

Rising Tuition and Student Debt, Uncertain Job Opportunities: Engineering Education in Challenging Financial Times

by

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Executive Summary. This paper attempts to provide some basic information on important aspects of financing undergraduate education in the U.S. and then explores those issues as they relate to undergraduate engineering education. Attention is given to the puzzling price of tuition, the costs borne by students and institutions, scholarships and financial aid, the driving forces behind rising institutional costs, rising student debt and sometimes disappointing student outcomes, and both simple and structural potential remedies. Recent developments in massively open online courses provide hope for some efficient new models of education, and observations from a global perspective provide important insights. Since graduates with STEM-intensive majors seem, on average, to have better career outcomes, colleges should provide more transparency on student outcomes and debt by college major and, in addition, provide better academic advising and career counseling early in the academic program.

The Context. Public concern over the rising cost of higher education has never been so high and it continues to grow. Some are now wondering if the growing student loan debt might be headed down the same path as the home mortgage crisis that triggered the recent Great Recession. Providing their children with the best possible university education is among the highest priorities of most middle class families today. But, this involves somehow gaining admission to the best university a child can get into, finding a way to pay the intimidating costs, and then surviving the rigor of a competitive academic environment in order to graduate. Most people believe that a college education is essential for a successful career (as well as a successful democracy). For a family struggling to pay the bills and educate their children, the situation can seem overwhelming. As both student debt and public concerns rise, and while higher education appears unresponsive, legislators seem more and more interested in potential interventions. Market pressures and alternative approaches to higher education continue to gain attention. Pressure for change is rising from all sides. The current path does not seem sustainable. Substantive change appears likely in the next few years, but what will it be? What will happen to the quality of undergraduate education as more attention is focused on lowering the cost—particularly now that innovation skills are more important than ever¹? What will it mean for residential undergraduate education in engineering? Based on conversations from many others who have studied these issues in depth, this paper explores some important aspects of the problem of financing an undergraduate engineering education.

The Sticker Price of Higher Education is Misleading. American higher education remains the envy of the world. Seven of the top ten universities in the world identified in the most recent Times Higher Education ranking are U.S. institutions. The sticker price for each of these is similarly among the highest in the world, as is the competition for admission to the entering class each year. Each of these institutions has an applicant pool that is many times larger than the number of available seats in the first year class. American families who want the best for their children often feel obligated to do what they can to provide access to this top level of education, if their student is academically capable. However, the combination of the high competition for admission and the high price of tuition present an intimidating deterrent for many. The perception, particularly among poor families (but increasingly

¹ Friedman, T., "Need a Job? Invent It," New York Times, 31 March 2013.

also among middle class families), is that even if they could gain admission they could never afford the cost of attendance². As a result, many aim lower, in an attempt to be pragmatic.

The tragic irony is that this perception is frequently misleading. As reported by Matt Krupnick in the San Jose Mercury News last March (quoted in a recent article in the Chicago Tribune by Morton Schapiro, Sandy Baum, and Michael McPherson³):

“The impossible has happened: Harvard is now thousands of dollars cheaper than Cal (California) State (at) East Bay for middle income California students. So is Princeton. And Williams College. And Yale.” Krupnick used public information from the colleges to figure out what a family of four earning \$130,000 a year would be asked to pay, taking into account financial aid grants, for a year at California State University at East Bay (\$24,000), University of California at Santa Cruz (\$33,000), and Harvard (\$17,000).

(Of course, this presumes that the student is able to gain admission to each of these schools.)

The problem—which is widespread—is that there is little correlation between the “sticker price,” or the advertised full tuition, fees, room and board of the institution, and the actual “net cost to students,” which is often much lower. The net cost is reduced by a process of financial aid which is administered differently by each institution in which both grants and loans are offered, often on both need-based and merit-based criteria. From the perspective of the student, financial aid decisions are rarely transparent and are frequently difficult to understand, adding to the confusion.

It is fascinating that in higher education, the practice is to list the maximum price of the institution, even though many people pay much less, while in other industries (like automobile sales), the practice is just the opposite—to list the minimum price, even though many people pay much more. In the case of automobiles, the intended result is that the advertisements attract more people into the showroom to seriously consider a new car. However, for universities, the unintended result is the opposite, presenting an intimidating price that discourages window shopping. This practice may be contributing to the very small number of highly qualified students from financially poor families that even bother to apply at the nation’s best universities⁴. This is particularly unfortunate for these students, since for individuals with the same academic potential, graduation rates are significantly higher when they enroll in more selective universities³.

What Determines the Sticker Price? In a provocative New York Times op-ed piece⁵, Henry E. Riggs⁶ asserts that tuition is set according to the laws of supply and demand, not the cost of providing an education. *“Market strategists know that costs are usually irrelevant in determining prices. The optimum price is the one the market will bear, the price at which demand and supply are matched. Tuition in the private higher-education industry is a classic example of price leadership—the ‘top players’ define the sticker price, and all others follow suit... ‘Prestige’ and ‘quality’ are in the eyes of the beholder. Wannabes price themselves accordingly...”* Riggs also points out that the price differential between institutions that are vastly different in mission, size, endowment value, etc. is incredibly small, raising questions about the extent to which the price was determined by operating

² Not all poor families aspire for their children to attend college. In some communities, cultural preferences work against attendance at any college, especially those that are distant and promote values that diverge from those at home.

³ Schapiro, M., Baum, S., and McPherson, M., “Fact and Fiction About Getting a College Education,” Chicago Tribune, 3 March 2013 available at this website: www.chicagotribune.com/news/opinion/ct-perspec-0303-college-20130303_0.7778001.story.

⁴ Markovich, P., “Elite Colleges Fail to Gain Students on Pell Grants,” Chronicle of Higher Education, 27 March 2011.

⁵ Riggs, H. E., “The Price of Perception,” New York Times, 13 April 2011.

⁶ Former president of Harvey Mudd College and founding president of the Keck Graduate Institute.

costs. The fact is that top institutions receive many, many times the number of qualified applications for admission than the number of available seats in the incoming class. There is little market pressure on them to reduce their price. (A more recent article in the New York Times makes similar points.⁷)

Per Student Operating Costs. Since the full price of tuition, room and board are so high, it is natural to assume that what colleges and universities actually spend on operations is pegged to this number. But this, too, is an incorrect assumption. In fact, many selective institutions spend significantly **more** each year than the full sticker price times the number of enrolled students⁸. At first this may be surprising. However, in reality, selective institutions have several independent sources of revenue, only one of which is tuition, room and board. These institutions often also receive significant funds each year from donations, endowment spending and external research funding that are ultimately spent on enhancing the learning environment and experience of students.

