AN AGENDA FOR THE FUTURE

Report of the

Task Force on Undergraduate Education

Columbia University

April 2009

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Acknowledgements

This report is the product of the collective thinking of the Task Force on Undergraduate Education. The Task Force included faculty, student, and administrative representation from all of the relevant constituencies. Members of the four working groups and their chairs were key collaborators in the process. The chairs of the four working groups – Peter Awn, Martha Howell, Ann McDermott, and David Weinstein – prepared drafts, consulted widely and made presentations to the Arts and Sciences faculty as well as to the Board of Trustees of the University. The Task Force was also assisted by the advice of numerous faculty who met with the Task Force and who commented on its proposals throughout the entire process.

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Background

Undergraduate instruction is offered in three schools and colleges of the University and at Barnard College. Two of the schools are overseen by the Faculty of the Arts and Sciences – Columbia College and the School of General Studies. Columbia College is the largest and oldest of the undergraduate schools at Columbia. Established as King's College in 1754 with an entering class of 8 young men; the College today enrolls over 4,200 women and men of traditional college age. Students complete a liberal arts curriculum composed of three parts: a common set of general education courses known as the Core Curriculum, a major or concentration, and electives. Literature Humanities, Contemporary Civilization, Music Humanities, Art Humanities, Undergraduate Writing, and Frontiers of Science are taken by all College students; in addition, every student completes two "global core" courses in non-western cultures and two science or quantitative reasoning courses chosen from approved distributional lists. Students are required to complete at least one of the 70 majors, 48 concentrations or 24 premedical concentrations approved by the Arts and Sciences, and may take electives to deepen their understanding of their chosen field or to explore other areas of interest. Approximately 1,000 students are awarded the Bachelor of Arts degree from the College each year.

The School of General Studies (GS) was established in 1947, although its roots extend back to University Extension, which first began awarding the bachelor's degree in 1921. GS provides a traditional Ivy League liberal arts education for students who have, for personal or professional reasons, interrupted their education. Most bring 1-2 years of previous college-level study, but all are required to complete a minimum of half of their degree requirements at Columbia and complete the same majors. The 1,200 GS students are taught by the same Arts and Sciences faculty as teach the students of Columbia College (and SEAS), in the same classes

at the same time. The School of General Studies awards both Bachelor of Arts and Bachelor of Science degrees, and students must complete one of the 70 Arts and Sciences majors in pursuit of the degree. Approximately 250 students graduate from GS each year.

The School of Engineering and Applied Science (SEAS) first began enrolling young men in 1864 in the then School of Mines. It currently enrolls over 1,400 men and women for undergraduate study in a total of 15 majors. Students may also pursue one of 34 minors, most of which are in fields in the Arts and Sciences. Students in SEAS complete much of the same Core Curriculum (see above) as is taken by students in Columbia College. SEAS awards approximately 365 bachelor's degrees each year.

Established in 1889, Barnard College currently enrolls 2,400 undergraduate women studying for the Bachelor of Arts degree in 47 fields of study. Barnard students complete certain majors, in part or in whole at Columbia, while some Columbia College, GS and SEAS undergraduates take most or all of their major, concentration or certificate programs in Barnard-based departments. Pursuant to an inter-corporate agreement first established in June 1900 with Columbia University, Barnard College maintains its own Board of Trustees, president, faculty, facilities, and financial independence. The agreement includes a key provision which stipulates that Barnard students would receive a Columbia degree and be permitted to take upper-level courses at the University. Thus, a faculty member teaching an undergraduate course in the Arts and Sciences or in Engineering and Applied Science could well have students sitting in her or his classroom from all four schools - Columbia College, SEAS, GS and Barnard. The same can hold true for a Barnard faculty member teaching undergraduate courses.

It should be noted that the School of Nursing offers an accelerated combined-degree (BS/MS) program for college graduates without previous nursing education. There are two

components: pre-licensure study which prepares the student for basic nursing practice and specialty study which focuses on an advanced practice role in professional nursing. Students receive the bachelor's degree on route to the master's degree. The Task Force did not address School of Nursing undergraduates.

An Agenda for the Future

Report of the Task Force on Undergraduate Education

Introduction

The Task Force on Undergraduate Education assembled for the first time in the fall of 2006 at the invitation of, and under the chairmanship of, President Lee C. Bollinger. The creation of this Task Force represented the belief of the senior leadership of the University that the continuing excellence of undergraduate education is the central commitment of the institution and its most compelling concern. President Bollinger asked the Task Force to consider a number of important questions relating to undergraduate education, and the members of the Task Force considered these questions over the course of two years.

The deliberations of the Task Force fell into two, sometimes overlapping, categories. The first category involved a series of what came to be called "structural" questions: What is the appropriate size of the undergraduate student body, and what is the appropriate distribution of students among the various undergraduate schools (Columbia College, the School of Engineering and Applied Science, and the School of General Studies)? What steps should Columbia take to enhance the quality and improve the conditions of students in General Studies, and would a changed relationship between GS and the College contribute to those goals? How can Columbia increase the number of international undergraduate students? The second category involved a wide range of questions about the ways the curricula of the undergraduate schools might be revised and enhanced.

From the beginning, the President made clear that the Task Force had no authority by itself to make changes in the curriculum. Its goal was to make recommendations that would then be considered through existing or revised academic processes. But because the Task Force,

unlike most standing committees**,** was so broadly representative of the University – including administration, faculty, and students – its members hope and believe that its recommendations will receive serious attention.

This Task Force follows in the footsteps of many earlier examinations of undergraduate education at Columbia. A Committee on Undergraduate Education (CUE) published a report in 1994 that raised many of the same issues that emerged in the discussions of the current Task Force. (Some of the faculty who served on the CUE in the early 1990s served on this Task Force as well.) Other studies of undergraduate education occurred almost every decade from at least the 1940s. The current Task Force initiative, like the earlier efforts, reflects the longstanding commitment of the University, and of the faculty in particular, to undergraduate education at Columbia. It also reflects the recent growth in both the size and the stature of Columbia College and the School of Engineering and Applied Science, the recognition of the changes in higher education that have occurred, and will continue to occur, in the face of a rapidly and profoundly changing world.

The Task Force has come to the end of its work in a time of significant financial constraints, and many of the aspirations and recommendations that appear in this report may be deferred for consideration until new revenues become available. But we believe that this exercise has provided an important vision of how undergraduate education at Columbia – already a source of great pride to the University – can become stronger and better aligned with the issues facing the University in the twenty-first century.

This report addresses a series of issues that the Task Force has identified as important, and it presents proposals that have gained the support of most (but not always all) of the members of the group. They include proposals for increasing the size of Columbia College,

enhancing General Studies, internationalizing the undergraduate experience, facilitating interdisciplinary studies, strengthening undergraduate science, addressing concerns about teaching, and providing the Arts and Sciences with a vehicle that will make possible a coordinated vision of the curriculum, the deployment of faculty, and the impact of related proposals in this document.

Much of the Task Force's work on curriculum was conducted by a series of Working Groups on particular topics, which included members of the task force and some faculty from outside the Task Force. Their reports are summarized in this document, and the reports of the working groups themselves are included in the appendices.

1. Enlarging Columbia College

Columbia College, despite considerable growth in recent decades, remains the smallest in the Ivy League and among our other peers around the country. The College is small not only in relation to peer institutions, but also in relation to the size of the University. Columbia College enrolls only 46 percent of the undergraduates at Columbia – with the remainder in the School of Engineering and Applied Science, the School of General Studies, and Barnard College. It is, in other words, a relatively small college positioned in the midst of other substantial undergraduate schools. The 4,100 College students are also positioned among approximately 25,000 total students enrolled in Columbia's undergraduate, graduate, and professional schools.

The Task Force proposes a carefully planned and long-term expansion of Columbia College of approximately 15 to 20 percent, with the aim of strengthening the College, Arts and Sciences, and the University. Such an expansion would provide more students with the opportunity to benefit from a Columbia education, would allow the College to accept more

international students without reducing the number of American students, would make the College proportionately larger within the University and within the undergraduate population, and over time would generate more additional revenues through tuition. Growth would also create a larger College alumni body and thus enhance the College's and the University's fundraising capacities. The extraordinary quality of our enormous pool of undergraduate applicants (21,300 for 1,000 places in 2009) ensures that a larger student body would not lead to any diminution in the quality of students.

The costs of expansion at this scale are significant and would extend over more than a decade. Those costs would include funding for incremental financial aid to maintain our deep commitment to need-blind, fully-funded admissions; additional dormitory, dining, classroom, athletic, and study space; increased student services; faculty growth; and close attention to the staffing of the core curriculum. Significant additional revenues will need to be identified before we will be able to meet all these goals**.** But the Task Force believes that, were expansion to become affordable and were it to be done consistent with the needs of students and faculty, it would be worth pursuing.

2. Strengthening General Studies

Columbia is unusual, perhaps unique, among American universities in having created a separate school for nontraditional students and, at the same time, making few distinctions between traditional and nontraditional students in their access to courses, majors, faculty, and other academic opportunities. General Studies students, many of whom enter the University after having spent time at other institutions, do not fully participate in the College's core curriculum; but in almost all other respects, their academic experience is identical to that of

students in the College. The students in the School of General Studies bring with them substantial non-academic experiences that enrich the character of undergraduate life and the quality of the classroom experience.

There are, however, significant differences in other aspects of the lives of General Studies students. They enter Columbia through an admissions process separate from that of the College. They do not have access to established undergraduate housing, although the School has acquired its own housing for some of its students. They are not eligible for the need-blind, fully-funded financial aid that is available to students in the College and SEAS, although they do receive some financial aid through their school. For General Studies to reach its full potential, it will need to address these problems. Increasing the amount of housing available to General Studies students and significantly increasing financial aid would deepen the applicant pool significantly, make it possible to attract many more students from across the nation and the world, and over time improve the already high quality of students. It would also, of course, improve the experience of students once they are here. Such enhancements would require significant additional revenues, and so this goal as well will await better financial times.

In the meantime, there are opportunities to integrate General Studies more effectively into the larger undergraduate population. Members of the Task Force have proposed a closer relationship between the College and General Studies in undergraduate admissions, student services, and advising. Members of the Task Force also recommended that students in General Studies should have greater and easier access to the core curriculum.

A closer relationship between General Studies and the College – both in the short term and the long term – could create a more unified undergraduate population, with many common experiences and qualifications.

3. Internationalizing Undergraduate Education

Columbia has established as one of its core missions a greater engagement with the world beyond our campus. For undergraduates, that means, among many other things, bringing more international undergraduates to Columbia College, creating a curriculum that provides students with a greater understanding of global issues, and providing greater opportunities for students to have academic and other experiences abroad.

The Task Force proposes a significant increase in the number of international students in the College, SEAS, and General Studies, both because we believe that a Columbia education will be of value to non-American students and because the presence of international students will enrich the experience of all undergraduates. This will require, in all three schools, new revenues to ensure that international students will be eligible for levels of financial aid comparable to those now available to North American students in the College and SEAS.

The Task Force also supports a significant increase in the number and range of international experiences available to students. Because of the difficulty many students face in spending an entire semester or year abroad, Columbia should ensure that there are international opportunities in the summer and during other, shorter-term breaks in the academic year. Such experiences could include, among others, research trips, independent study, internships**,** and sponsored volunteer activities. Not all such programs would be linked to language instruction. As Columbia opens global centers in various parts of the world, undergraduate programs should be integrated into their mission at an early point.

International experiences for undergraduates do not always require travel abroad. Columbia should take advantage of its location in one of the world's most global cities to bring students into contact with diverse international communities in the metropolitan area.

And not least, the Task Force proposes a broad effort to bring greater international content to the curriculum, including the core curriculum. There is broad support for a continuing re-examination of the formerly Major Cultures component of the core, now the Global Core, and a faculty committee was reviewing this part of the core at the same time that the Task Force was meeting. Over time, the goal should be to staff and structure the Global Core in ways comparable to that of the Western core. In addition, the Committee on Global Thought has considered ways in which to engage with undergraduate education, and the Earth Institute – itself a highly international institution – is in the process of planning and proposing an undergraduate major.

4. Facilitating New Interdisciplinary Opportunities

It should not be the role of the Task Force to identify what kind of interdisciplinary programs would be of value to undergraduates. That is the job of the faculty. But it is appropriate to recommend vehicles for facilitating interdisciplinary opportunities for students and to identify obstacles that might be removed.

Columbia is a highly balkanized university, divided not only by the high level of autonomy of the various schools but also by a tradition of independence within departments and programs. There has been significant progress over the last two decades in creating interdisciplinary programs for undergraduates. From a point in the late 1980s where there were virtually no interdisciplinary programs for undergraduates, there are now important new

institutions that offer majors in an array of interdisciplinary fields, among them the Institute for Research on Women and Gender; the Institute for Research in African American Studies; the Center for the Study of Ethnicity and Race; the Program in American Studies; and the Institute for Comparative Literature and Society. But obstacles remain. There are both budgetary and cultural barriers that inhibit such simple interdisciplinary activities as faculty from different schools or departments teaching courses together, let alone creating robust interdisciplinary programs.

The University and the individual Schools should create agreements that would remove budgetary obstacles that prevent faculty from teaching in departments and schools not their own. Academic units must be protected from too many faculty moving their teaching to other units, so there must be limits on the "freedom of trade" that would be necessary to enhance interdisciplinary activity. But it would be of great value to the university to create carefully limited opportunities for faculty to teach from time to time outside their home units.

Several decades ago, Columbia supported a small number of non-departmental seminars known as Colloquia, through which upper-class undergraduates could revisit aspects of the core curriculum at a later stage of their education. These colloquia attracted some of the most eminent faculty in the University and often brought professors from different disciplines together in the classroom. Reviving something similar to those team-taught colloquia would enhance undergraduate education today. The Faculty should support seminars outside of departments that would be selected on the basis of their innovative quality. Such teaching opportunities are common in many colleges in the form of freshman seminars. Columbia's core curriculum leaves little room for first-year students to take such courses, but that should not prevent the creation of comparable courses available to students at any point in their undergraduate program. These

courses might be called College Seminars. They could build upon the interdisciplinary strengths of both the core curriculum and the majors, as the former colloquia did.

The College and GS already offer some opportunities for students to take courses in Columbia's professional schools. It would be particularly valuable to find more ways to attract faculty from Columbia's many professional schools to offer undergraduate courses. Some of the University's most distinguished scholars teach outside the undergraduate schools. Finding a way to make possible undergraduate teaching by those professional school scholars who wish to do so would open important new opportunities for students. The creation of College Seminars would also help facilitate such teaching opportunities.

5. Advancing Undergraduate Science Education

In many ways, Columbia offers extraordinary opportunities to undergraduates for the study of science. The distinguished science faculty of the Arts and Sciences is deeply committed to undergraduate teaching. In many fields, classes are small; and students have many opportunities to work closely with faculty on research. Despite some overcrowded classes, substandard classrooms and teaching labs, undergraduate scientists at Columbia do very well in their studies and, to the degree we can tell, do very well in subsequent careers, many of them in scientific fields.

For many years, however, Columbia has been concerned about the relatively low number of undergraduate science majors. The College has responded to this challenge with, among other things, a new core course in science**,** and the very successful Rabi Scholars Program, named after one of the great Columbia physicists of the middle of the twentieth century. The Rabi program demonstrates that Columbia can effectively serve very talented and highly motivated science

students by providing them with close faculty supervision, early research opportunities, and summer-on-campus programs. Rabi scholars typically do extremely well in their studies and in their subsequent careers. "Opportunities for supervised research are likely to be a very important component of our science program, but are in short supply," the report of the Working Group on Science Education states.

