, OFS</td>
<td>Reduction in TAs necessary to teach topic. Improved student learning</td>
</tr>
<tr>
<td>Service courses</td>
<td>Many of the GIR courses are taught in very large settings. These courses put large demands on faculty time, although there is a significant value to the students in experiencing a famous faculty member lecturing. There are technology opportunities to improve the delivery of service courses.</td>
<td><em>Provide self-learning opportunities -- through computer and video-based learning experiences)</em> OCW</td>
<td>TLL, OEIT</td>
</tr>
<tr>
<td>Creating new and meaningful problem sets take a significant amount of faculty time. Grading problem sets can take a large amount of TA time (Students spend a huge amount of time doing problem sets)</td>
<td><em>Help faculty and instructors rethink problem sets</em> E.g. 1. Grade a random # of pset questions 2. Use fewer psets 3. Shift student expectations from problem sets as an evaluative tool, to problem sets as a learning experience</td>
<td>TLL</td>
<td>Reduction in departmental costs (fewer TA hours spent grading) Reduction in faculty time spent developing pset questions.</td>
</tr>
</tbody>
</table>
Appendix E: Incremental teaching cost assumptions

We make the following assumptions:

- each student takes 100 credit hours per year
- half of these credit hours are in capacity-constrained subjects
- the incremental teaching cost is $100 per credit hour for capacity-constrained subjects
- there is zero incremental teaching cost in the subjects that are not capacity constrained

Given these assumptions, then the incremental cost per student is

\[(50 \text{ credit hours per year in capacitated subjects}) \times ($100 \text{ per credit hour}) = $5K\]

In our view, the first bullet item seems roughly correct.

The second bullet is a guess. For our purposes a “capacity-constrained subject” is a class that could not assume an increase of 10% more students without making some accommodation. Typically this is a large lecture class with multiple recitation sections, or a popular class that is taught in multiple sections. In each case, more students would require more sections.

Freshmen typically take three large (capacity constrained) classes each semester and one smaller class. Sophomores are probably taking 2 to 3 large classes each semester if they are in a popular major. For juniors and seniors whether or not they are in capacity-constrained subjects depends on major.

For the third bullet, there are several ways to develop this estimate. Suppose we have a 12 unit subject that needs another recitation section to handle 25 students. Then this section delivers 300 credit hours. If we could do an incremental section for $30,000 – this equates to $100 per credit hour. This is about the cost of a full-time TA; alternatively this would correspond to paying an instructor $24K plus EB to lead a section.

Alternatively, we have estimated an average cost per credit hour in engineering ranging from $300 to $400. But this estimate has a large fixed cost component (faculty salaries) and allocates all of the school’s teaching costs to undergraduates. We expect that assuming the incremental cost to be $100 per credit hour is not unreasonable.