In the case of Olin College, which is an undergraduate institution, the annual per student operating expenditures are about twice that indicated by full sticker price, before any scholarships are applied. For major research institutions—where the mission includes major commitments to research and graduate education—the annual per student operating expenditures may be even more.

The reality is that, even though the price of tuition is high, excellent higher education in the U.S. is very highly subsidized by several stakeholders. Simply put, even students at selective institutions who receive no scholarships or financial aid pay less than half the full cost of their education.

Is College Now Too Expensive to be a Good Investment? With all the news about rising tuition and student debt, and the uncertainty of jobs waiting for college graduates, some families may now wonder whether the game has fundamentally changed and attendance at college may no longer be the good investment that it once was. This question is very well addressed in the Schapiro, et al., op-ed piece³.

In their article, they conclude that *“it is more important than ever to get a college degree, and the investment of time and money pays off well for the vast majority of students.”* In spite of the recent sensational press coverage of higher education disappointments, the reality is that a college degree remains essential for career success in the 21st century.

Among the facts presented in their article³: (1) even in today’s economy, *“college graduates have much better odds of getting and keeping a job and having a viable path to long-term career success; (2) 30 percent of students who get bachelor’s degrees at private non-profit colleges and universities do so with no education debt, and the average debt accumulation among those who do borrow is about \$27,000, almost the same as the average new car loan⁹; (3) students who qualify for admission at a top private college or university often wind up paying less than they would at a public institution closer to home. A student whose family income is outside the top 5 percent (\$200,000 in 2010) will generally qualify for a need-based grant at one of these expensive places; (4) the odds of success are greatest at the most selective colleges, public and private; and (5) people with higher levels of education are more likely to have rewarding jobs, more likely to exercise regularly, less likely to smoke, more likely to be active voters and volunteers, and more likely to engage in activities with their children.”*

Scholarships and Financial Aid. In the language of college finances, “scholarships” usually are awards based on merit or achievement, independent of financial need. “Financial aid” is different in

⁷ Sullivan, P., “Measuring College Prestige vs. Cost of Enrollment,” *New York Times*, 19 April 2013.

⁸ Dartmouth College provides an explanation of the expenditures per student in relation to tuition and financial aid at this website: http://www.dartmouth.edu/~alfund/why_give/business_model_text.html.

⁹ Data on student debt at Olin College shows that more than 80% of students graduate with no debt, and the average loan for those that do have debt is about \$12,500. (However, these numbers may rise in the next few years when students paying a larger portion of their tuition begin to graduate.)

that it is usually based on the level of a student's financial need in shouldering the educational costs, independent of merit. Not all institutions offer merit scholarships, and few institutions can now afford to offer sufficient need-based financial aid to cover all the costs, even for the neediest families.

The definition of financial need and "expected family contribution" varies from institution to institution. A number of institutions base their need calculations on a federal formula that uses the Free Application for Federal Student Aid (FAFSA) form. While this formula-based approach offers a degree of transparency, many financial aid officers complain that the formula needs revision and that only the neediest families seem to qualify for adequate support using this methodology¹⁰.

The use of merit scholarships when full need-based support is not available to all students is often criticized in higher education because it is assumed that providing scholarships to high achieving students comes at the expense of providing need-based support for other deserving students who may have only slightly less academic potential. The implication is that institutions may use merit scholarships more to increase their reputation than to enable good students to get an education¹¹. Furthermore, students with high academic achievement deserving of merit scholarships often come from high income families, so these scholarships tend to disproportionately benefit the wealthy. To some people, this raises questions of social justice associated with all merit-based scholarships¹².

In reality, it is likely that offers of financial aid from many colleges involve simultaneous, rather than sequential, consideration of merit and need in order to tailor an offer to an individual candidate. A good overview of the financial aid puzzle, together with pragmatic advice to families facing the decision on which college to attend is available in a recent feature article in the *Wall Street Journal*¹³. In particular, the advice on comparing offers from multiple schools and the focus on including data on student outcomes is very useful.

From its inception, Olin College has offered very generous merit scholarships to all admitted students. We also meet all demonstrated financial need¹⁴ (with grants, not loans) of every admitted student and are need-blind in our admission policies. The two forms of financial support are not in competition at Olin. The merit scholarships help to reduce the barriers to the pursuit of a career in engineering, an area of national need. By providing such merit scholarships, we believe we are making an investment in the lives of high achieving young people who will become a force for change and innovation wherever they go¹⁵.

What are the Forces Behind the Steady Increases in Tuition? There are basically two fundamental forces behind the continuous increases in tuition. One is the culture of higher education that generally prioritizes improvement in quality of the learning experience (including an amenities "arms race") above other alternatives (like cost savings), and the other is the rapid rate of decline in state support for public education (which affects only state-supported institutions).

¹⁰ Ricker, J., email communication, 7 March 2013.

¹¹ Kiley, K., "Fund-Raising the Bar," *Inside Higher Education*, 26 March 2013.

¹² However, major athletic scholarships are given strictly on merit and they do not seem to benefit only those from wealthy families.

¹³ Simon, R., and Barry, B., "Making Sense of College Aid: Many schools' financial-aid letters are devilishly difficult to figure out. Here's what you need to know," *Weekend Investor, Wall Street Journal*, 23-24 March 2013.

¹⁴ Olin's financial need policy expects all admitted students to contribute \$3,500/year toward their educational costs. However, the majority of Olin's students have the opportunity to work in paid corporate internships each summer to defray this expense while also gaining work experience and thereby improving their employability.

¹⁵ The U.S. National Science Foundation provides nationally competitive Graduate Research Fellowships based only on merit to about 1,000 high achieving students annually to support them in pursuit of advanced graduate study in STEM subjects. These merit scholarships have been instrumental in eliminating financial barriers and persuading many exceptional scientists and engineers to pursue a career in these fields of national need. Other nations have similar programs (i.e., Bolashak International Scholars program in Kazakhstan, etc.).

The first issue is the result of the important efforts of faculty and administrators to make decisions and investments that give students access to the most enriching learning environment available. This applies equally to private and public institutions and results in choices that usually increase the cost of providing an education for each student. This usually has two aspects to it: access and quality. Access usually is associated with more direct contact with faculty members (smaller class size, more teaching assistants, etc.), and quality is usually related to the most renowned and accomplished faculty.