Among the many important recommendations for enhancing science education for undergraduates is **a** substantial enlargement of the Rabi scholars program, or the creation of additional programs in other areas of science, which would help the College attract more of the best science applicants. The Working Group also noted the particularly low undergraduate enrollment in biology, which suggests that a focused effort to recruit biologists – through an expanded Rabi program or a new program focused on the field – would help address this anomaly. The Task Force also recommends an increase in summer research opportunities for science students whether or not they are Rabi scholars. And it recommends, finally, that the proposed Education Policy and Planning Committee (see below) provide leadership for departments in the development of curricular innovations for science students in their first two years and for modernizing the majors.

6. Addressing Inequalities and Anomalies in Undergraduate Teaching

The Working Group on Teaching called attention to inequalities in the classroom experience of many undergraduates. Students in some of the most popular majors encounter very large lecture classes, sometimes – but not always – accompanied by discussion sections conducted by graduate students. Newly popular fields have not always been able to match the growth in students with growth in faculty. Students in smaller majors are more likely to have

small courses, many seminars, and robust relationships with faculty. This is a common dilemma in all universities, but that should not prevent Columbia from trying to address the problem.

Growth in faculty size has not always been tied closely to instructional demand, and few believe that instructional demand should be the only basis for hiring faculty. But attention to teaching needs should be a significant factor in determining faculty size. The Working Group on Teaching recommends improving data analysis on course enrollments and, over time, leveraging faculty expansion to bring Columbia more in line with evolving undergraduate demand for classes.

Grading standards are also highly variable from department to department, which may create inappropriate incentives when students are choosing courses or majors. The Working Group recommends, therefore, strengthening current efforts to disseminate information about grading norms so that faculty and administrators can better understand their evaluation policies. Columbia already includes information on transcripts on the percentage of A grades in each course. But further study of disparities in grading standards among undergraduate departments, and of grade inflation, are clearly needed.

7. Reconsidering Curricular Structure

The Working Group on Curricular Structure looked at the curriculum as a whole, with attention not only to the College and General Studies, but to SEAS, Barnard, the Post-Bac Pre-Med Program, and the small number of "special students" who take courses at the University. The Working Group noted a potential tension between the College's robust and very extensive core curriculum and the demands of the majors. It noted too, as the 1993 CUE report did as well, that the combination of the core and the majors leaves less room for electives than would be the

case in other universities**.** Recent data suggests that students take on average one elective per semester, although many students may use these "electives" to support their majors.

The Working Group affirmed its commitment to the core curriculum as the signature of the Columbia undergraduate curriculum and noted that "there is little disagreement, here or in the nation, that Columbia's general education is exceptionally successful." That success rests on its "coherent curriculum" and its "pedagogical structure – the small seminar in which students confront the primary texts and cultural documents themselves and are compelled to come to their own understanding of them, with the help of their instructors and classmates." The Working group also noted that at least one key element of the core curriculum – the "Major Cultures" (now "Global Core") requirement – should be strengthened. The College's Committee on the Core was working on a revision of the requirement as the Task Force was meeting and has already established the revised "Global Core" requirement that provides an important first step in strengthening this vital part of the core. Continued attention to the global core should be a high priority for the College and SEAS.

The Working Group's principal recommendation, strongly endorsed by a unanimous vote by those attending the final meeting of the Task Force, is "that a faculty-led group – the Education Policy and Planning Committee – be appointed to work with the Deans of Undergraduate and Graduate Education and the Vice President on coordinating curriculum across schools, departments, institutes, and programs and to advise the Vice President regarding allocation of faculty resources to undergraduate teaching." The goal of this committee is "to provide a structure for the coordination of existing bodies that manage curriculum (whether departmental committees, institute or program committees, the Committees on Instruction for the

respective schools, or the committees that design and manage the Core) with those responsible for faculty planning."

The Task Force supports this proposal because it believes that the current division of authority over the many different pieces of the curriculum makes it difficult to coordinate and reconsider the structure of undergraduate academic life. In many ways, this proposal is the most important of all those that have emerged from the Task Force. It will create a vehicle for consideration of all the other proposals in this report, and it will make possible careful and reasoned changes in the undergraduate curriculum over time in a way that, in the past, has been continually frustrated by the absence of any group capable of looking broadly at the overall pattern of the undergraduate experience.

Appendices

Appendix A

COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK
PRESIDENT'S ROOM

August 10, 2006

Dear [ ],

I am writing to ask you to serve on a task force on undergraduate education at Columbia. The task force will meet on a fairly regular basis over the course of the academic year and issue a report in the spring. (A Fall meeting schedule is attached.) I will personally chair the task force.

We have one of the finest undergraduate programs in the world. The educational experience Columbia provides students is properly noted for many things, most especially the Core Curriculum and the dedication of our faculty to teaching undergraduates. Because of the centrality of undergraduate education to the University, however, it is appropriate every decade or so to reflect on how we might improve what we do for, generally speaking, the youngest members of our intellectual community. That is the purpose of this task force.

We will take up a number of key issues: How well is our undergraduate curriculum serving the rapidly changing needs of our increasingly globalized world – a world, I think we now understand, that will require precisely the combination of highly specialized knowledge and broad general learning to which Columbia has long been committed? Is the balance we have struck between general learning and disciplinary specialization the right one for our present needs? Do we provide enough opportunities for interdisciplinary learning? Have we taken enough advantage of our location in on of the world's great cities?

The task force will also consider questions of intellectual scale: What is the appropriate size of the undergraduate student body? If we should prepare for an increase in the number of students, what needs to be done to support a larger student population (e.g., dormitories, social and athletic facilities)? Should an increase emphasize certain types of students (e.g., international students)? What is the best balance of students within the overall student body (e.g., College, General Studies, and SEAS)? What is the appropriate size of our faculties and our graduate students to fulfill the mission of the University with respect to undergraduate education?

These are, clearly, exceedingly important questions for us to consider thoughtfully and to offer recommendations on. I very much hope that you will be able to join us on the task force.

Sincerely,

Lee C. Bollinger

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Appendix B

Membership of the Task Force on Undergraduate Education

Lee C. Bollinger, President, *Chair*

Alan Brinkley, Provost and Allan Nevins Professor of American History, *Vice Chair*

Alfred V. Aho, Lawrence Gussman Professor of Computer Science, *Department of Computer Science*

Paul J. Anderer, Theodore and Fanny de Bary and Class of 1941 Collegiate Professor of Asian Humanities, *Department of East Asian Languages and Cultures* (2006-07)

Peter Awn, Dean of the School of General Studies and Professor of Religion

Brody Berg, Student Council President, School of General Studies (2008-09)

Elizabeth Boylan, Provost and Dean of the Faculty of Barnard College

Niko Cunningham, Student Council President, School of General Studies (2007-08)

Andrew Delbanco, The Julian Clarence Levi Professor in the Humanities, *Department of English and Comparative Literature*

George Deodatis, Professor, *Department of Civil Engineering and Engineering Mechanics*

Michelle Diamond, Student Council President, Columbia College (2007-08)

Nicholas B. Dirks, Vice President for the Arts and Sciences and Dean of the Faculty and Franz Boas Professor of Anthropology and History

Geraldine Downey, Vice Provost for Diversity Initiatives and Professor of Psychology

Stuart J. Firestein, Professor, *Department of Biological Sciences*

Seth E. Flaxman, Student Council President, Columbia College (2006-07)

Morton B. Friedman, Vice Dean, Fu Foundation School of Engineering and Applied Science and Professor of Civil Engineering and Engineering Mechanics

Robert D. Friedman, Professor, *Department of Mathematics*

Zvi Galil, Dean, Fu Foundation School of Engineering and Applied Science and Morris A. and Alma Shapiro Professor and Julian Clarence Levi Professor of Mathematical Methods and Computer Science (2006-07)

Steven Gregory, Professor, *Department of Anthropology*

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Robert E. Harrist, Jane and Leopold Swergold Professor of Chinese Art History, *Department of Art History and Archeology*

Jean E. Howard, William B. Ransford Professor of English, *Department of English and Comparative Literature*

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George E. Lewis, Edwin H. Case Professor of Music, *Department of Music*

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Andrew J. Millis, Chair and Professor, *Department of Physics*

Vijay Modi, Professor, *Department of Mechanical Engineering*

Shahid Naeem, Chair and Professor, *Department of Ecology, Evolution, and Environmental Biology*

Gerald Navratil, Interim Dean, Fu Foundation School of Engineering and Applied Science and Thomas Alva Edison Professor of Applied Physics and Applied Mathematics (2007-09)

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Robert Shapiro, Professor, *Department of Political Science* (2007-09)

Elaine Sisman, Anne Parsons Bender Professor of Music, *Department of Music*

Joan E. Spero, Trustee of Columbia University, *President of the Doris Duke Charitable Trust Foundation* (observer)

Elizabeth Strauss, Student Council President, School of Engineering and Applied Science (2007-08)

Peter Valeiras, Student Council President, School of Engineering and Applied Science (2008-09)

David Weinstein, Carl Sumner Shoup Professor of Japanese Economics, Department of Economics,

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Susan Glancy, Chief of Staff, *Office of the President*
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Evelyn Schwalb, Director, *Office of the President*
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Appendix C

Membership of the Working Groups

Working Group on Curricular Structure

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Niko Cunningham, Student Council President, School of General Studies (2007-08)

Andrew Delbanco, Julian Clarence Levi Professor in the Humanities, Department of English and Comparative Literature

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Andrew F. Laine, Vice Chair and Professor of Biomedical Engineering and Professor of Radiology, Department of Biomedical Engineering and the Department of Radiology

Jacob Matilsky, Student Council Representative, General Studies (2007-08)

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Robert Shapiro, Professor, Department of Political Science

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George E. Lewis, Edwin H. Case Professor of Music, Department of Music

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Claudio W. Lomnitz, Professor, Department of Anthropology

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Working Group on Organization and Expansion

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Peter Awn, Dean, School of General Studies and Professor of Religion

Nicholas B. Dirks, Vice President for the Arts and Sciences and Dean of the Faculty and Franz Boas Professor of Anthropology and History

Zvi Galil, Dean, Fu Foundation School of Engineering and Applied Science and Morris A. and Alma Shapiro Professor and Julian Clarence Levi Professor of Mathematical Methods and Computer Science (2006-07)

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Geraldine Downey, Vice Provost for Diversity Initiatives and Professor of Psychology

Stuart J. Firestein, Professor, Department of Biological Sciences

Morton B. Friedman, Vice Dean, Fu Foundation School of Engineering and Applied Science and Professor of Civil Engineering and Engineering Mechanics

Robert D. Friedman, Professor, Department of Mathematics

Charles Hailey, Pupin Professor of Physics, Department of Physics

Mary McGee, Dean of Students and Associate Dean of Faculty, School of General Studies (2006-08)

Andrew J. Millis, Chair and Professor, Department of Physics

Shahid Naeem, Chair and Professor of Ecology, Evolution, and Environmental Biology

Gerald Navratil, Interim Dean, Fu Foundation School of Engineering and Applied Science and Thomas Alva Edison Professor of Applied Physics and Applied Mathematics (2007-09)

Duong Phong, Professor, Department of Mathematics

Elizabeth Strauss, Student Council President, School of Engineering and Applied Science (2007-08)

Kathryn Yatrakis, Dean of Academic Affairs, Columbia College

Working Group on Teaching

David Weinstein, Carl Sumner Shoup Professor of Japanese Economics, Department of Economics, *Chair*

Alfred V. Aho, Lawrence Gussman Professor of Computer Science, Department of Computer Science

Nicholas Dames, Theodore Kahan Associate Professor in the Humanities, Department of English and Comparative Literature

George Deodatis, Professor, Department of Civil Engineering and Engineering Mechanics

Michelle Diamond, College Student Council President, Columbia College (2007-08)

Patricia E. Grieve, Nancy and Jeffrey Marcus Professor of the Humanities and Chair of Literature Humanities, Department of Spanish and Portuguese

Tory Higgins, Stanley Schachter Professor of Psychology and Professor of Business, Department of Psychology and School of Business

Nicholas Turro, William P. Schweitzer Professor of Chemistry and Professor of Chemical Engineering and of Environmental Engineering and Materials Science, Department of Chemistry and Department of Earth and Environmental Engineering

Gregory Wawro, Professor, Department of Political Science

Appendix D

Possible Topics for Working Groups

November 14, 2006

1. Expanding Opportunities

   How might we expand curricular opportunities for undergraduates that do not emerge naturally out of existing institutions (departments, institutes, and the core)? Should we create vehicles to encourage more teaching of undergraduates by members of our professional school faculties? By people from outside the University? For more extensive undergraduate instruction in the arts? Is the core carrying too much of the burden of general education? What other mechanisms would facilitate such offerings?

2. Internationalizing the Curriculum

   Does our curriculum adequately prepare undergraduates for the new, globalized world in which they will live? What kinds of courses and experiences (e.g. study abroad, internships) do we want them to have, and do we make adequate opportunities available now? Is there reason to review the Major Cultures requirement in response to a changing world?

3. Interdisciplinarity

   Do we provide enough interdisciplinary opportunities for undergraduates? Should we consider creating, or making it easier for students to create, joint majors (as opposed to the double majors so many of them now pursue)? What areas of inquiry would be served by new interdisciplinary programs?

4. The Classroom Experience

   Who is teaching our students? Are we content with the present situation? Do we need to reconsider the way we staff the core curriculum? Are graduate teaching fellows properly utilized? And what is the mixture of students that undergraduates experience in their classes?

5. The Structure of the Curriculum

   Are what some have called the "containers" of our undergraduate curriculum appropriately sized? We probably agree that a strong undergraduate education should include general education (our core), specialized education (our majors), and opportunities for exploration (electives). Do we provide ample opportunities for all three of these goals? Are there adjustments that might make the balance among these elements more appropriate?

Appendix D-1

Report of the Working Group on Curricular Structure

Task Force on Undergraduate Education

April 22, 2008

Committee Members:

Martha Howell, Miriam Champion Professor of History, Chair

Andrew Delbanco, Department of English, Julian Clarence Levi Professor in the Humanities

Michelle Diamond, Student, President of Columbia College Student Council

Jean Howard, Department of English, George Delacorte Professor in the Humanities

Andrew Laine, Professor of Biomedical Engineering and Radiology (Physics), SEAS

Jacob Matilsky, Academic Affairs Representative, School of General Studies

Ann McDermott, Esther Breslow Professor of Biological Chemistry; Associate Vice President for Academic Planning and Science Initiatives

Christia Mercer, Department of Philosophy, Gustave M. Berne Professor in the Core Curriculum

Susan Pedersen, Department of History, James P. Shenton Professor of the Core Curriculum

Austin Quigley, Dean, Columbia College

Robert Shapiro, Professor of Political Science

Elaine Sisman, Anne Parsons Bender Professor of Music

Staff:

Lucy Drotning, Associate Provost

Mia Mendicino, Coordinator, Academic Affairs, Columbia College

Introduction

The committee on curricular structure has looked at the curriculum as a whole, both from the point of view of undergraduates and of the faculty who have responsibility for the undergraduate classroom. Much of the year was spent gathering information about the precise structure and content of the curriculum as experienced, not just by Columbia College and General Studies students, but also by students from SEAS, Barnard, the Post-Bac program and the smaller category of "special students," who together constitute almost half of undergraduate enrollment in Arts and Sciences classrooms. In the past, none of those responsible for undergraduate education has had such robust and detailed information -- not the Deans, not the faculty, and not the Vice President. Although no specific recommendations flow from that material – considerably more study and discussion would have to follow from it – it is clear that responsible planning about faculty resources, structure of the curriculum, and any plans for future growth of the College must begin with the secure knowledge of what our faculty and students are now doing that data of this kind can provide.