An example might be offering students the opportunity to choose from a larger number of interesting and well-presented courses with small classes and access to well-qualified faculty members. Who could object to this goal? However, if a class of 20 students currently taking one course is divided into two classes of 10 students each taking two slightly more specialized classes, the amount of faculty time and effort is doubled for the same tuition revenue. Most of the costs within a college or university are associated with salaries which are roughly proportional to the teaching load assigned to faculty members. Furthermore, really well qualified faculty members are usually judged to be those with the most experience and external recognition for the quality of their ideas as well as their teaching. These are usually senior faculty members whose salary is the highest. So, choosing to offer more high quality options to students almost always adds to the cost.

Another example is the result of trying to keep up with the most recent advances in a field. The introduction of new experimental or simulation methods in a field creates a need to purchase equipment and software and hire a specialized staff to maintain it. This almost always adds to the cost of providing a modern education, but is essential to preparing students for emerging methods and concepts.

For state-supported institutions, another problem has arisen. State legislatures, under severe budgetary pressures resulting from the Great Recession, federal mandates for funding other issues (like healthcare), and a resistance to further increases in state taxes^{16,17}, have been substantially reducing the level of state support for higher education in nearly every state. Since the beginning of the Great Recession in 2008, the cumulative reduction is remarkable, as shown in Figure 1. Since many state universities depend on this revenue to cover a significant portion of their operating costs, they have reluctantly had to raise the level of tuition to compensate for this loss of revenue without reducing the quality of the educational experience, as shown in Figure 2. The result is a rapid shift in costs from the state taxpayers to the students and their families. This has been a major driver of recent tuition increases in many state institutions.

What Can Be Done to Reduce Costs and Improve Outcomes for Students? One of the most devastating problems created by the runaway costs in higher education arises when students accumulate large student loans and then don't graduate. A variation on this problem occurs when a student with large debt graduates but is unable to find employment that provides an income large enough to pay back the loan. The ratio of the amount of the student loan to the starting salary upon graduation arises as an important metric. This calculation provides the number of years the graduate would have to work in order to pay back the loan if s/he could devote her/his entire salary to debt repayment. If there ever was a time when colleges and universities should focus on preventing this problem, it is now.

¹⁶ Presentations at the Higher Education Working Group on Global Issues of the Council on Foreign Relations, New York, NY, 18-19 March 2013.

¹⁷ Oliff, P., Palacios, V., Johnson, I., and Leachman, M., "Recent Deep State Higher Education Cuts May Harm Students and the Economy for Years to Come," Center on Budget and Policy Priorities, Washington, DC, 19 March 2013.

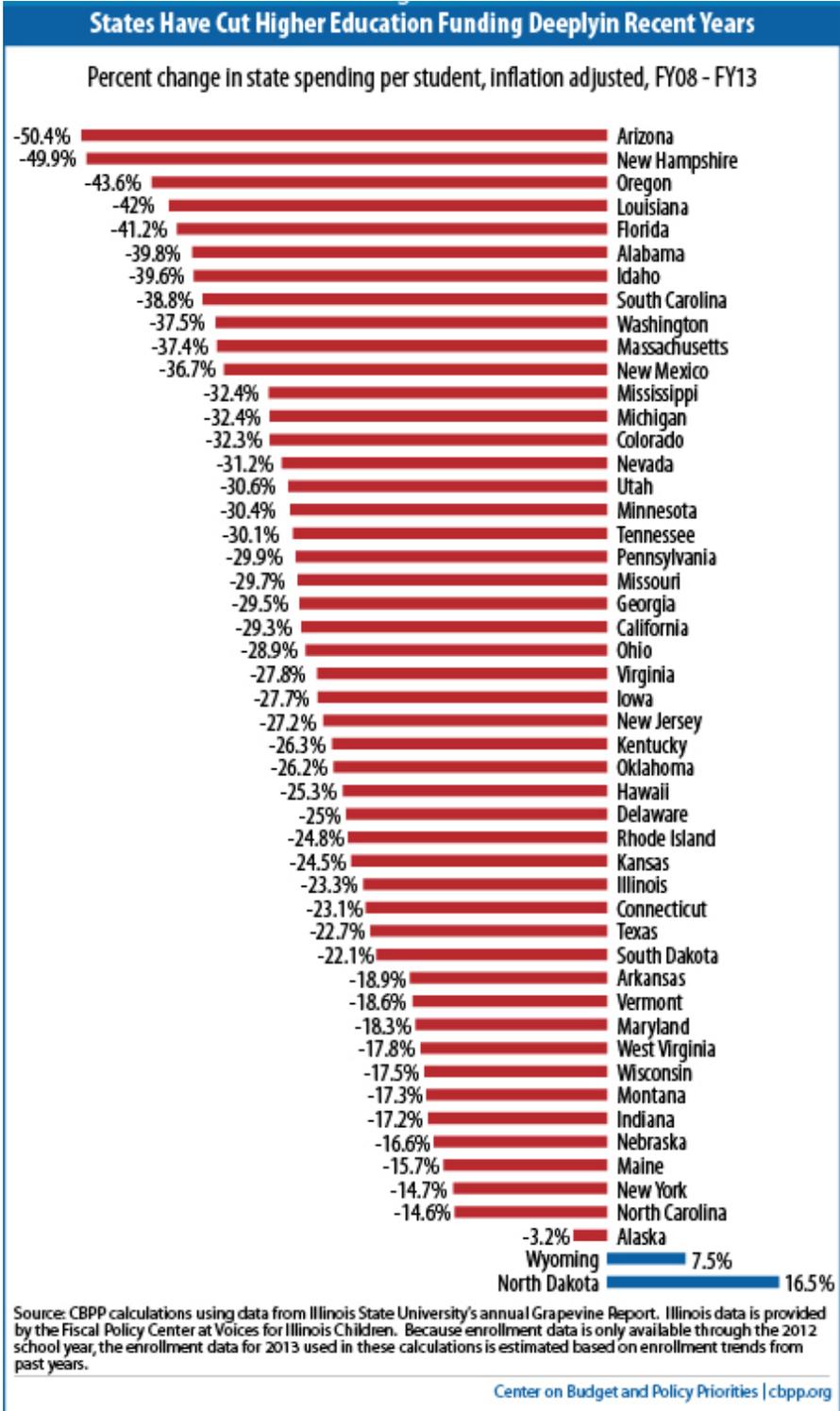


Figure 1 – Percent Change in State Funding Per Student, Inflation Adjusted, FY08-FY13 (used by permission, Center on Budget and Policy Priorities)

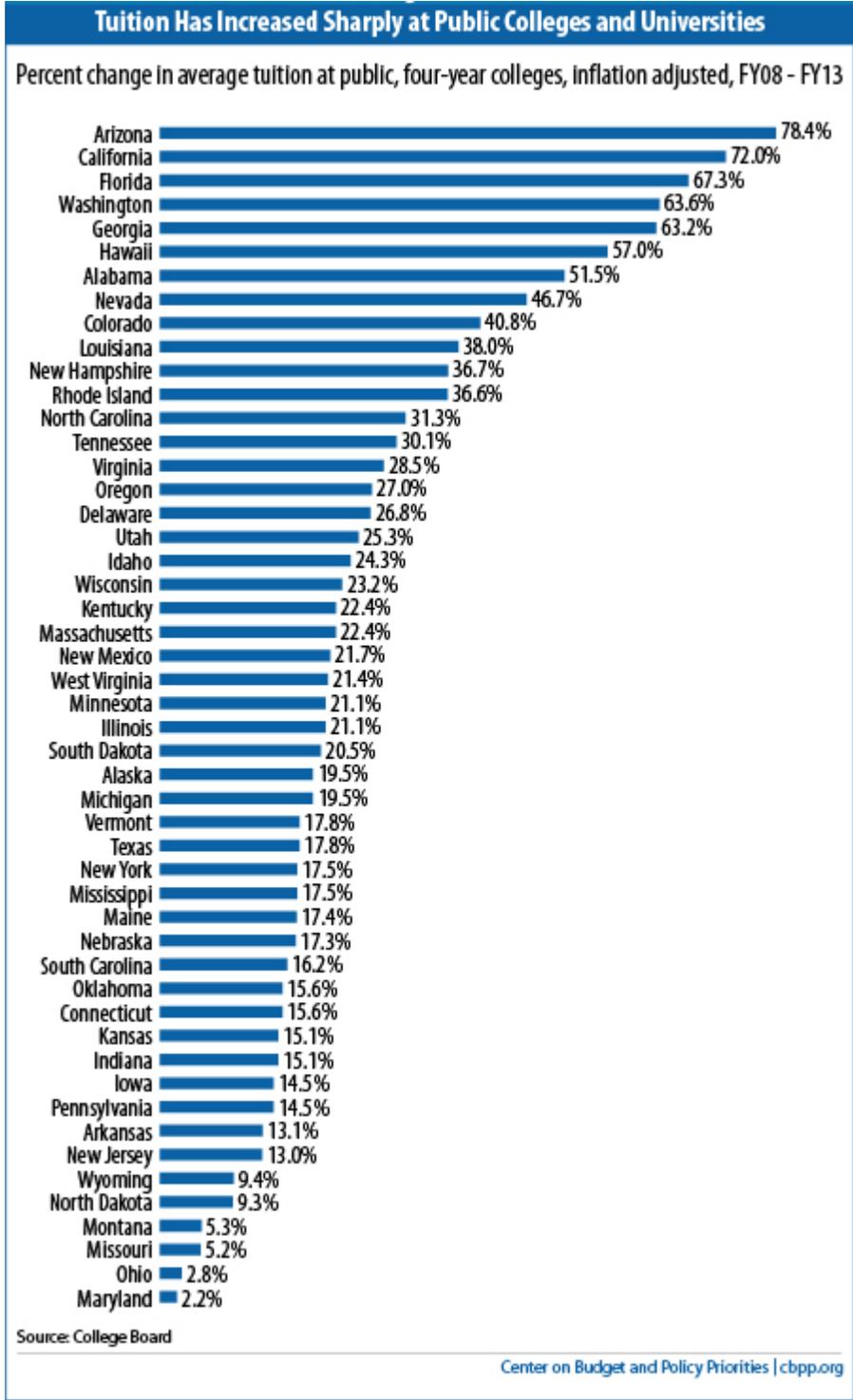


Figure 2 – Percent Change in Average Tuition at Public, Four Year Colleges, Inflation Adjusted, FY08-FY13 (used by permission, Center on Budget and Policy Priorities)

Let's explore what this might look like. First of all, if student outcomes were of sufficiently high priority, then colleges would make great efforts to collect data and closely monitor the trends. However, I believe too few institutions actually do this well. As a result, there is significant room for improvement in this area at many institutions. Relatively few institutions collect and maintain extensive data on what happens to students after commencement (except, perhaps for the purpose of asking alumni for donations). The hesitance of colleges to collect and disclose this information, together with growing public concern, recently resulted in legislation in Virginia to mandate that each institution in that state collect and publish this information annually¹⁸. (Similar disclosure efforts are underway in Tennessee, Arkansas, Colorado, Nevada, and Texas.)

Once the metrics are available, the next step is to align the academic and administrative procedures with the desired outcomes. This may require changing priorities to make sure that decisions are made in order to reinforce the desired outcomes for students, and not some other reason. As simple as this sounds, it is not hard to find examples in most institutions where important administrative decisions are made on some basis other than improving student outcomes. Some of the needed improvements in alignment can be accomplished easily while others would require significant change.

Improved Student Advising: Low Hanging Fruit. Perhaps the simplest thing we can do is make sure students are well informed of the consequences of the decisions they make in choosing courses and extracurricular activities. In many institutions, the entire area of student advising could be significantly improved. It is particularly important today that colleges empower students with the facts about the financial implications of the academic program they are pursuing early in their academic career—before it is too late to make choices that better align with their needs and expectations. Perhaps surprisingly, faculty members are not generally the best source of such information. In talking with students at many colleges, it is easy to find individuals who complain about academic advising. Students sometimes report that the advice they received from a faculty member turned out to be inaccurate, resulting in their need to enroll for an additional semester to complete the graduation requirements—resulting in a substantial increase in education costs. In other cases, students report that the published information about program requirements was inaccurate, leading to a similar outcome. However, rarely do the students receive any counseling at all about the career or financial implications of their academic choices until they are near graduation¹⁹. This really should not be the case.