In the following pages I provide a very abbreviated overview of what we have learned. **The principal focus of this report is, however, to present our recommendation that a faculty-led committee be appointed to work with the Deans of Undergraduate and Graduate Education and the Vice President on coordinating curriculum across schools, departments, institutes, and programs and to advise the Vice President regarding allocation of faculty resources to undergraduate teaching.** As the data I present makes clear, our present structure, the product of a complex history of once-distinct schools and faculties, makes it hard for faculty, Deans, and the Vice President to work together on planning undergraduate education. In our view, the Educational Policy and Planning Committee we recommend would provide the structure for assuring better use of our faculty resources, better fits among departmental curricula, better coordination with the College's Core curriculum, and better planning about such cross-school matters as advising, grading, assignment of credits, and the like. We have devoted a lot of thought and discussion to the committee's functions and structure. Although the precise composition of the committee is not finally decided, it is clear that we want faculty to have ownership and leadership of the committee but we also want them to be positioned to draw upon the expertise of senior administrators, to have access to the data that research staff in the Provost's, Vice President's, and College Dean's office are now able to provide, and to be able to plan together with the Schools, Departments, Institutes, and Programs that manage curriculum. We do not intend that this committee replace any existing structures at these levels, but expect that it will work with, and among, them to improve communication and planning and to standardize policies where such standardization makes sense.

Curricular Structure

The following analysis of some defining features of our overall curriculum is keyed to a power point presentation that is attached in a separate file. It is based on extensive research of enrollment patterns, course offerings, and faculty allocation, but the slides are not intended to summarize the range or depth of that research. Instead, they attempt only to sketch an overview of the whole. In particular, the presentation omits any consideration of our science programs, since a separate committee is reporting on that aspect of our curriculum.

The first slide is intended to represent the overall experience of Columbia College students. **Slide 1**

- Of the 124 credits required for graduation, 29 are spent in Core courses: Lit Hum, CC, Music Hum, Art Hum, Frontiers of Science, and University Writing.
- Another 14 to 34 are spent on two more science courses, two courses in the Major Cultures sequence, and up to four courses of basic language instruction (students can place out but less than a third of College students are exempted from the entire requirement). Together, the Core and these "distributional" courses make up Columbia College's General Education program. Both General Studies and SEAS students have access to parts of that program, but not in its entirety.
- Between 29 and 69 credits are devoted to a major (if the student chooses to major; it is possible to graduate only with a smaller "concentration" but few students do).
- On average, then (taking 39 credits as the actual weighted average major), students spend 35-51% of their time in General Education courses (Core plus the required science, Major Cultures and language courses), 31% in the major, and 18-34% of the time on electives.

The next slide looks at the disciplinary focus of the College's General Education requirements: **slide 2**

- 56-65% of the requirements are in the Humanities, counting University Writing as a Humanities.
- Thus, at least 20-33% of a student's class-time at Columbia will be spent in the Humanities (assuming no study of the Humanities beyond General Education courses); in contrast 7-12% of the time will be spent in the sciences.

The third slide illustrates that Columbia College students tend to choose Humanities courses over Social Science or Science courses as electives, once they exit both General Education and the disciplinary focus of their major. **Slide 3**

The fourth slide illustrates that two-thirds of the courses with socio-cultural content in the General Education sequence focus on the West. **Slide 4**

The fifth slide illustrates the diverse enrollments in Major Cultures courses and the variation in class size among those offerings. **Slide 5**

The sixth slide shows that about half of Columbia College students major in one of five departments, three of them in the Social Sciences. **Slide 6**

The seventh slide illustrates that our largest majors require fewer courses than comparable majors at peers. **Slide 7** It is worth noting that at Yale, all of these majors require a senior project and that at Harvard most do. In contrast, none of these majors at Columbia requires a senior thesis or project, although all make a senior project a requirement for honors (which is limited to 10% of the graduating class). (At Columbia, only a few of the interdisciplinary majors [ELAC,

American Studies, Women's Studies, for example] require a senior project.) It is also worth nothing that only one of the five largest majors at Columbia offers all qualified seniors an opportunity to do a senior project in a faculty-led seminar; the remainder, like most majors at Columbia, restrict that opportunity to the top 10% of the class who are otherwise eligible for departmental honors and most supervise that research through independent studies rather than seminars.

The eighth slide illustrates the rising incidence of double majors at Columbia (note that this appears to be a national trend); the slide also shows that over a quarter of those students choosing to double major do so by combining majors from the most popular majors **slide 8**

The ninth slide looks at the incidence of faculty instruction in the three different levels of undergraduate education – the Core, 1000-2000-level departmental and interdepartmental courses, and 3000-4000 level departmental and interdepartmental courses. **Slide 9**

The tenth slide illustrates that while 58% of the courses offered by Arts and Sciences faculty are undergraduate level, undergraduates constitute 80% of all enrollment in Arts and Sciences faculty-taught courses. **Slide 10**

The last two slides bring us to the recommendation for an Educational Policy and Planning Committee (EPPC).

- The first simply breaks down the curriculum into its three parts: Core, Undergraduate departmental and interdepartmental courses and Graduate departmental and interdepartmental courses, indicating who has responsibility for designing and mounting the courses. **Slide 11**
- The next is more complex, and is in fact intended to demonstrate the complexity of Arts and Sciences. The bar represents each of the student constituencies enrolled in Arts and Sciences classrooms and indicates the proportion of total enrollments accounted for by these students. As the right-hand labels to the bar chart indicate, responsibility for each student body is widely dispersed among schools, programs, and departments that have no common structure for planning and coordinating. **Slide 12**

Educational Policy and Planning Committee

Principles informing our recommendation

We have approached our review in the belief that undergraduate liberal arts education is a central mission of the Arts and Sciences at Columbia, and that we seek to direct the full potential of the various parts of the Arts and Sciences to this end. We are distinguished from our peer institutions in undergraduate education by several features. First, our largest and most central undergraduate body (the College) remains deeply committed to a program of general education, enshrined in the Core Curriculum, that is unique both in its extent and in its commitment to a central common core (courses that are taken in common by all College students, and many others). Second, we have the largest and most fully integrated undergraduate program for non-

traditional students. Third, we educate our undergraduates in the context of a research university whose excellent graduate programs and New York location make an indispensable contribution to the undergraduate experience.

Columbia College and the School of General Studies are thus embedded in a complex of undergraduate and graduate schools to whose students Arts and Sciences faculty have significant obligations. This complexity makes our task more difficult in some ways, but it also offers opportunities for a rich curriculum that, combined with the cultural and social advantages of New York City, can make the undergraduate experience at Columbia uniquely rewarding. We can offer more than the first-class instruction, intense engagement with professors, and individualized support that all good liberal arts colleges seek to provide. We can also provide teachers whose scholarship is shaping fields of inquiry internationally and nationally; access to a city-wide range of cultural institutions; regular opportunities for participation in vigorous debates that are changing the way we understand the natural, the social, and the creative world; and chances to test oneself, as an undergraduate, against some of the most interesting minds and the most accomplished scholars in the field.

The central task confronting us at Columbia, as at many of our peers, is to balance and combine the general and specialized parts of the undergraduate curriculum so as to awaken students' intellectual curiosity about the world; deepen their moral sensibility; expand their aesthetic understanding and interests; equip them to choose their careers wisely; and help them adjust to a rapidly changing world. At this moment in history, we must be sure that students' education includes sustained study of diverse cultures, awareness of the interactions among communities world-wide, and understanding of the process of scientific inquiry, the empirical status of scientific findings, and the social implications of both.

General education is institutionalized here in a series of Core courses, which provide the intellectual signature of Columbia College as well as an important resource for students in General Studies and in the School of Engineering and Applied Science (SEAS). At its center are four courses (6 semesters) that study "great books," along with art and music "masterpieces," in small seminars, the sometimes-called "classic" Core. Over the years Columbia College has added two semesters of "Major Cultures" (courses focusing on non-western societies, which students choose from a long list of possibilities), a new, experimental course called Frontiers of Science required of everyone, two additional semesters of science, two years of language instruction if the student didn't "pass out" upon entrance to Columbia (which only a minority do), and a writing course.

The character of the "classic" Core is well established, although its specific content is subject to regular review and amendment. There is good reason for this tradition of gradual rather than rapid revision, for there is little disagreement, here or in the nation, that Columbia's general education is exceptionally successful. Our success reflects, in part, a coherent curriculum that systematically investigates western culture and thought. It rests just as importantly, however, on its pedagogical structure – the small seminar in which students confront the primary texts and cultural documents themselves and are compelled to come to their own understanding of them, with the help of their instructors and their classmates. Teachers of these courses not only impart information but also position students to figure things out for themselves, building intellectual

skills while adding to intellectual capital. And, finally, success owes something to the program's interdisciplinarity, an approach that takes learning as a life goal, rather than as pre-professional training. These courses provide students direct access to ideas, debates, artistic expressions, and interpretations that have shaped or powerfully articulated assumptions of western society and culture, without imposing the kind of analysis that would be demanded in a scholarly encounter with the material.

Educational Policy and Planning Committee

Our recommendation for this committee follows from these principles but is also based on the conviction that undergraduate education in Arts and Sciences has to be considered as a whole that includes the Core, the Majors, and electives. Planning for undergraduate education, graduate instruction and faculty development are also interdependent and should properly be considered in relation to one another. Columbia has, however, historically lacked a well-established institutional structure able to perform such a comprehensive role. This has not only inhibited effective cooperation between the Dean of Faculty (Vice President) and the Dean of the College, but has also made it difficult for administrators and faculty alike to see the interrelationship of the various parts. It is often hard for faculty and administrators to understand, for example, exactly how faculty resources are being deployed, precisely where students are spending their classroom time, and even how successful we have been in meeting our goals. The result has sometimes been confusion, replication of effort, and misunderstanding, which has at times produced disengagement or sporadic and sometimes ineffectual local reform.

Our goal, then, is to provide a structure for the coordination of existing bodies that manage curriculum (whether departmental committees, institute or program committees, the COIs of the respective schools, or the committees that design and manage the Core) with those responsible for faculty planning. The committee would thus be positioned to collect the information necessary for making informed recommendations to the Vice President concerning the allocation of faculty lines based on curricular planning for undergraduate education. Among its roles could be: to conduct discussions with departments, schools, and programs about curriculum; to organize the sharing of information and to help coordinate planning across schools, departments, programs, and disciplines; to review and evaluate programs in the context of faculty resources; to share information and articulate norms about best practices; to investigate and make recommendations about issues that cross schools, departments, and disciplines such as classroom facilities, advising, grading policies, registration procedures and scheduling, teaching evaluations, mentoring and assignment of graduate student teachers in departmental classrooms, and the employment of adjunct faculty; and thus to inform and report to the A&S faculty about all matters regarding curricular planning and its implications for faculty deployment.

The committee would be chaired by a senior faculty member appointed by the Vice President, with the advice of the Dean of the College, ECFAS, and the Steering Committee of the Chairs. Additional members would include the Vice President of Arts and Sciences, the Dean of Columbia College as Associate Dean of Undergraduate Education, and the Dean of GSAS. A recommendation has been made that the Dean of General Studies should also sit on the committee since the students in the two schools still do not yet have an entirely coordinated curriculum The remaining members would be chosen from the senior faculty. These would

include the chairs (or designated substitutes) of three major curricular standing committees (the Committee on the Core, the Major Cultures committee, and the Committee on Science Instruction [COSI]). A recommendation has also been made to include the chair of the COI of SEAS to facilitate interdisciplinary programs and courses within the Sciences. Three additional members would be appointed by the Vice President, with the advice of the Dean of Columbia College, from a slate of six faculty members, (two each from humanities, science, and the social sciences) nominated by a combined committee of ECFAS and the Steering Committee of the Chairs, and with attention paid to ensuring wide representation of disciplines and methodologies. It is anticipated that the committee would meet regularly and would have significant and designated administrative support from the Vice President's office. It is anticipated that the chair of the committee might need to be released from a course, it being understood that the task of directing such a committee could only be reasonably assigned to someone with long experience of, and an ongoing commitment to, undergraduate teaching.

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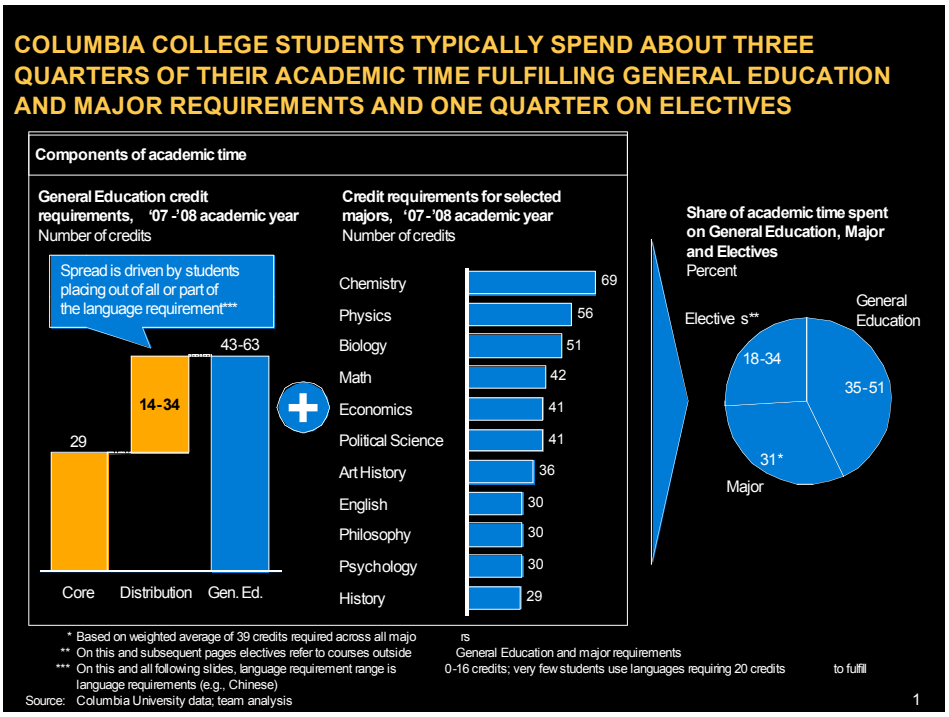

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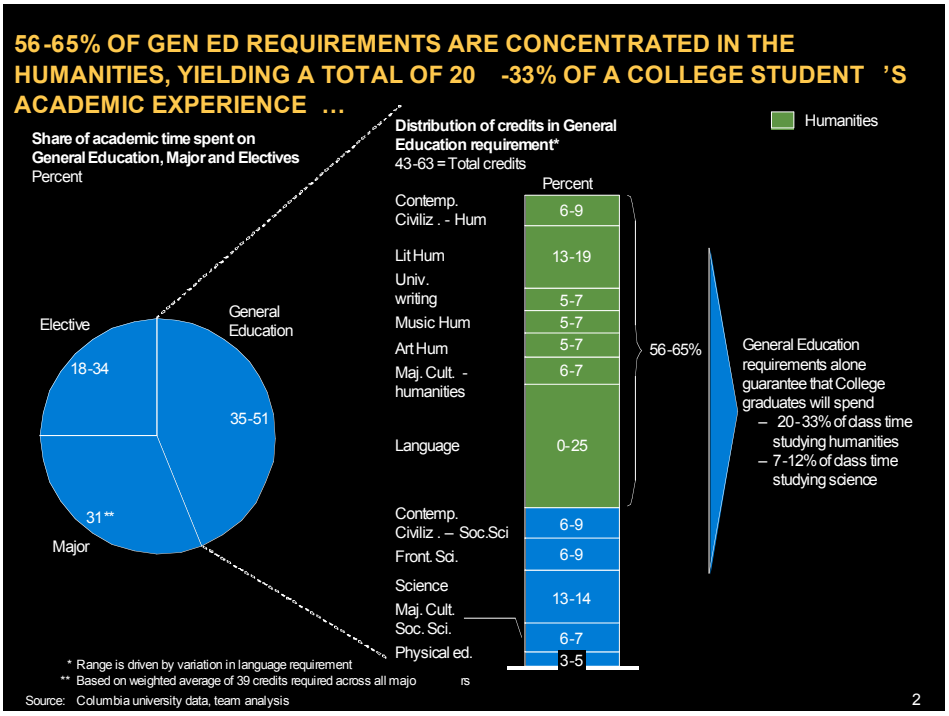