Internships and Cooperative Experiences. Students who participate in summer internships or cooperative experiences in companies generally have significantly more and better career opportunities upon graduation. Making sure students are aware of these opportunities and advised to take advantage of them is the responsibility of colleges and universities. To provide the best learning environment and placement outcomes for students, a good case could be made that internships (or co-ops) should now be embedded within all academic degree programs.

The Value of a Balanced Education Including both STEM and non-STEM Disciplines. This paper has been focused on growing public concern about the rising cost of higher education and declining career opportunities for students. It is important to remember that a good undergraduate education

¹⁸ Anderson, N., "New data tells what a Virginia college degree is worth," [The Washington Post](#), 4 October 2012.

¹⁹ In many institutions, there may also be a form of conflict of interest within the university in providing effective guidance to students in this area. A common example occurs when resources within the university are distributed in response to student enrollment patterns (to maintain equal faculty teaching loads). In that case, an academic department that establishes a popular new academic program in response to a sudden student interest in an emerging field will often result in a shift in student enrollment patterns. Faculty teaching loads will increase in popular programs and decrease in unpopular ones. Resources are then redirected to the popular new program and away from the unpopular ones— independent of whether the new program improves student outcomes or worsens them. While helping students find their passions is generally a good idea, if it occurs at the expense of rigor and of career opportunities, then it is not in the best interest of students. Unfortunately, students—like all of us—are often attracted to subjects that are interesting but not necessarily demanding.

should be much more than preparation for a first job. It should provide a foundation for a life of independent learning and a long progression of successful careers. Any excellent education should stretch the intellect in unexpected ways, provoke introspection, help shape identity, and empower the student with a realistic “can do” attitude in life. Of course, this is much more than what is obtained in any single course or in training for a job. It is the cumulative total of an immersive experience in which students also learn to live independently, manage their time and resources, make life-long friends, form sophisticated opinions on complex issues like religion and politics, and develop a balance of critical (or analytical) thinking and creative (or synthetic) thinking skills. An education is far more than preparation for a job. I firmly believe that a broad liberal education—balanced with both a strong foundation in the natural sciences and mathematics and a strong foundation in literature, social sciences and the arts—is the best possible preparation for a successful life in the 21st century, no matter what career a student chooses. Many educators believe this, too.

Furthermore, Olin College was created for the specific purpose of developing a new paradigm for engineering education aimed at providing the enhanced knowledge and skills that will be needed in the 21st century. Recent reports from the National Academy of Engineering²⁰ clearly indicate that substantial improvement is needed in the areas of creativity, leadership, teamwork, entrepreneurial thinking, and understanding the global cultural context to be an effective engineer in this century. Competence in these areas cannot be achieved without solid preparation in the liberal arts. Therefore, I also firmly believe that a broad, liberal education is absolutely essential for any well-educated engineer or major in any other STEM-intensive field.

So, while this paper is focused on preventing a crisis immediately upon graduation due to crushing debt and few job opportunities, an excellent education goes well beyond this and provides higher level educational benefits that open doors at mid-career or later in life. As we think about measuring excellence in an educational program, the metrics, therefore, should extend well beyond starting salary and student loan debt.

Choice of Major and Resulting Career Outcomes: STEM²¹ vs. Non-STEM. However, there is a strong belief at many institutions that, in the long run, it doesn’t matter what major an undergraduate student chooses. Apparently, all roads lead to success, provided the student learns to think critically and follows her/his passion. There have even been some longitudinal studies to support this assertion²². Of course, some majors provide an easier entry into the job market and larger starting salaries, but by mid-career, the differences will all even out—or so the story goes.

Personally, I have noticed evidence from a number of sources that seem to raise questions about this assumption, particularly as it relates to comparisons of outcomes for students who choose a major in STEM-intensive fields and those who do not.

For example, in a recent survey by Payscale.com²³, in which salaries of thousands of college graduates are compared, by college major, at both the starting level (two years of experience) and at mid-career (15 years of experience), those with top mid-career salaries by undergraduate major are:

1. Petroleum Engineering
2. Aerospace Engineering
3. Actuarial Mathematics

²⁰ The Engineer of 2020: Visions of Engineering in the New Century, National Academies Press, 2004.

²¹ STEM is an acronym for Science, Technology, Engineering and Math.

²² Altonji, J.G., Blom, E., & Meghir, C. (2012). “Heterogeneity in human capital investments: High school curriculum, college major, and careers.” NBER Working Paper 17985. Cambridge, MA: National Bureau of Economic Research.

²³ 2012-2013 PayScale College Salary Report
<http://www.payscale.com/college-salary-report-2013/majors-that-pay-you-back>.

4. Chemical Engineering
5. Nuclear Engineering
6. Electrical Engineering
7. Computer Engineering
8. Applied Mathematics
9. Computer Science
10. Statistics

The report is based on annual salaries for college graduates without advanced degrees, so these results reflect only the value of preparation in the undergraduate major. (Mid-career salaries for the top ten range from \$100,000 to about \$160,000.) Furthermore, 22 of the top 25 fields by discipline are STEM intensive, and 36 of the top 50 disciplines. On the other hand, 22 of the disciplines ranked between 76 and 100 are non-STEM intensive.

When the data is organized by the institution (rather than by undergraduate major)²⁴, the top ten institutions ranked by mid-career salary are²⁵:

1. Princeton University
2. Harvey Mudd College
3. California Institute of Technology
4. United States Naval Academy at Annapolis
5. United States Military Academy at West Point
6. Massachusetts Institute of Technology
Lehigh University (tie)
8. Polytechnic Institute of New York University
Babson College (tie)
10. Stanford University

Mid-career salaries for the top ten institutions range from \$114,000 to \$137,000. It is noteworthy that six of these top ten institutions are STEM-intensive. The message seems to be that an undergraduate major in a STEM-intensive field not only leads to top career opportunities immediately after graduation but also at mid-career.

(A similar report on starting salaries by discipline is available from the National Association of Colleges and Employers²⁶.)

In addition, Spencer Stuart periodically produces a statistical study of the background of the S&P 500 CEOs. When reviewing the educational background of this sample of major corporate leaders, they report that the most common undergraduate major is Engineering. In the 2006 study²⁷, they report that 21% of the CEOs had an undergraduate major in Engineering. This seems significant for two reasons. First, very few undergraduate programs in Engineering contain any explicit preparation for leadership, finance, or management. Secondly, the percentage of all bachelor degrees awarded in the U.S. to Engineers in recent years has been below 10% (last year it was below 5%), so the result for CEOs appears to indicate an over-representation.

I don't know of any definitive scientific studies that examine the longitudinal outcomes for STEM-intensive and non-STEM intensive majors, but perhaps there should be. It would be helpful to know

²⁴ 2012-2013 Payscale College Salary Report: <http://www.payscale.com/college-salary-report-2013/full-list-of-schools>.

²⁵ Olin College is ineligible for this ranking since it is too new to have graduates now in mid-career.

²⁶ January 2013 Executive Summary, NACE Salary Survey: <http://www.naceweb.org>.

²⁷ Spencer Stuart, Leading CEOs: A Statistical Snapshot of S&P 500 Leaders, February, 2006.

the facts in this area in order to fully advise students and their parents when they enter college, in case they might aspire to this type of career success²⁸.

MOOCs: An Emerging Disruptive Force with Potential for Significant Reduction in Student Costs. Last year, a major milestone in the development of massively open online courses (MOOCs) took place when Udacity and Coursera spun out of Stanford University and EdX was formed between MIT and Harvard²⁹. These new organizations are designed to provide global access to complete university courses online at no charge. Not only do these online courses provide access to content but also feedback on assignments. Today, content from many of the most respected universities in the world is now available for free from these sources. Clayton Christensen recently predicted³⁰ that such new developments will one day disrupt the business of higher education by providing content that is not only higher quality and much less expensive, but that is also presented in ways that lead to higher levels of student success.

Of course this technology is in the early stages of development. Many questions remain about the extent to which it has the capability to compete with face-to-face learning environments for many aspects of education, but there is growing confidence that it is here to stay and that it is already competitive with both the learning outcomes and the cost³¹ associated with traditional large lecture courses.

Recently, President Mohammad H. Qayoumi of San Jose State University in California pioneered an agreement with Udacity to work together to provide a short menu of carefully selected courses available to students at a cost of \$150/course. Successful completion of any of these courses will be counted toward the requirements for the bachelor degree at SJSU. The goal is to carefully expand this program as experience is obtained and improvement is implemented so that eventually a student at SJSU may complete as much as one fourth of the degree requirements working online at very low cost. If this program succeeds as intended, it has the potential to increase access to an accredited undergraduate education at a substantial reduction in cost for a very large number of students in California.

²⁸ Of course, not every student may be interested in STEM fields, and we would not want to steer all students to major in these fields unless they develop a sincere interest. But it appears that a sound foundation in STEM subjects—no matter what major is chosen—would enhance career opportunities for all students. Of course, most institutions require all students to complete general education requirements that include STEM and non-STEM subjects. However, two disturbing trends in recent years may be working against the goal of providing every graduate with a solid foundation in STEM subjects. The first is the appearance of special STEM general education courses on most campuses that are intended for non-STEM majors and that are designed to be less demanding, presumably to accommodate students whose high school preparation in math and science is weak. (However, the general education requirements in the non-STEM areas have not seen a similar decline in rigor.) Secondly, the grade point averages in STEM subjects in colleges and universities appear to be consistently lower than those in non-STEM subjects. To address this problem broadly, we need to develop and spread new effective pedagogical approaches that result in greatly improved student interest and success in STEM fields, both in high schools and in the first two years of college.

²⁹ Miller, R.K., "E-Learning and Undergraduate Engineering Education," Franklin W. Olin College of Engineering, Needham, MA, May 2012.

³⁰ Christensen, C., Johnson, C.W., and Horn, M.B., Disrupting Class: How Disruptive Innovation Will Change the Way the World Learns, New York, NY: McGraw Hill, 2008.

³¹ While the potential exists for the costs of online course delivery to drop well below the traditional lecture format, these costs are not yet as low as one might expect. Reports from colleagues currently using a major MOOC platform indicate that it is costing them about \$30k/course to access the MOOC platform. In addition, colleagues involved in preparing courses for distribution on a major MOOC platform report that it is costing them about \$200k/course to redesign the course and related pedagogy and activities in a manner that is consistent with the required quality online learning experience.

President Qayoumi's vision for the transformation of undergraduate education in California through the use of technology and other means is presented in a white paper that is available online³². In recent personal conversations with President Qayoumi, he reported to me on several recent experiments at SJSU that led to his conclusion that the technology is ready now to make this ambitious project successful. In essence, SJSU began with an electrical engineering circuits course offered at MIT and available through EdX. In a controlled experiment in which the same material was provided through a standard SJSU lecture format for one group, and in a flipped course involving the MOOC format through EdX for the other group, they found that not only did the students in the flipped-MOOC format manage to perform as well as the students in the standard format at the end of the course, they significantly outperformed them. The average on the final exam on the flipped-MOOC course was 20% higher, and perhaps more importantly, the standard deviation was reduced by a factor of two. As a result, while 40% of the students in the standard format course were required to repeat the class, fewer than 10% of the students in the flipped-MOOC course had to do so. The grand plan at SJSU now is to standardize 25 to 40 of the most popular lower-division courses in a range of disciplines. Then, partnering with industry and other organizations, redesign 25 to 40 upper-division courses that make use of the existing content. Next, make all of these redesigned courses free and publicly available. Finally, test the pilot program in California and, based on the results, refine the process and scale it up for national adoption.

As predicted in last year's white paper²⁹, it appears that appropriate use of MOOC technology now has the potential to reduce the cost of higher education significantly by replacing less effective large lecture courses wherever they exist with more engaging technology-enhanced versions of the same content. However, as noted last year, questions remain about the potential for MOOCs to teach the skills of innovation and to substitute for experiential learning in a laboratory setting, etc. The other end of the learning spectrum still appears to depend on personal mentoring and coaching with close contact involving real experts and colleagues. In addition, questions remain about the effectiveness of assessment of student learning in MOOCs as well as the actual cost reductions when the model is scaled up in enrollment beyond the current pilot experiments.

Other Notable Experiments in Educational Innovation. As public concern about the rising costs of higher education has risen in recent years, so has the incentive to find alternative models that promise more affordable alternatives. Venture capital is fueling two particularly bold educational experiments that involve for-profit institutions with radical changes in the learning model intended to deliver a high quality education at substantially reduced cost.