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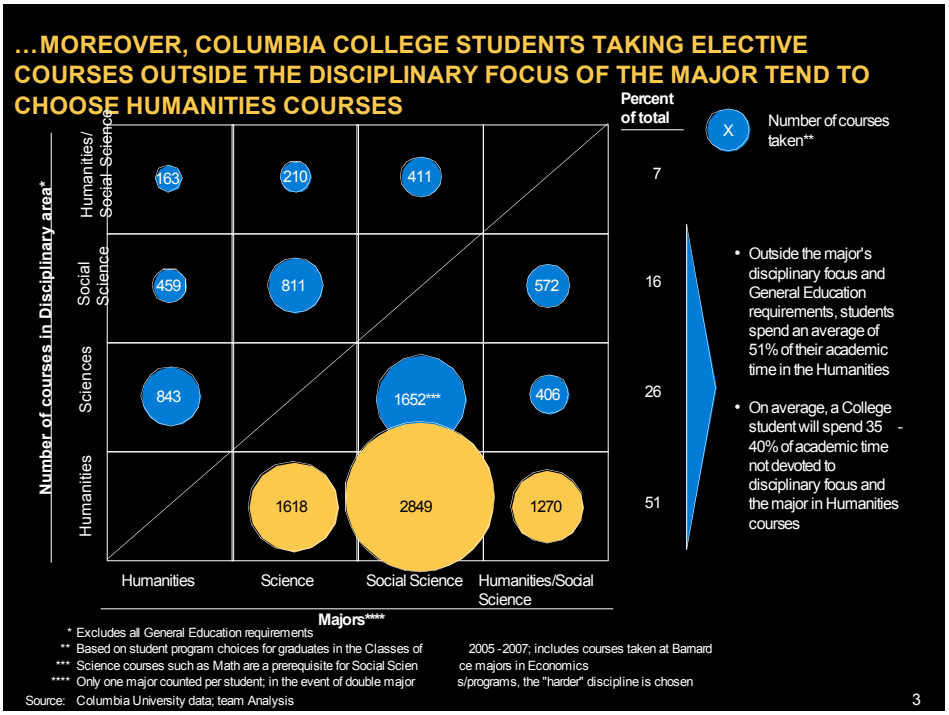

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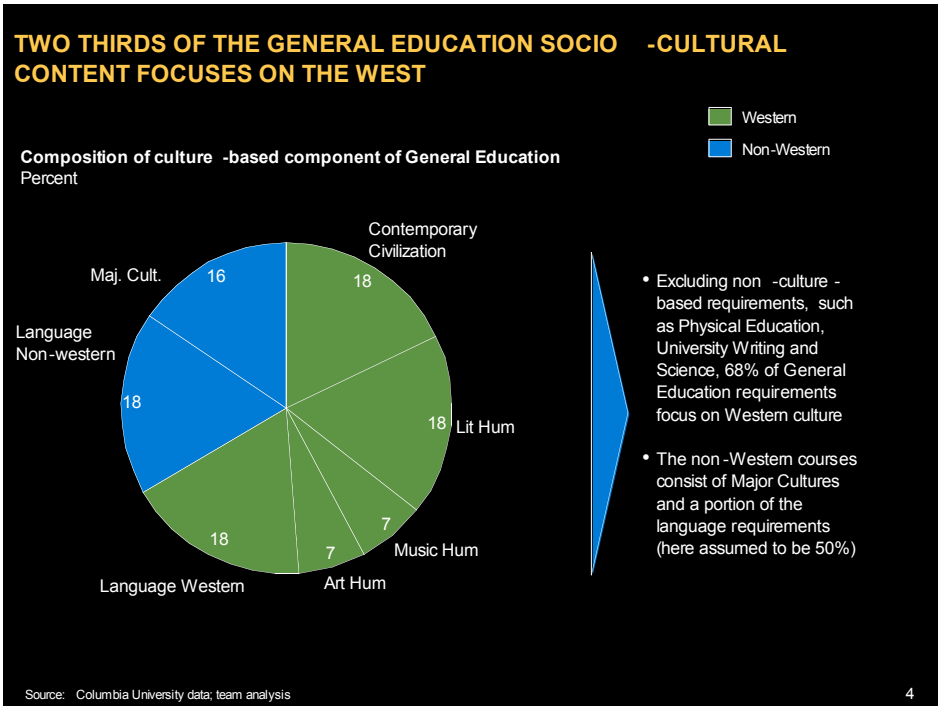

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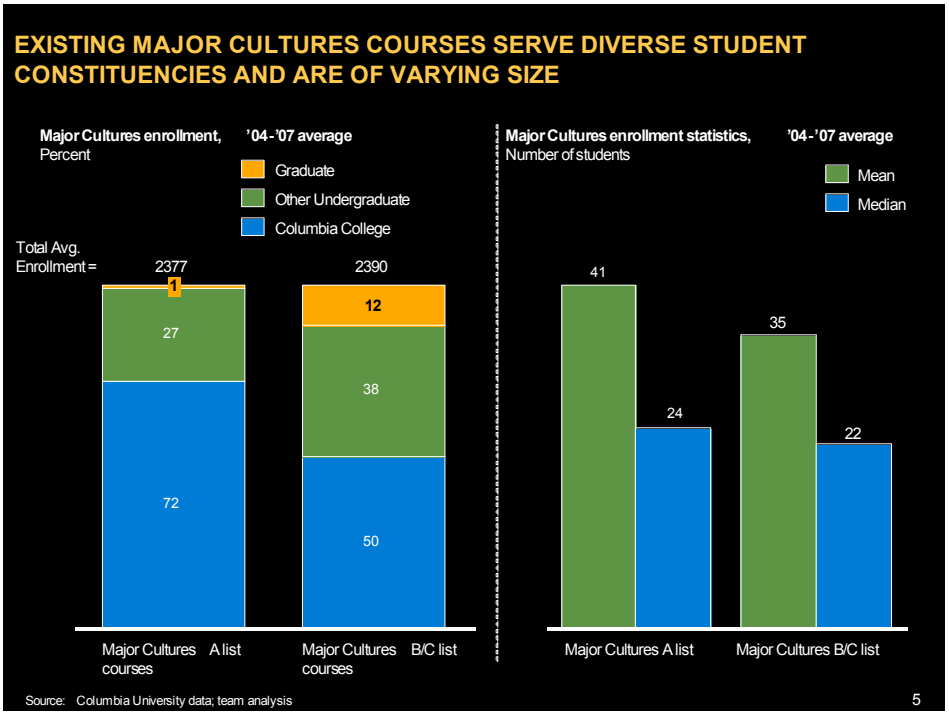

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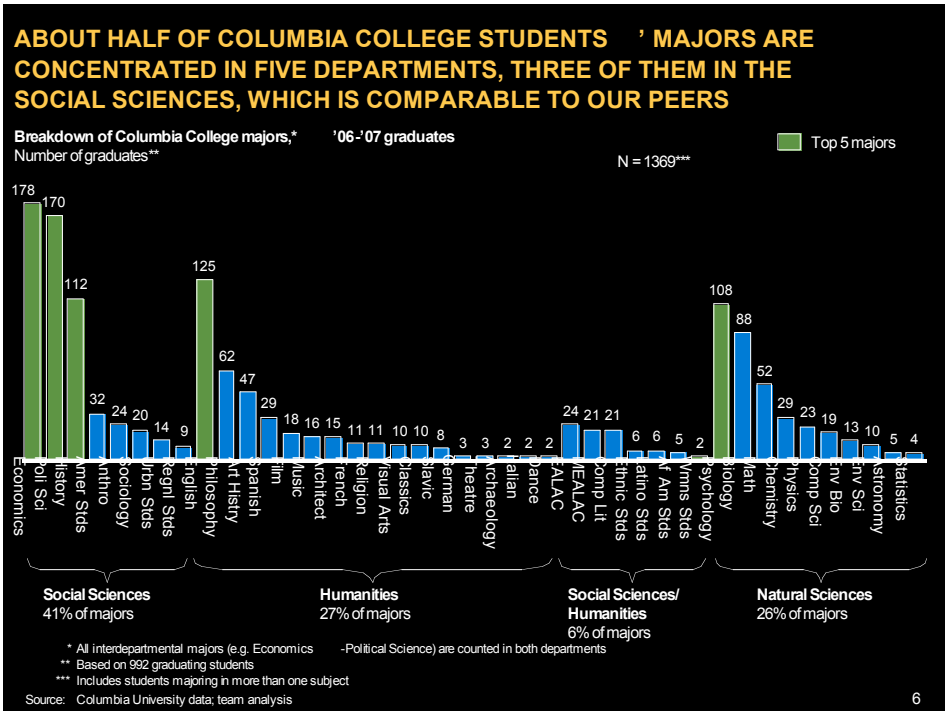

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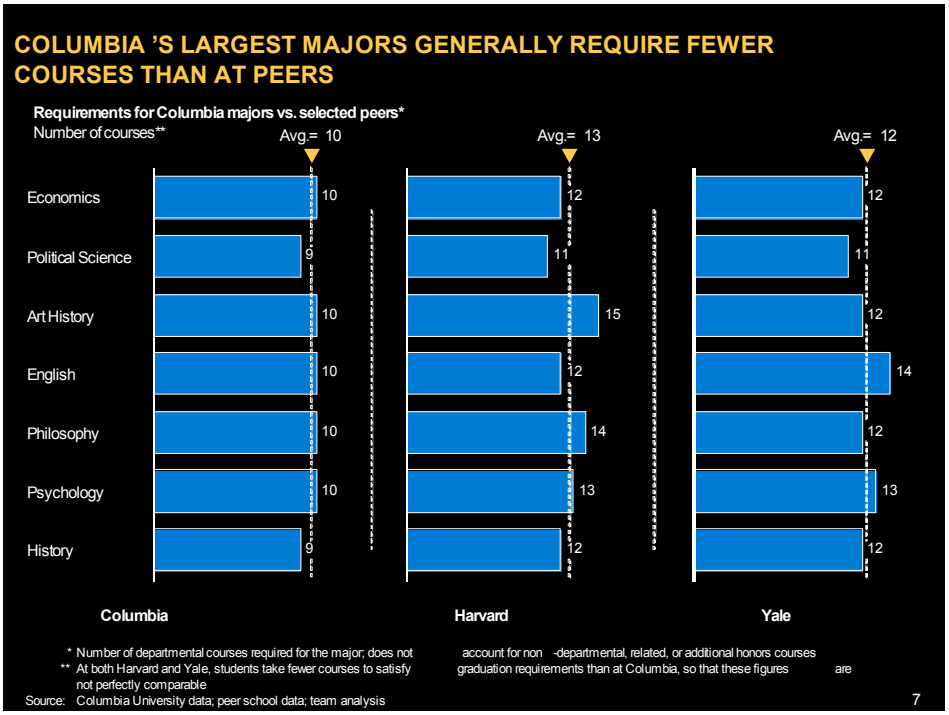

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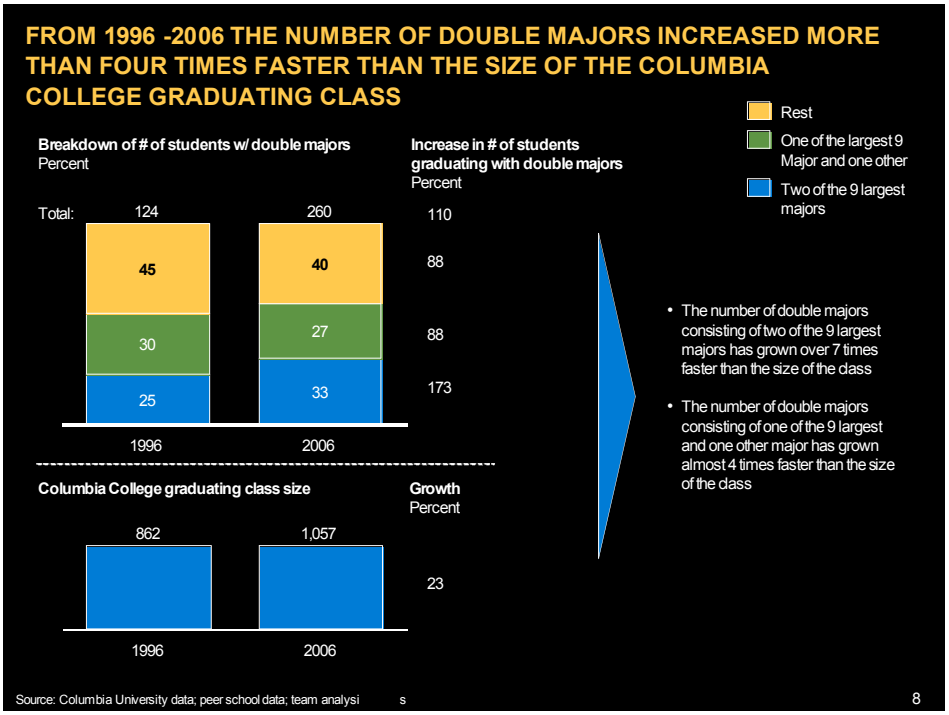

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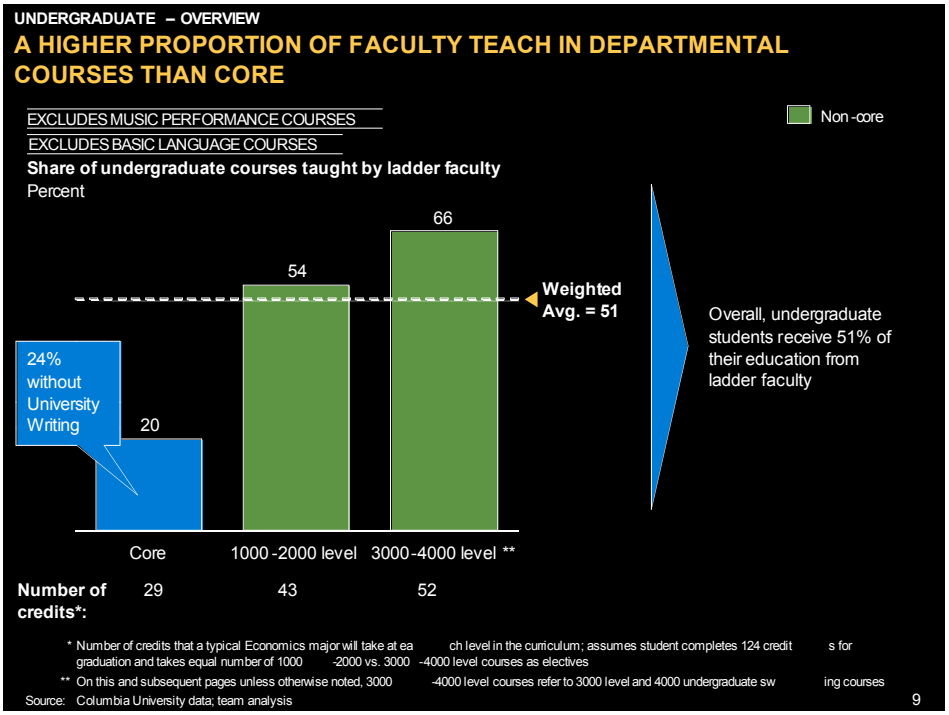