One is the Minerva Project³³, led by Ben Nelson, an entrepreneur who created Snapfish. The Minerva model aims to attract elite students away from Ivy League universities to learn without lecture classes, through online discussion-intensive seminars in traveling cohorts that live together but move to a new city each semester. Although the project has yet to attract substantial levels of funding, it has attracted several respected leaders, including Larry Summers, former president of Harvard University (and former Treasury Secretary) as chairman of the Advisory Board, and Stephen M. Kosslyn, former director of the Center for Advanced Study in the Behavioral Sciences at Stanford as founding dean of the College. (Kosslyn also served as Dean of Social Sciences at Harvard.) They anticipate offering their education at about half the price of Ivy League universities. Furthermore, in order to promote innovation in teaching, the Minerva Project recently announced³⁴ the establishment of a new \$500,000 annual prize to a faculty member at any university who can demonstrate exceptional innovation in teaching.

³² Qayoumi, M.H. and Polese, K., "Reinventing Public Higher Education: A Call to Action," Office of the President, San Jose State University, San Jose, CA (2013) <http://www.sjsu.edu/president/whitepaper/>.

³³ Rivard, R., "The Minerva Moment," *Inside Higher Ed*, 5 April 2013.

³⁴ Lewin, T., "Yearly Prize of \$500,000 is Created for Faculty," *New York Times*, 22 April 2013.

The other model is University Ventures³⁵ in New York. Funded with more than \$100 million in investment capital, University Ventures has a record of partnering with existing universities to build “transformative companies in postsecondary education”. Their strategy is to identify academic disciplines and geographic regions where rising demand and shrinking supply create rapidly growing market and student service opportunities. They apply management expertise and internet technologies in a focus on student outcomes to create consistent and sustainable results.

Taking a Global View. Finally, as noted earlier, the U.S. is home to seven of the top ten universities in the world, according to the most recent Times Higher Education survey. Many of our practices within higher education are widely admired and emulated by institutions in other nations (academic freedom and peer review, emphasis on research in addition to teaching, independent governance, etc.). However, our practices with regard to financing higher education and to providing a range of excessive amenities may not represent best practice across the globe.

Dr. Jamil Salmi, former head of Tertiary Education at the World Bank and well known author in the field of world class universities, has visited and consulted broadly across the globe for decades on how to improve higher education. Recently, he sent me a few observations about the American approach to financing higher education and how it compares with other nations. (His views are presented in a brief letter attached to this white paper.)

It is striking that, compared to other institutions around the world, the U.S. Federal Government does not subsidize higher education institutions directly, while students and their families are required to pay a much larger portion of the cost of their education than in most other developed nations. According to Salmi, the U.S. is not among the top tier of nations that provide financially viable access to excellent higher education. Neither is it among the second tier of nations. The U.S. is currently in the third tier in this regard, together with Chile, China, Japan, and South Korea. However, with the recent major decline of state funding of public higher education, the U.S. is now in serious danger of dropping from the third tier to the bottom tier where access to higher education is insufficiently funded overall. The consequences this represents for the nation’s ability to maintain its competitive advantage in the production of advanced human capital are grave.

When asked how the U.S. might improve in providing affordable access to quality education and reducing unnecessary cost, Salmi’s response is insightful. First, he suggests that we consider adopting a “unified income-contingent loan” (ICL) system similar to the Australian Higher Education Contribution Scheme. The ICL would be available to all students enrolled in an accredited college or university and repayment would be collected through the federal income tax. This approach has proven to be both more efficient and more equitable than the patchwork of student loan programs currently existing in the U.S.

Finally, Salmi recommends that U.S. colleges and universities take a closer look at the desirability of keeping high-profile sports as a central dimension of the college experience. The U.S. stands out internationally for this practice, even though the cost of competitive college sports has grown at up to triple the pace of spending on academics. (It is remarkable that seventy U.S. college presidents and provosts failed to identify the cost of competitive athletics among the drivers for rising costs in higher education³⁶.)

Summary and Conclusions. In an age of rising tuition, soaring student loan debt and uncertain employment, colleges and universities have an increased responsibility to improve student outcomes, both in the short-term and the long-term. The tragic problem of students leaving school with high levels of debt and few job opportunities to repay their loans appears to be less severe for students

³⁵ Lederman, D., “Venture Fund for Traditional Colleges,” *Inside Higher Ed*, 17 January 2012.

³⁶ Reed, W., results of a recent survey by the Davis Educational Foundation reported in a letter contained in the appendix to this paper.

majoring in STEM-intensive fields. Colleges should pay more attention to tracking student outcomes and then using that information to align academic and resource decisions within the institution. Empowering students with facts about outcomes while they are early in their academic program is important but often missing. Finally, colleges should be quick to experiment with and adopt emerging learning methods and technologies that promise to reduce costs while improving student outcomes.

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Questions for Discussion.

1. Is cost efficiency the primary goal of college education? Should it be? What cost metrics should we be using to evaluate effectiveness?
2. Is or should college cost be commensurate with expected income? To what extent should college be about preparing for employment?
3. What opportunities are there for Olin College to help improve student outcomes and educational efficiency at other institutions as flipped-MOOC format instruction and other innovations spread to large universities?

APPENDICES

Thoughts on the rising cost of higher education in the US

Jamil Salmi³⁷

(1) what are the top two or three reasons why you think the cost of higher education (in the US) is so hard to reduce

From the viewpoint of their financing strategies, tertiary education systems all over the world can be divided roughly into four main groups:

- i. well-funded systems that rely almost exclusively on public funding (more than 1.5% of GDP) and public provision (more than 90% of enrollment). These include the Gulf countries, the Scandinavian countries, Saudi Arabia, Scotland, Singapore, and Switzerland;
- ii. public systems that are relatively well-funded through a combination of public resources and a significant level of cost-sharing with appropriate student aid. Examples are Australia, Canada, England, Hong-Kong (China), Iceland, the Netherlands, and New Zealand;
- iii. mixed provision systems (more than 25% private enrolment), relatively well funded through public resources and high levels of cost-sharing in both public and private institutions. These include Chile, China, Japan, South Korea, and the US; and
- iv. public and mixed provision systems that tend to be insufficiently-funded overall (rest of the world).

In this context, it is striking to observe that in the US the state governments have been reducing steadily the level of public subsidies for higher education, to the point that in a growing number of states public universities receive today less than 10% of their resources from government. The US is at risk of moving from the third to the fourth group of funding systems, with all the dangers that it represents for the nation's ability to maintain its competitive advantage in the production of advanced human capital.

A unique feature of the US, compared to the rest of the world, is the fact that the Federal government does not subsidize higher education institutions directly, but only indirectly through the Pell grants and the federal student loans. So on the one hand you have the states providing direct funding to the public universities but hardly any funding to the private higher education institutions, and the Federal government providing indirect funding to all institutions through student aid (and research money). A complicating factor is the complexity of the student aid picture, with a patchwork of several programs with different rules and levels of benefits.

(2) what are the top two or three things that can and should be done to help address these costs?

The existing student loan schemes should be transformed into a unified income-contingent loan (ICL) system similar to the Australian Higher Education Contribution Scheme (HECS). The ICL would be available to all students enrolled in an accredited college or university. Repayments would be

³⁷ Independent expert on tertiary education and former Education Sector Manager, The World Bank, Washington DC. Dr. Salmi is the principal author of the Bank's new Tertiary Education Strategy entitled "Constructing Knowledge Societies: New Challenges for Tertiary Education," and is the author of several books, including The Challenge of Establishing World Class Universities.

collected through the federal income tax administration. Such an approach has been found to be both more efficient and more equitable than the patchwork of student loan programs currently existing in the United States.

Alternatively, the Federal government could encourage the states to move to a voucher type funding system, along the one piloted in Colorado in the early 2000s. The Colorado experience was not very positive for lack of bi-partisan support and because of insufficient funding, but the ongoing experience in Lithuania shows that channeling public resources through the students, increases competition and pushes higher education institutions to improve the quality and relevance of their programs.

Finally, US colleges and universities, especially the private ones, should take a closer look at the desirability of keeping high-profile sports as a central dimension of the college experience. The cost of competitive college sport has grown at up to triple the pace of spending on academics. As much as sport activities are an important part of the life of students, high-profile sports have nothing to do with the core mission of educational institutions and divert large chunks of resources.

Comments on Rising Costs of Higher Education Based on Seventy Responses from College Presidents and Provosts to a Recent Survey

Will Reed³⁸

The Davis Educational Foundation wrote to all college and university presidents in New England and received seventy responses from presidents and chief academic officers. They listed a number of causes, including: (a) an academic culture focused on improving the quality of the educational experience and reinvesting savings to improve quality rather than reduce the growth in tuition; (b) widely held perceptions that price equals quality; (c) increased expectations for what a college experience should include which has led to an "amenities war"; (d) a weak relationship between what it costs to educate a student and what the student actually pays; (e) demographic trends in the Northeast in the number of college age students, increasing the competition for students and expanding geographic recruitment areas; (f) annual compensation and benefits increases; (g) small teaching loads and small class sizes; (h) mission drift and curriculum bloat from adding new courses and programs without corresponding scrutiny of under subscribed courses; and (i) the cost to maintain and improve the physical plant, infrastructure and technology.

In my opinion, the two issues that are the key cost drivers are: 1) the academic culture, and 2) compensation and financial aid.

The Academic Culture. The academic culture in a traditional residential college or university is not designed for efficiency. Just the opposite. It is a community of extremely bright individuals, overflowing with new ideas on what should be studied, researched, and taught. It is designed to create a stimulating environment, to expand minds, to probe and challenge ideas, to discover and rediscover. The ideal is "Mark Hopkins on one end of a log and a student on the other end." The best institutions tend to have the highest faculty/students ratios and the smallest average class size. Efficiency has not been highly valued. Scholarly pursuits are valued, research and discovery are valued, the "life of the mind" is what is important. Until recently, little effort was placed on the economic and efficient delivery of content. The faculty/student ratio has been a reliable proxy for determining the quality of the institution. And for good reason, because small class size has been important in enriching the educational experience. The American higher education system has been regarded as the best in the world. The problem is that the average family income has not kept pace with the growth in tuition to the point that the cost of a college degree is out of reach for many.

Compensation and Financial Aid. For most colleges and universities, the combination of total compensation and unfunded financial aid account for 75-80% of the operating expense budget. Because tuition has outpaced inflation and incomes, tuition discounting has become a common recruitment tool. It is not uncommon for middle-tier institutions to have a tuition discount rate of 50-70%. For many colleges and universities, the "sticker price" is meaningless and only serves to discourage potential students with limited means from applying. Net tuition has remained flat over the last few years because of high tuition discounting. It is a system that makes no sense and is quickly becoming unsustainable.

The increase in total compensation is driven by the growth in non-teaching positions, high benefit costs, especially health care, generous leave and vacation policies and the need to increase salaries annually to keep pace with inflation and remain competitive in the marketplace. There are, simply put, too many mouths at the trough. The growth in compensation is driven, in part, by the increased expectation of what a college experience should provide. Parents and students expect the college experience to meet all the academic, technical, social and emotional support of every student. Providing these services requires a large staff and is not cheap.

³⁸ President, Davis Educational Foundation, and former Chief Financial Officer at Wellesley College.

Two suggestions on how to address the cost problem.

1) Have an adult conversation with the entire campus community about the economic realities facing higher education and (you name the institution) in particular. Reining in costs is really a thankless task and to be successful needs the understanding and support of the community. There needs to be a campaign to educate the community and to engage them in finding solutions on how to reduce the cost structure while improving the quality of the educational experience. The creative energy that resides within the campus needs to turn its attention to the value added of all activities. There needs to be plenty of data behind the decisions on what and how to contain cost and a thorough understanding and knowledge of the consequences of changes. The scope needs to be broad from the low hanging fruit (administrative procedures and practices) to the more difficult, but substantive, pedagogical issue of how classes are taught and content delivered. It involves an examination of the expensive policies and practices that every school has but does not think much about. Instead of the examination being a "downer" it should be exciting and stimulating, a breath of fresh air, a way to improve and to help students and their families lessen the financial burden. It is a way to be a leader of change and to challenge the perception that price equals quality.

2) Shorten the length of time to a baccalaureate degree. For many students it takes 6 years to complete the requirements for a baccalaureate degree. The causes are many--not being college ready and having to take remedial courses, taking too many courses that do not meet the requirements of their major, courses required for the major not being available, needing to work excessive hours to pay for tuition, and so on. Every extra year spent at college is expensive--tuition and room and board and loss of income from working. There needs to be more experimentation with the 3 year degree, taking courses on-line during the summer, credit for advance placement courses, competency based credits, credit for prior learning, tuition incentives, streamlined programs and stronger advising, much stronger advising. Every institution is different just as every major has its own requirements. Schools need to experiment with a variety of ways to teach with a goal for improving learning while reducing the time to degree. The credit-hour model needs to be re-examined.