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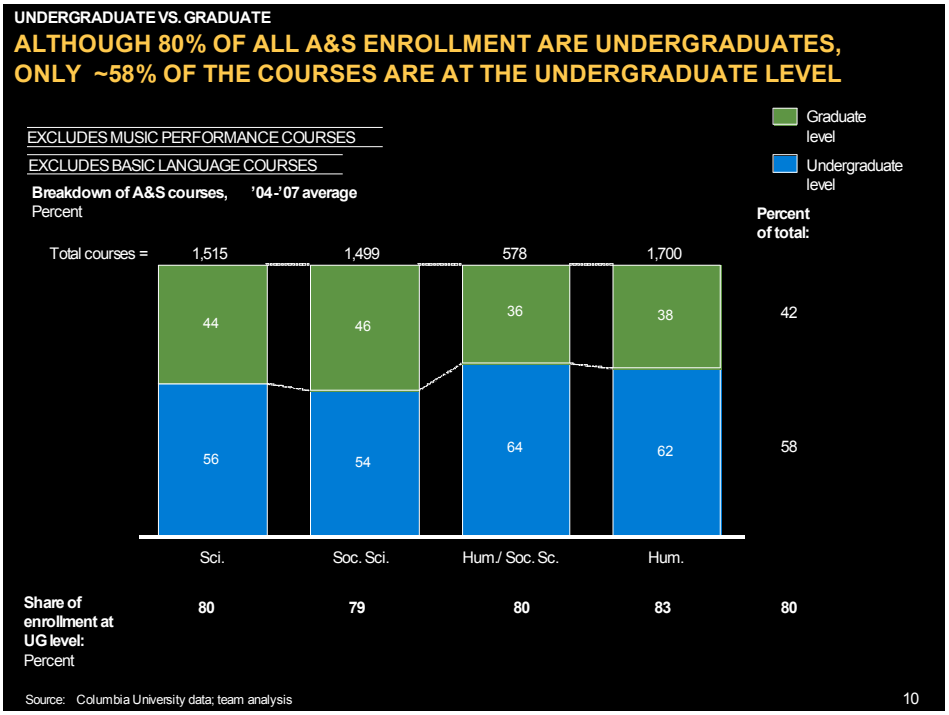

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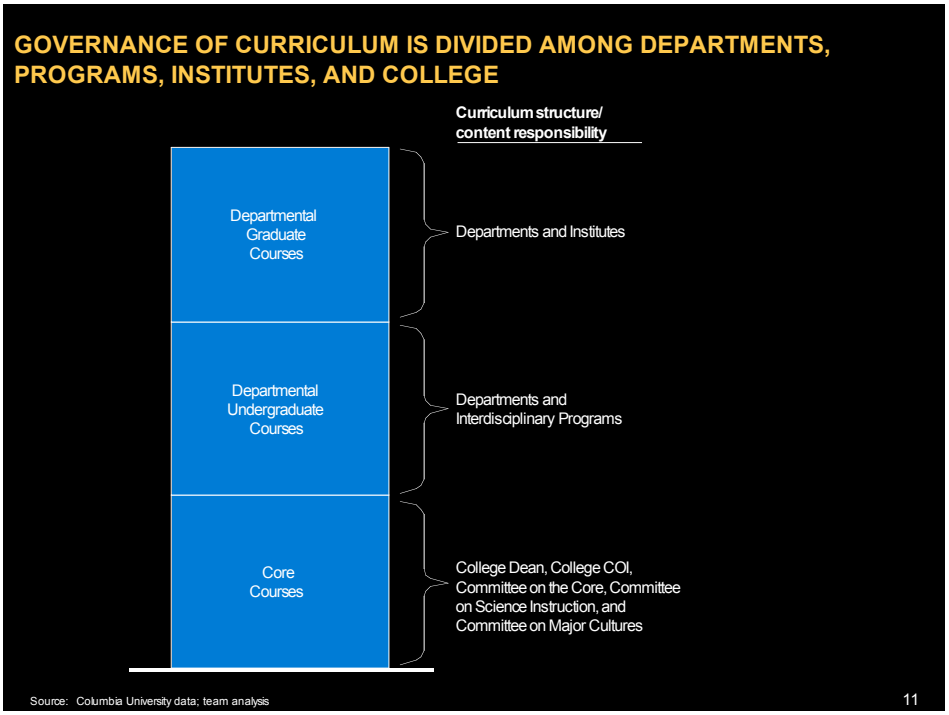

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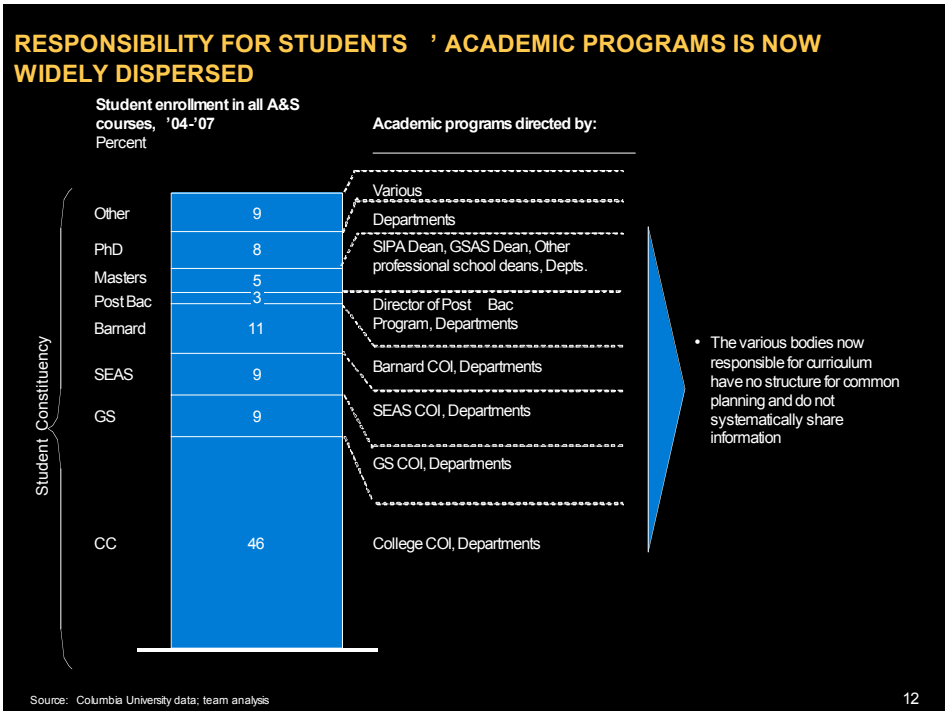


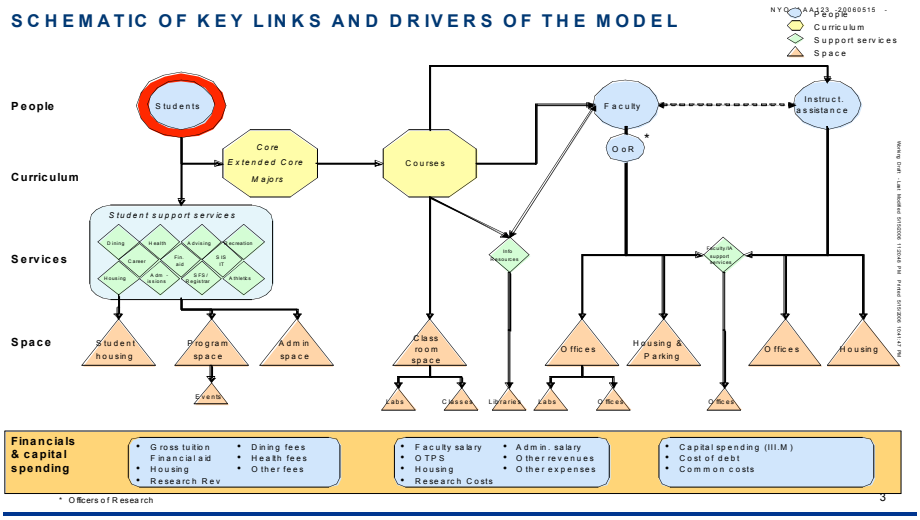
Appendix D-2
Considering College Expansion
Task Force on Undergraduate Education
March 2, 2007

Considering College Expansion

March 2, 2007

Model Structure

SCHEMATIC OF KEY LINKS AND DRIVERS OF THE MODEL



Admissions

• Two scenarios are examined: 15% and 20% growth in the College regular entering class (currently 1,013 per year)

• Growth begins in 2011 on a small scale, with housing in existing buildings through graduate student relocation

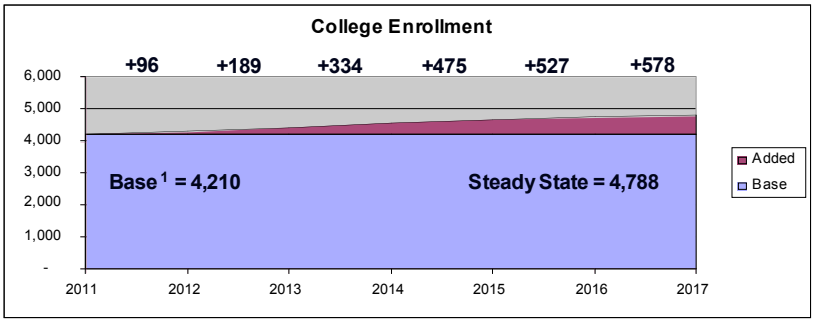
• By fall 2016, total enrollment grows by either 578 or 770

• New students are modeled on existing profile (international %, financial aid need, majors, enrollment attrition and course demand)

• All other undergraduate enrollment levels assumed constant

Enrollment

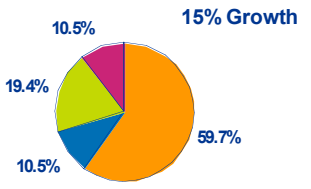
• In the 15% scenario, the regular entering class size is increased by 96 from 1,013 to 1,109 in 2011 and by another 55 to 1,164 in 2013:



[1] Base enrollment includes transfers and visiting students, but t hese numbers are assumed constant.

Undergraduate Enrollment: Instructional FTEs [1]

By fall 2016, College enrollment in Columbia courses would grow from the current 57% to either 60% or 61%



[1] All enrollment figures measured in full -time tuition equivalents and adjusted to reflect CU course loads (32% of Barnard student courses taught at Columbia, 98% for SEAS , 90% for College and 88% for GS)

Financial Aid

- Financial aid policies that will continue to attract and suppor t the very best students from around the world
- College, need -blind, full -need domestic financial aid, including no loans for families with less than $50,000 income
- When student budget grows at 5% per year, per -student aid costs grow at 7 –8% per year
- Aid as a % of tuition increases from 32.2% this year to 34.6% next year and then gradually to 39.5% in 2017, when steady - state enrollment is reached

Instructional Costs: Undergraduate Enrollment

- Existing registration patterns used to project course demand
- Current faculty course loads, distribution of faculty ranks across courses assumed to persist
- Costs include current salary levels, housing costs, research and teaching assistants
- Since the College represents only about 57% of undergraduate enrollment, total growth is muted by constant enrollment assumption in other schools (SEAS, GS and Barnard)

Instructional Costs: Courses and Faculty

- As enrollment grows, some courses will need to be added (core courses); others will have empty seats
- Course growth will be less than undergrad enrollment, but A&S faculty increase will be about the same as enrollment due to relative weighting of faculty towards College students:

	15%	20%
Undergraduate Enrollment in CU courses	8.9%	11.9%
Number of Courses	5.2%	6.9%
Number of A&S Professorial Rank Faculty	7.9%	10.5%

Additional Note on Added Faculty

• Faculty are added based upon their undergraduate teaching course load only

• About 30% of the courses taught by professorial -rank A&S faculty include no undergraduates

• The model includes no valuation of this extra faculty resource, which will increase capacity for other activities

• This capacity could be used to increase teaching resources in other programs (Masters, Post -Baccalaureate, etc)

Recruiting Staff

• International admissions staffing is increased to support overall enrollment growth and to prepare for recruitment in new regions of the world. Building new pipelines in these countries is a five-year process, to be started in July 2008:

• Professional international recruiting staff grows from 1.4 to 6.0 FTEs, support staff, travel, mailing and publications budgets increased

• Total cost of about $900 thousand per year

Student Services

• In the first year of expansion (fall 2011), budgets for all student services are increased to support higher enrollment (admissions/financial aid, residential programs, career education, student development, etc.)

• For instance, in the 20% growth scenario staffing is increased by 16; operating budget by $3 million

• Timing is in advance of enrollment, in three equal parts 2011 – 2013 (enrollment increases by 17% in 2011, 33% in 2012 and 58% in 2013)

Construction and Renovation Costs

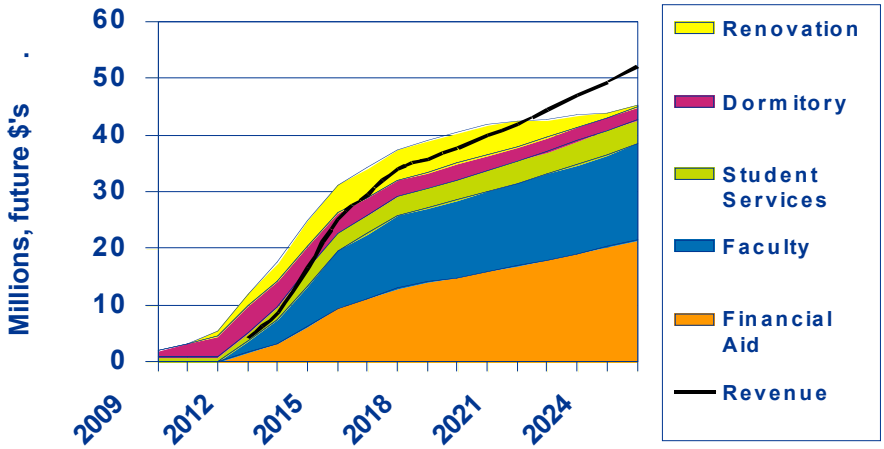
• Dormitories and dining facilities: $126 –168 million, depending on growth scenario, with a $60 million gift assumed, remainder financed with 25 -year debt

• Renovation of classrooms, faculty offices and laboratories in existing and planned buildings ($12 –18 million), financed with 10-year debt

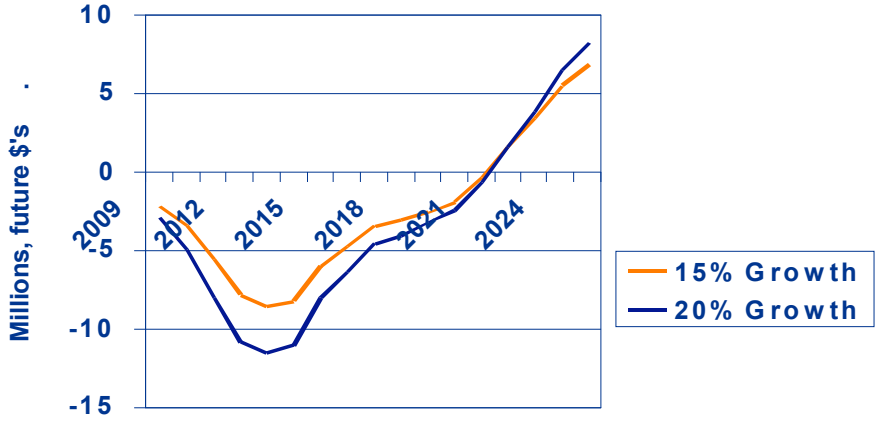
• Student service relocations and renovations required to support expansion of office including admissions, financial aid and career education ($30 million), financed with 10 -year debt

Projected Financial Results

Cost Structure for 15% Growth Scenario



Annual Net Surplus/(Deficit)



Financial Statistics (Millions)

	Growth Scenario	
	15%	20%
First year of enrollment growth	2011	2011
Steady state enrollment	2016	2016
First net positive financial result	2022	2022
Cumulative net investment before 2022		
Future dollars	$ (57.3)	$ (78.2)
Current dollars (5% annual discount)	(41.2)	(56.3)
Average per year (current $'s)	(3.2)	(4.3)
Maximum in a single year (current $'s)	(6.4)	(8.6)
2025 Result		
Future dollars	6.9	8.3
Current dollars (5% annual discount)	2.9	3.4

Appendix D-3

Report of the Working Group on Science Education

Task Force on Undergraduate Education

April 12, 2008

Purpose:

Describes the state of undergraduate science education at Columbia University with a focus the connection to the research mission of the university. Examines recent innovations in programs and trends in students. Makes recommendations for policies, efforts, and resource allocations going forward.

Committee Membership:

Geraldine Downey, Vice Provost for Diversity Initiatives, Professor (formerly Chair) of Psychology

Stuart Firestein, Professor of Biological Sciences

Mort Friedman, Vice Dean of SEAS, Professor of Civil Engineering and Engineering Mechanics

Robert Friedman, Professor of Mathematics

Charles Hailey, Pupin Professor of Physics

Andy Millis, Professor and Chair of Physics

Shahid Naeem, Professor and Chair, Department of Ecology, Evolution and Environmental Biology

Gerry Navratil, Dean of SEAS

Duong Phong, Professor of Mathematics

Kathryn Yatrakis, Dean of Academic Affairs, Columbia College, and Professor of Political Science

Chair: Ann McDermott, Esther Breslow Professor of Chemistry and AVP for Academic Planning and Science Initiatives in the A&S

Staff: Lucy Drotning, Associate Provost

Introduction/Summary

In the pipeline of science talent and workforce, the elite research universities in the U.S. serve a unique role. Beyond the facts that this handful of institutions carry out key research, and that their Ph. D. graduates have typically gone on to become the leadership in industry academic and government research laboratories, these institutions are also very important in terms of their undergraduate education mission. A college emphasizing an all-around education sitting inside a major research center can provide a powerful educational opportunity for tomorrow's scientists, and non-scientists alike. Are we capturing this unique opportunity? This report attempts to analyze our success on this front and to make recommendations for the near term future. It is an opportune time to do so, because of the establishment of the CU President's Task Force on Undergraduate Education, which has been asked to review the overall situation with respect to undergraduate education and Columbia University and make reports to the Trustees of the University. It is an important time to do so also in terms of the national situation, in that as time passes it is increasingly important for educated and powerful leaders to have a good understanding of basic science and technology. As well, the US is arguably losing its edge in science and engineering relative to other nations ("Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future" NAS Press, 2007).

In the context of this challenge to foster the pipeline of science talent throughout the nation, Columbia University has a particular opportunity and a particular set of challenges. In terms of an opportunity, the attraction of the city of New York and its intellectual environment of the arts, and the environment of Columbia University, with a delightfully focused undergraduate program in the midst of a premiere research institution with a renowned faculty, can in principle be as meaningful to science students as to history or economics students. The science departments, moreover, are all very strong, with many in or near "top-10" rank. In terms of the difficulties of achieving this potential, we battle the fact that our name brand recognition for undergraduate education is really humanities. We are continually frustrated by the relatively small size of our endowment compared to our aspirational peers, whose endowments and commitments to science grow at a dizzying pace over the past decade. We are especially disadvantaged by the fact that maintenance in our buildings is so badly deferred that experimental forefront research is not practically possible for many of our disciplines, and never an outside review of our science goes by without a scalding mention of this challenge, and indeed the Review of the Sciences conducted in 2001-2002 makes a strong point about this particular challenge.

We identify and make recommendations relative to improving the undergraduate pipeline of students in science in terms of quality and quantity of students we attract and especially with respect to the instructional program. We recommend that a strong emphasis is placed on continuing to striving to offer research opportunities in first class laboratories to undergraduates, both on the Morningside campus, through renewed emphasis on renovations of the spaces and renewal and selective enlargement of the faculty, and in Manhattanville, where a good plan for integrating the A&S and the undergraduate mission into the new campus has yet to be articulated. We also recommend that a strong emphasis be placed on carrying out active recruiting and advising of our potential science majors. We make suggestions regarding ongoing

curriculum and program review, with student and faculty input, including discussion of advising, class sizes, support for instructors, and modernization of course offerings.

Findings

With roughly 300 undergraduate degrees conferred in science out of ~1675 total degrees (of which ~75 are psychology, sometimes categorized as a social science, and of which ~230 are from CC), the number of majors in the natural sciences is somewhat low as compared with peers (see appendix items 1-3). More specifically, in Mathematics the numbers are on the high side of the middle range, and in Biological Sciences the numbers are dramatically low, apparently the lowest in the peer group studied. These observations were based upon data downloaded from IPEDS with particular emphasis on CU, Stanford, Yale, Princeton and Harvard, although a number of other schools were also investigated. The size of the faculty (AAUDE data exchange) and the amount of research space in biology (NSF survey) is also remarkably low for Biological Sciences as compared to our peers.

Our classes overall have percentages of underrepresented minorities that are on a par with may of the peer institutions, but well below for example Stanford's population. The physical sciences and engineering are below the rest of the undergraduate population in this regard. African-American students represent 130 (8%) and 99 (6%) Hispanic students of the 1675 total degrees conferred per year; but in the physical sciences and mathematics only 4 African-American (4%) and 4 Hispanic (4%) out of 103; in engineering and computer science 10 African American (2.7%) and 16 (4%) Hispanic out of 362; in biological sciences and psychology 7 African-American (5%) and 17 Hispanic (11%) out of 152.

Attrition in the potential science major pipeline was examined by Columbia College staff (see appendix items 4 and 5). There is no attrition of note (<15%) from declaration of major at the end of the second year to completion of the major at the end of the fourth year, in any of the sciences. The situation with respect to the time between statement of interest at time of application and declaration of major at the end of the second year is slightly more complex. Of the 125(135) matriculated students who indicated interest in biological sciences as their first choice on their admissions form, only 37 (31) declared and 31 (32) graduated. In the other disciplines examined the attrition defined in this way is apparently fairly unremarkable (<40%, data not shown). In other words, roughly 100 students out of each class of 1000 indicate interest in biology but do not follow through with a program in this area. Not to oversimplify, it is worthwhile noting that some students also switch into biological sciences during their first years (i.e. do not state an interest and ultimately major in biology). Moreover a loss of students in biology in the first two years has been noted at Yale and at Harvard as well, and in part it is assumed that it relates to the fact that the students do not at the time of application have much of a basis for selection. Nevertheless, this is a singular pattern (unseen in the other disciplines and in the other science topics specifically) and deserves more study.

The challenge of low numbers of science majors clearly can be combated at the stage of the entering class, a proof of principle for which is the Rabi scholars program. In the physical and mathematical science there have been remarkable faculty efforts to enhance the pool of potential majors for the past 16 years, through the Rabi scholars program. Talented potential science

majors are selected by a faculty group; from a large (~400+) pool of students stating interest in a science, and with nearly perfect SAT scores and strong letters, approximately 100 are selected primarily on the basis of clear interest in science and some research experience as seen from their essay and letters of recommendation. They are courted by phone calls etc. and ultimately 10 Rabi scholars matriculate, all of whom are funded for research every year to a total cost of $8k per head. In addition, 30 "Special Research" Students (non-funded) matriculate. Curiously, the Rabi program is not openly advertised, and no visible recruiting for this program to actively enhance the pool has been carried out. A strong preponderance of the Rabi and SR students are Mathematics majors (see appendix item 6) and overall more than 85% remain in science or mathematics to graduation. Both Rabi and SR students typically have both more points and better grade point averages than the rest of the science majors. Approximately half of our recent valedictorians are Rabi scholars.

Opportunities for supervised research are likely to be a very important component of our science program, but are in short supply. The SURF (summer undergraduate research fellows program) hosted by the Biology department is heavily oversubscribed every year (~170 applicants for ~65 slots), despite the fact that the students are not provided housing and must identify faculty financial sponsorship for a nominal stipend. Anecdotally, there appears to be a big gap relative to opportunities afforded by our peer institutions. Put together with the overall poor quantity and quality of research space on campus, this presents a deterrent for the undergraduate student who wants to take advantage of the key advantage of science education in a research university.

We discussed the question of whether the course requirements for many of the science programs are too onerous. The degree requirements for many programs (chemistry, biochemistry EEEB or biology), when combined with the heavy and specific requirements of the core curriculum, make up nearly the total points required for graduation, unless significant numbers of the courses can be omitted due to advanced standing. The requirements for our science majors were compared with those from peer institutions. With the exception of Harvard's new science curriculum, the numbers and details of the course requirements were broadly similar to other peer institutions. Although the numbers of courses might be on par with other institutions, nevertheless there might be merit in conducting discussions at the departmental level regarding whether the science majors could be made more flexible, particularly for those students who do not aspire to graduate studies in discipline.

Data on classroom composition for popular or required first and second classes suggests that science classes may have dramatic differences in comparison with the humanities courses taken in their first two years, that might be important in the student experience. This is particularly so for the "prerequisite" science classes taken by engineering students, premedical students (both CC and Postbac Premedical students of GS) and potential science majors, namely first year physics, calculus, general chemistry and organic chemistry. The 1000-2000 level science courses are typically taught in much larger groups (60-200 students as compared with 20-22 for the core curriculum). The 1000-2000 level science courses are generally graded on a somewhat more harshly as compared with the humanities courses (-see Report of the Working Group on Teaching). The 1000-2000 level science courses are most often taught by ladder faculty while the core curriculum courses are taught by non-ladder. A written survey regarding some of these

issues is underway, and student focus groups that could probe these issues are planned for later this spring.

General science requirements for CC are more flexible as compared with peer institutions; in particular there is no quantitative reasoning requirement for CC students, but rather three science one-term classes. A new core course, "Frontiers of Science", is now in its 3rd year as a fixed one-term first-year component of the core. For non science students, it counts towards one of the three required science classes. For science majors, it is effectively incremental. Some science majors petition to take it later in their program (or not at all) because their first terms tend to be very heavy with science prerequisites. Ultimately, "Frontiers of Science" could be a very important course for the non-science majors because it has a significant component of quantitative reasoning in its syllabus, and exposes students to forefront research in a multidisciplinary and somewhat hands-on fashion. In tackling these issues it is an ambitious course and unlike anything carried out by our peers. The course has encountered challenges, and is currently under review, at this stage by the Committee on Science Instruction (COSI).

Our remarks regarding the need to improve offerings and review the requirements for non-science majors, and the discussion of somewhat low numbers of science majors, are reminiscent of prior CC reports on science education, and indeed of reports from our peer institutions. *(this section to be enlarged with quotations)* On the other hand, it is important to recognize the remarkable faculty led efforts, described above, that have been carried out over the past decade (Rabi scholars, Frontiers of science), which provide a proof of principle of what could be with more firm and broader support for these initiatives.

Recommendations

1) It is of utmost importance to enlarge the Rabi Scholars program in terms of the numbers of slots available each year, to stabilize a secure funding base for the program, and redouble the effort to identify students with specific interest in experimental science. Endowing this program has been a major fundraising goal over the recent past.
2) The Rabi program at present is focused on admissions selection. The college should engage faculty and students in active recruitment for Rabi and Special Research students, by sending science faculty as well as our best postdocs and students to high schools, to college fairs, and on campus tours to meet with the potential undergraduates. We should also invite the faculty to work with our recruiting officers, and prepare brochures for the recruiting officers, to help to make them more accurately aware of the undergraduate programs in the science departments and the opportunities for research. We should carry out web-based advertising of the Rabi program connected to the application information. The college has embarked over the last year on attempting to tackle some of these issues through cooperation with the departments.
3) The remarkable observation that fully 10% of each class has a pattern of indicating interest in biology but not following through with a program in this area, and that our final program is the smallest among peers, deserves further investigation. An ongoing study of this group of students includes examination of their academic records; we urge that written surveys, and student focus groups be carried out, and the results of these studied be discussed with the DUS from Chemistry and Biology and with the members of

COSI. We conclude though that we should make an effort to search for the best biology undergraduate students during admissions process, and that a closer collaboration between the regular admissions officers, and the Rabi selection group is needed, specifically, that the selection that goes through the regular admissions process involving students with an interest in Biology should involve some consultation with the Rabi selection faculty group. It is noteworthy that some conversations between this committee and the college and the department have begun already this year.

4) We recommend a stronger effort to include a racially diverse group in the science undergraduate population at Columbia University.
5) Participation in original research is a key component to undergraduate science education and a particular attraction to the university for a college student. To increase undergraduate research opportunities both summer and upper division students during school year, we need more support for summer science research programs such as the SURF program. Providing housing for the students is very important, as is making the stipend consistent with financial aid requirements.
6) We should seek ways to involve science faculty and upper division science majors in first year advising for the students who indicated interest in science, including opportunities for faculty to provide training for the class advisors. The college might provide lists of first year students who indicated interest in science on their application forms to the corresponding departments, so that the departments can send invitations to their open house programs to mix with current science majors. In the years since this committee has begun meeting, the college has begun discussion with the departments on this topic.
7) To support undergraduate research, and our research mission generally, we need to invest heavily in renovations for the science research space on the Morningside campus.
8) The current plans for space expansion in Manhattanville have had little involvement with A&S. With respect to the science buildings, more attention must be paid to the undergraduate perspective in the planning of new space, specifically the need for classrooms, instructional laboratories, and meeting spaces for the students.
9) We suggest establishing a faculty group to consider potential 1000 and 2000 level science curriculum innovations, including Frontiers of Science, the typical science prerequisite classes (principally Calculus, General Chemistry, and Introductory Physics), and the typical courses used to fulfill the science requirement by non-science majors (Introductory Psychology, Introductory Astronomy, etc.). There are many thoughtful national reports on this topic and many useful models for change already well established in both university and college settings. The group should consider the issue of class size, and of the need for modern and electronic classrooms, the use of information technology to support teaching (course management, course evaluations, on-line key data on the students, clearer on-line information about the curriculum, tools for coordinating amongst the set of faculty concurrently teaching the same group of students, etc.). In addition orientations for new instructors are needed (covering for example academic advising, our curriculum, and the roles of the various deans), as well as ongoing opportunities to improve teaching skills. We need to provide better support for faculty who take on special teaching initiatives and curricular innovations. A review of 1000 level science classes obviously should interact strongly with the ongoing business of the departments, and with the ongoing business of COSI, so consideration should be given to representation of or communication with between the DUS , the faculty who teach these

classes, the chairs of the science departments and COSI. It is very important that client groups (GS , SEAS) and students also have appropriate representation in this committee. Inevitably any improvements will involve resource needs, and thus this committee should have communication as well with representatives of the administration who might be able to commit resources to improving undergraduate education. The committee should be supported in terms of institutional data during its deliberations. Logically, this review could be taken on by a subcommittee of the newly proposed EPPC.

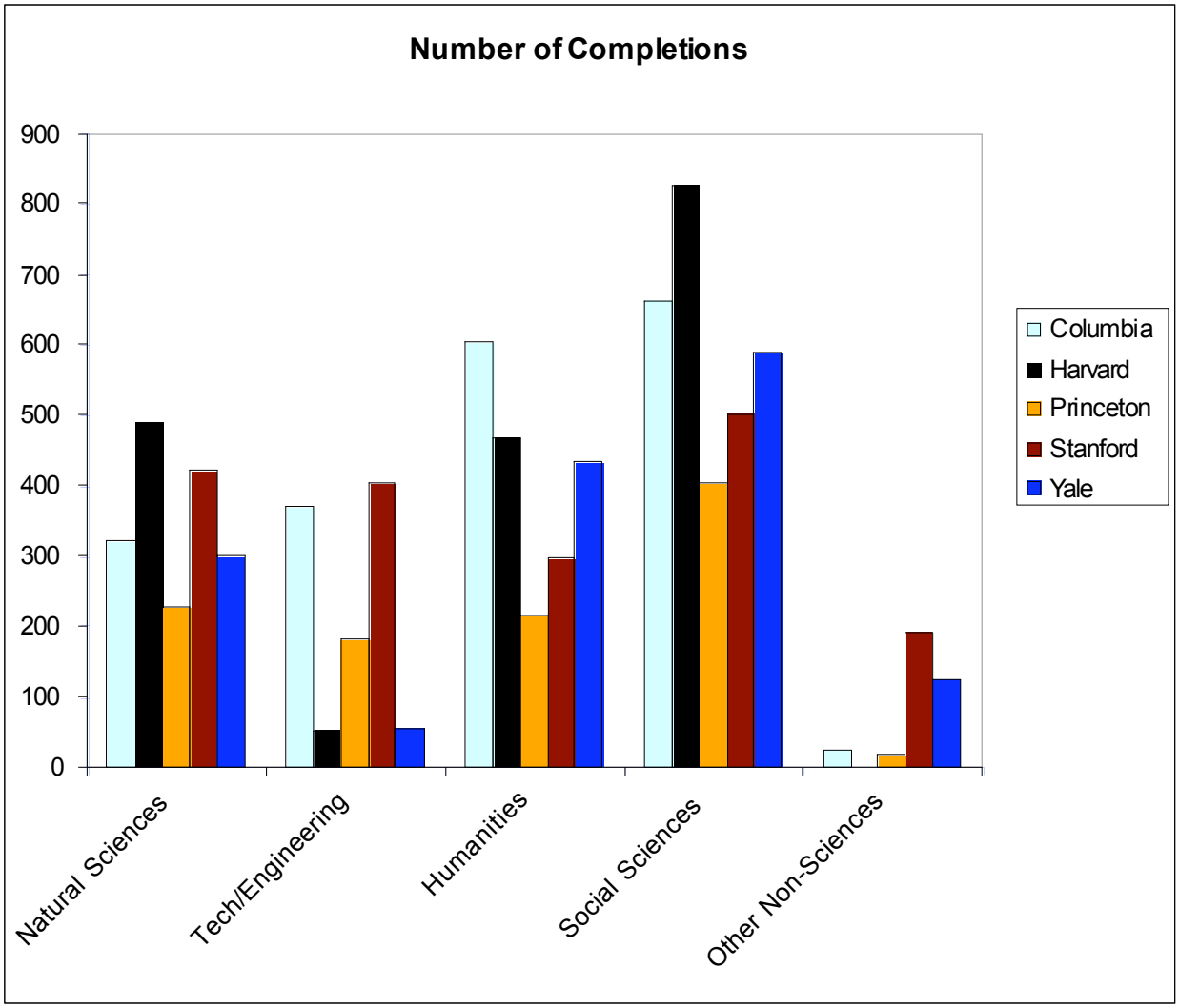
10) We recommend that a faculty group be convened to consider ways to modernize our majors, including considering the resources needed to make curricular modernization. A particular emphasis should be put on science programs that have very heavy course requirements and heavy prerequisites to examine whether the programs could be made easier to enter and / or easier to complete. This task interacts strongly with the ongoing business of the departments, and with the ongoing business of COSI, so consideration should be given to representation of or communication with between the DUS, the faculty who teach the corresponding classes, the chairs of the science departments and COSI. Logically, this also could be carried out by the newly proposed EPPC or a subcommittee, or by the department during their regular ARC review, with oversight by EPPC.
11) We recommend that student focus groups and surveys on science education be periodically conducted to probe the issues outlined above (perceived quality of the 1000 level science classes, workload and overall quality in the science majors, and other factors contributing to choice of major), and that the data be shared with departments.

Degrees Conferred - 2006

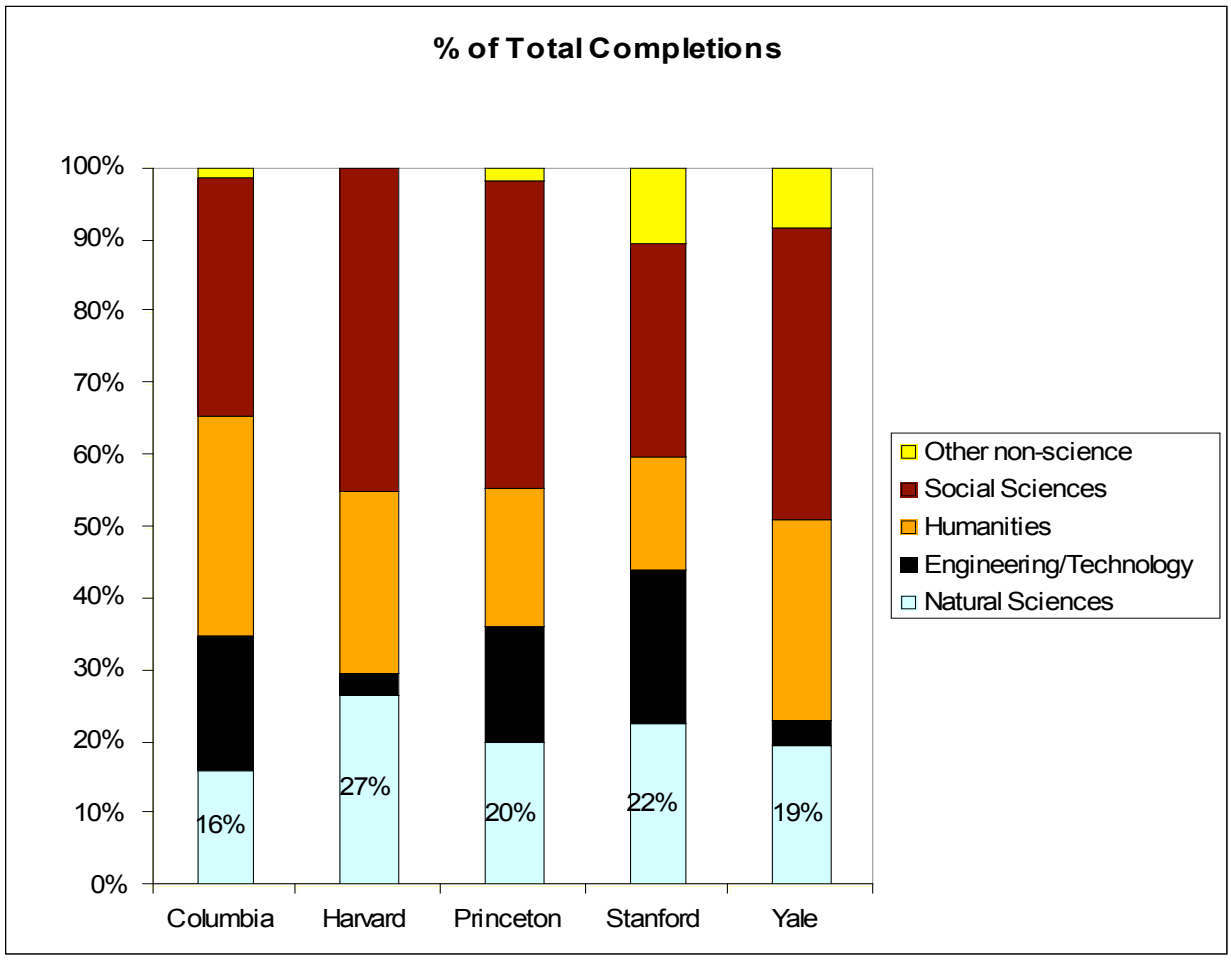
Year (ending June)	(Multiple Items)

Sum of TOTAL (M&F)	Institution Name											
CIP Family Name	Chicago	Columbia	Cornell	Duke	Harvard	M.I.T.	Northwestern	Princeton	Stanford	U.Penn	Yale	Grand Total
AGRICULTURE, AGRICULTURE OPERATIONS, AND RELATED SCIENCES.	0.00%	0.00%	11.54%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.81%
ARCHITECTURE AND RELATED SERVICES.	0.00%	0.56%	3.82%	0.00%	0.00%	1.68%	0.00%	1.33%	0.00%	0.44%	1.63%	0.98%
AREA, ETHNIC, CULTURAL, AND GENDER STUDIES.	1.31%	4.14%	1.56%	2.58%	1.96%	0.00%	1.36%	2.04%	2.83%	1.32%	6.51%	2.21%
BIOLOGICAL AND BIOMEDICAL SCIENCES.	10.45%	4.85%	11.18%	7.19%	8.37%	9.83%	4.27%	8.80%	8.32%	4.33%	7.75%	7.42%
BUSINESS, MANAGEMENT, MARKETING, AND RELATED SUPPORT SERVICES.	0.00%	0.00%	12.71%	0.00%	0.00%	7.09%	0.88%	0.00%	0.00%	24.75%	0.00%	6.47%
COMMUNICATION, JOURNALISM, AND RELATED PROGRAMS.	0.00%	0.00%	2.24%	0.00%	0.00%	1.15%	14.62%	0.00%	1.55%	3.89%	0.00%	2.93%
COMPUTER AND INFORMATION SCIENCES AND SUPPORT SERVICES.	1.08%	2.68%	2.32%	2.58%	1.47%	15.15%	1.14%	0.00%	4.37%	0.44%	0.78%	2.38%
EDUCATION.	0.00%	0.30%	0.06%	0.00%	0.00%	0.00%	0.44%	0.00%	0.00%	0.16%	0.00%	0.12%
ENGINEERING.	0.00%	16.05%	17.77%	14.92%	1.36%	36.05%	11.12%	16.18%	16.04%	6.72%	2.74%	12.09%
ENGLISH LANGUAGE AND LITERATURE/LETTERS.	6.07%	7.93%	2.41%	5.92%	6.04%	0.71%	3.46%	5.33%	4.90%	3.02%	8.60%	4.60%
FAMILY AND CONSUMER SCIENCES/HUMAN SCIENCES.	0.00%	0.00%	4.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.63%
FOREIGN LANGUAGES, LITERATURES, AND LINGUISTICS.	6.84%	6.66%	1.78%	3.89%	4.35%	0.35%	2.84%	4.53%	2.93%	4.69%	2.67%	3.71%
HEALTH PROFESSIONS AND RELATED CLINICAL SCIENCES.	0.00%	0.35%	0.00%	2.80%	0.00%	0.00%	0.85%	0.00%	0.00%	5.35%	0.00%	1.23%
History, General.	5.99%	9.54%	2.43%	0.00%	10.39%	0.18%	6.04%	10.40%	3.20%	6.58%	12.90%	5.89%
Institutional Food Workers.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
LEGAL PROFESSIONS AND STUDIES.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.14%	0.00%	0.00%	0.52%	0.00%	0.22%
LIBERAL ARTS AND SCIENCES, GENERAL STUDIES AND HUMANITIES.	2.92%	0.66%	1.13%	0.00%	6.74%	1.15%	0.04%	0.00%	0.43%	0.93%	0.98%	1.27%
MATHEMATICS AND STATISTICS.	6.45%	3.94%	1.13%	2.14%	3.70%	6.11%	2.17%	1.42%	3.20%	1.29%	1.30%	2.58%
MULTI/INTERDISCIPLINARY STUDIES.	0.38%	0.00%	1.61%	0.60%	0.11%	4.61%	0.85%	0.18%	12.74%	4.19%	9.77%	3.08%
NATURAL RESOURCES AND CONSERVATION.	0.92%	0.00%	1.36%	0.77%	0.71%	0.00%	0.66%	0.00%	0.00%	0.74%	0.72%	0.64%
PHILOSOPHY AND RELIGIOUS STUDIES.	3.61%	3.63%	0.88%	2.85%	2.34%	0.09%	1.44%	4.62%	2.40%	3.54%	2.93%	2.47%
PHYSICAL SCIENCES.	6.53%	3.13%	2.52%	3.89%	7.12%	11.07%	1.29%	5.07%	4.37%	1.01%	2.87%	3.63%
PSYCHOLOGY.	5.15%	4.29%	1.87%	9.71%	6.80%	0.00%	8.51%	4.80%	5.17%	3.81%	5.86%	5.02%
PUBLIC ADMINISTRATION AND SOCIAL SERVICE PROFESSIONS.	2.38%	0.00%	2.49%	8.45%	0.00%	0.00%	1.44%	7.29%	1.60%	0.55%	0.00%	1.97%
SOCIAL SCIENCES.	36.64%	23.83%	10.38%	29.13%	34.53%	4.25%	26.99%	25.51%	23.61%	18.48%	25.60%	22.48%
THEOLOGY AND RELIGIOUS VOCATIONS.	0.54%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%
VISUAL AND PERFORMING ARTS.	2.76%	7.47%	2.80%	2.58%	4.02%	0.53%	8.47%	2.49%	2.35%	3.26%	6.38%	4.13%
Grand Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

	Natural Sciences	Tech/Engineering	Humanities	Social Sciences	Other Non-Sciences	TOTAL
	Count	Count	Count	Count	Count	
Columbia	321	371	604	661	24	1,981
M.I.T.	344	591	32	50	99	1,116
Chicago	384	14	318	554	1	1,271
Cornell	1046	712	381	445	783	3,367
Duke	432	319	327	531	60	1,669
Harvard	491	52	470	826		1,839
Northwestern	493	341	478	895	320	2,527
Princeton	226	182	214	404	17	1,043
Stanford	422	403	298	502	192	1,817
U.Penn	600	261	611	914	1067	3,453
Yale	299	54	433	589	124	1,499



Undergraduate Completions in 2006						
	Natural Sciences	Tech/Engineering	Humanities	Social Sciences	Other Non-Sciences	TOTAL
	% of total	% of total	% of total	% of total	% of total	
Columbia	16.20%	18.73%	30.49%	33.37%	1.21%	100.00%
M.I.T.	30.47%	52.35%	2.83%	5.58%	8.77%	100.00%
Chicago	29.49%	1.08%	24.42%	44.93%	0.08%	100.00%
Cornell	29.60%	20.15%	10.78%	17.32%	22.16%	100.00%
Duke	23.70%	17.50%	17.94%	37.58%	3.29%	100.00%
Harvard	26.70%	2.83%	25.56%	44.92%	0.00%	100.00%
Northwestern	18.15%	12.56%	17.60%	39.91%	11.78%	100.00%
Princeton	20.09%	16.18%	19.02%	43.20%	1.51%	100.00%
Stanford	22.49%	21.48%	15.88%	29.90%	10.23%	100.00%
U.Penn	16.45%	7.15%	16.75%	30.40%	29.25%	100.00%
Yale	19.48%	3.52%	28.21%	40.72%	8.08%	100.00%



Science Attrition From Application to Graduation

	05-06 Graduates								
	Interest			Declared			Graduated		
	Number	% of Science Interest	% of Total Graduated Cohort	Number	% of Science Declared	% of Total Graduated Cohort	Number	% of Science Graduated	% of Total Graduated Cohort
Rabi Scholars	9	2%	1%	8	3%	1%	8	4%	1%
Science Research Designees (SR)	29	7%	3%	29	12%	3%	28	13%	3%
All Others Who Selected Science as 1st Area of Interest on Application	256	60%	28%	133	55%	15%	128	57%	14%
Subtotal All Science 1st	**294**	**69%**	**32%**	**170**	**71%**	**19%**	**164**	**74%**	**18%**
Those Who Selected Science as 2nd Area of Interest but Not 1st	84	20%	9%	19	8%	2%	19	9%	2%
Those Who Selected Science as 3rd Area of Interest Only	51	12%	6%	12	5%	1%	10	4%	1%
Subtotal All Science Applicants	**429**	**100%**	**47%**	**201**	83%	**22%**	**193**	**87%**	**21%**
Those Who Did NOT Select Science as an Area of Interest on Application	0	0%	0%	40	17%	4%	30	13%	3%
Total	**429**	**100%**	**47%**	**241**	**100%**	**26%**	**223**	**100%**	**25%**

Total Graduated Cohort	910

Biological Sciences* Attrition From Application to Graduation

	05-06 Graduates								
	Interest			Declared			Graduated		
	Number	% of Biological Science Interest	% of Total Graduated Cohort	Number	% of Biological Science Interest	% of Total Graduated Cohort	Number	% of Biological Science Interest	% of Total Graduated Cohort
Those Who Selected Biological Science 1st Area of Interest	125	63%	14%	37	67%	4%	33	63%	4%
Those Who Selected Biological Science as 2nd Area of Interest but Not 1st	57	29%	6%	7	13%	1%	8	15%	1%
Those Who Selected Biological Science as 3rd Area of Interest Only	16	8%	2%	1	2%	0%	1	2%	0%
Subtotal All Biological Science Applicants	**198**	**100%**	**22%**	**45**	**82%**	**5%**	**42**	**81%**	**5%**
Those Who Did NOT Select Biological Science as an Area of Interest on Application	0	0%	0%	10	18%	1%	10	19%	1%
Total	**198**	**100%**	**22%**	**55**	**100%**	**6%**	**52**	**100%**	**6%**

Total Graduated Cohort	910

Science Attrition From Application to Graduation

	06-07 Graduates								
	Interest			Declared			Graduated		
	Number	% of Science Graduated	% of Total Graduated Cohort	Number	% of Science Graduated	% of Total Graduated Cohort	Number	% of Science Graduated	% of Total Graduated Cohort
Rabi Scholars	8	1.7%	0.9%	8	3.4%	0.9%	8	3.5%	0.9%
Science Research Designees (SR)	39	8.5%	4.5%	31	13.0%	3.6%	32	13.9%	3.7%
All Others Who Selected Science as 1st Area of Interest on Application	264	57.4%	30.2%	141	59.2%	16.2%	134	75.3%	15.3%
Subtotal All Science 1st	**311**	**67.6%**	**35.6%**	**180**	**75.6%**	**20.6%**	**174**	**75.3%**	**19.9%**
Those Who Selected Science as 2nd Area of Interest but Not 1st	100	21.7%	11.5%	20	8.4%	2.3%	20	8.7%	2.3%
Those Who Selected Science as 3rd Area of Interest Only	49	10.7%	5.6%	9	3.8%	1.0%	8	3.5%	0.9%
Subtotal All Science Applicants	**460**	**100.0%**	**52.7%**	**209**	**87.8%**	**23.9%**	**202**	**87.4%**	**23.1%**
Those Who Did NOT Select Science as an Area of Interest on Application	0	0.0%	0.0%	29	12.2%	3.3%	29	12.6%	3.3%
Total	**460**	**100.0%**	**52.7%**	**238**	**100.0%**	**27.3%**	**231**	**100.0%**	**26.5%**

Total Graduated Cohort	873

Biological Sciences* Attrition From Application to Graduation

	06-07 Graduates								
	Interest			Declared			Graduated		
	Number	% of Biological Science Interest	% of Total Graduated Cohort	Number	% of Biological Science Interest	% of Total Graduated Cohort	Number	% of Biological Science Interest	% of Total Graduated Cohort
Those Who Selected Biological Science 1st Area of Interest	135	83.3%	15.5%	31	55.4%	3.6%	32	54.2%	3.7%
Those Who Selected Biological Science as 2nd Area of Interest but Not 1st	21	13.0%	2.4%	1	1.8%	0.1%	2	3.4%	0.2%
Those Who Selected Biological Science as 3rd Area of Interest Only	6	3.7%	0.7%	1	1.8%	0.1%	1	1.7%	0.1%
Subtotal All Biological Science Applicants	**162**	**100.0%**	**18.6%**	**33**	**58.9%**	**3.8%**	**35**	**59.3%**	**4.0%**
Those Who Did NOT Select Biological Science as an Area of Interest on Application	0	0.0%	0.0%	23	41.1%	2.6%	24	40.7%	2.7%
Total	**162**	**100.0%**	**18.6%**	**56**	**100.0%**	**6.4%**	**59**	**100.0%**	**6.8%**

Total Graduated Cohort	873

Rabi Scholars by Major, 1996-2008

Graduation Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	TOTAL
Number of scholars graduating in science	11	6	11	16	14	8	12	6	8	9	8	9	10	126
Major/Concentration														
Applied Mathematics	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Astronomy	1	1	0	0	0	0	0	0	0	0	0	0	0	2
Astrophysics	0	0	2	1	1	0	0	1	0	1	0	0	0	6
Biochemistry	0	1	3	0	6	2	2	0	3	0	0	2	0	19
Biology	1	1	1	4	1	0	1	1	1	1	0	3	1	16
Biophysics	0	0	0	0	1	0	1	0	0	1	0	0	0	3
Chemistry	0	2	0	1	1	1	0	1	0	1	0	1	2	10
Computer Science	2	0	0	1	3	1	1	1	1	0	0	0	1	11
Earth & Environmental Sciences	1	0	0	1	0	0	0	0	0	0	0	0	0	2
Ecology, Evolution & Environmental Biology	0	0	1	2	0	0	0	0	2	0	0	0	0	5
Mathematics	2	0	1	3	2	1	6	2	2	4	5	2	6	36
Mathematics-Statistics	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Neuroscience	1	0	1	2	0	1	1	0	0	0	1	0	0	7
Physics	5	2	3	3	1	3	6	0	1	3	4	3	5	39
Psychology	1	0	0	0	1	0	1	0	0	2	0	1	0	6
Statistics	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Total Number of Programs	14	7	12	18	18	9	19	7	10	14	10	12	15	165

Appendix D-4

Report of the Working Group on Teaching

Task Force on Undergraduate Education

April 21, 2008

Overview

The starting point the Teaching Working Group was that one of the principal functions of Columbia University is teaching undergraduates. Our undergraduates arrive at Columbia with a diverse and changing set of interests. These interests are evolving as the world globalizes and develops. A guiding principle of Columbia University's commitment to our undergraduates is that they should be treated fairly and treated well; if there are departures from these principles, there should be good reason. With these principles as a backdrop, the Teaching Working Group sought to understand how undergraduates are educated at Columbia, what classes they take, how much access they have to professors, and how they are evaluated. The student representatives to the Task Force on Undergraduate Education, played a critical role in framing our approach to the formulation of normative recommendations. They repeatedly emphasized that Columbia undergraduates wanted smaller classes and more mentoring experiences. The recommendations of our working group are designed to make amends to address these concerns.

The results of our analysis suggest that there are important inequalities in the treatment of undergraduate students. Depending on their interests, some students at Columbia have an undergraduate experience that is characterized by large classes with lower average grades, while a small number of students end up in departments with small classes that hand out higher average grades. The fact that Columbia treats certain majors largely anonymously, while at the same time treats other majors with ample access to faculty raises serious questions about inequities in undergraduate education at Columbia. Moreover, since a major reason why students select research universities over liberal arts colleges is the opportunity to interact with active research faculty, addressing these issues is paramount as we contemplate the future direction of Columbia.

In order to improve undergraduate education at Columbia, our committee makes three recommendations:

1. Improve the data analysis provided to the Vice President with additional staff and an educational planning committee.
2. Leverage university expansion to bring Columbia more in line with evolving undergraduate demand for classes.
3. Improve information about grading norms so that faculty and administrators can better understand their evaluation policies.

Four Facts about Undergraduate Instruction

Fact 1: There are Dramatic Disparities in the Classroom Experience across Departments

Columbia undergraduates took 2183 classes in academic year 2006, and the average class size was 25.0. However, these numbers are not particularly informative about the typical experience of a student because many more students are enrolled in

large classes than small classes. This can matter enormously for our understanding of how we treat the typical undergraduate. For example, knowing that the average class size is 25 is consistent with four classes of 25 students each but also with a very unequal distribution in which one class had 97 students and three classes had one student in each. In the former case, the typical student would sit in a class of 25 students, whereas the typical student in the latter case would sit in a class of 97. Since we are interested in understanding the experience of the typical student, we focus on the typical enrollment in a class taken by a student.

Figure 1 presents this information for all Columbia College undergraduates by department. On the horizontal axis, we rank departments by the number of majors and concentrators.[1] For every undergraduate who was a senior in 2007, we then computed the share of courses within the major department in various size categories over the course of his or her career at Columbia. Thus, one can see from the graph that 55 percent of the courses taken by Italian majors at Columbia in the Italian department had 10 or fewer students in them. In the Italian, Germanic Languages, Astronomy and Slavic Languages departments 32 Full Time Equivalents (FTEs) taught a total of 70 majors and concentrators. By contrast, approximately the same number of FTEs (34 in Economics and 36 in Political Science) instructed between nine and ten times as many majors and concentrators. To the extent that many of these majors would like to have mentoring experiences with faculty before graduation, the data suggest that the experience of majors and concentrators is likely to differ enormously in this regard.

Obviously, some departments teach a lot of non-majors so it is entirely possible that the classroom experience in the two departments is similar even if the number of majors differs enormously. Figure 1 demonstrates that this is simply not the case. The typical student majoring in one of these departments spends half of his or her time in classes with 10 or fewer students, whereas less than five percent of Economics or Political Science students have a comparable experience. Roughly half of all Columbia College students major in Psychology, History, Political Science, and Economics, and for these students, the vast majority of their classes are not intimate experiences.

Fact 2: Student Course Demand Has Shifted Sharply Towards Quantitative and Asia-Related Departments

What explains this pattern? Almost surely, one important factor is changing student demand for courses. Table 1 presents the ten Arts and Sciences departments with the largest falls in relative departmental undergraduate enrollments between 1986 and 2007. These relative declines are computed as the percentage change in enrollment in a department less the percentage change in undergraduate enrollment. As one can see from the table, with the notable exception of Astronomy, the departments with the most rapid declines in enrollments are those with a western civilization focus and or non-quantitative social sciences.

Table 2 presents the flip side of picture, i.e., the departments with the greatest increases in relative enrollments. With the exception of Music and Anthropology, these departments tend to fall into two categories as well: quantitative fields and non-western

[1] We will augment this with SEAS later.

area studies.[2] Taken together, the data suggest that there have been very significant shifts in student demand for courses away from the traditional western-civilization oriented humanities and non-quantitative social science courses and towards quantitative courses and Asia broadly defined.

Fact 3: Faculty Staffing Levels Have Been Slow to Adjust to Student Course Demand

What are the sources of this inequality? A major reason why students in some departments are treated to small, intimate classes and others are almost entirely taught in large lecture classes is that there are enormous differences in the faculty to student ratios across departments. Figure 2 shows the FTE to student ratios across Arts and Sciences departments. The departments are ranked by total enrollments.[3] As one can see from the figure, virtually all of the smallest departments have enrollment to FTE ratios of 60 or less and many of them have ratios of 40 or less. By contrast the largest departments in terms of enrollments typically have enrollment to FTE ratios of 80 or more.[4]

Undoubtedly a major cause of this disparity has been the speed at which the university has been adjusting to changing student demand for classes. Obviously, the university cannot adjust to extremely rapid changes in student interests due to long-term nature of faculty contracts and the possibility that student interests may represent intellectual fads. However, one might expect the university to adjust to very long run global trends. Few would argue that the economic rise of Asia and the increasingly technological nature of our society are trends that are likely to fade away in the foreseeable future. It is therefore not surprising that student demand for courses should shift towards these areas.

But how have faculty resources shifted? To assess this, we plotted the relative Arts and Sciences FTE growth in each department between 1992 and 2007 against the relative growth in non-core Arts and Sciences enrollments over the same period.[5] Assuming that the typical junior faculty contract is seven years and that the typical senior faculty member has a career at Columbia of 30 years with tenure, a fifteen year period should allow for full turnover of the set of junior faculty (twice) and turnover of about half of the senior faculty in a department. Thus, this is a period of time that should allow for the administration to adjust faculty resources to long-run changes in student demand. If one believed that FTEs adjusted one-to-one with long-run student demand, one would expect to see the data arrayed along the 45 degree line (i.e., a line with a slope of one). If FTEs were completely unresponsive, one would expect FTE changes to lie along a line with a slope of zero.

Figure 3 indicates that the slope of the line is actually 0.3, which indicates that historically only about one third of student changes in long-run demand for classes has

[2] The rise in enrollments in Anthropology may reflect problems that the department had in the 1980s as well as its non-western focus.

[3] Enrollments in this figure include the core. Core enrollments account for 42 percent of enrollments in English, 49 percent of enrollments in Art History, and 38 percent of enrollments in Music.

[4] An important exception to this pattern is History. This probably reflects that the department uses around 7 FTEs to teach around 20 core classes. If we reduce the History department's FTEs by this number the enrollment to FTE ratio rises from 52 to 61.

[5] As before, relative growth is defined to be the growth in the department less aggregate growth of all departments. The base year of 1992 was chosen because this is the first year in which FTE data is available.

been met by new faculty resources. Two-thirds of student demand changes simply results in larger classes for undergraduates. One of the problems with this plot is that the explosive growth of Statistics – which was largely due to the outsourcing of part of the econometrics sequence from economics – makes it hard to see the behavior of other departments. In Figure 4, we drop Statistics to see what is happening more clearly with the remaining 25 departments. Among these departments the response of faculty staffing to changing student demand is, if anything, slower. Only one quarter of all changes in student demand is met by more staff. Particularly surprising is the fact that there are two departments – Religion and Sociology – that increased their faculty size as student demand collapsed. This suggests that there has been a serious disconnect between changing student demand for instruction and the faculty hired to meet that demand.

Fact 4: Departmental Grading Policies are Very Unequal

A final issue concerning how undergraduate education is conducted at Columbia concerns the evaluation of students. Table 3 reports the mean and median grade by department. The striking feature of the table is that the sciences and hard social sciences give out much lower grades than the humanities. The median student in Chemistry, Economics, and Electrical Engineering receives a B+ whereas the *median* student in Italian, Slavic Languages, or Music receives a grade of A. In other words, in some departments an A- is a low grade while in others it's a high grade.

There are two obvious interpretations of this disparity in average grades across departments. The first is that student quality varies systematically across these departments. If relatively able, hardworking students end up in the humanities whereas the slackers cluster in economics and the sciences, then it may be the case that a common grading policy could produce these results. An alternative hypothesis is that different departments have different grading policies. This would be much more problematic because it would suggest that students are treated unfairly and that students may avoid some classes not for reasons of intellectual engagement but because they know higher grades can be obtained in classes in another field.

In order to separate these two hypotheses, we took data on every course taken by every student between AY2004 and AY2006 and estimated a linear regression model in which the dependent variable was the grade that every student received in every department. The independent variables were a series of indicators for each student (a student "fixed effect"), the level of the student when they took the course, whether they were a major in that department, the log of class size, the class level, and a series of department indicator variables. This model controls for student ability and tells us how the same student is graded in various departments.

The results from this analysis are presented in Table 4. The results indicate that hard sciences and hard social sciences are hard; they systematically give the same student lower grades. This strongly supports the hypothesis that the same student gets lower grades in quantitative courses than in non-quantitative courses. The table indicates that the average student in a Chemistry course will be on the margin between a B and B+, but that same student will receive an A- or A in most humanities departments. Indeed, Philosophy is the only humanities department that grades like a science department; all of the others grade much more leniently.

Recommendations

Our analysis of Teaching at Columbia has uncovered four important facts that guide our recommendations. First, the classroom experience of Columbia Undergraduates differs enormously across departments. Second, student demand for courses has been shifting sharply towards Asia-related and quantitative fields. Third, the supply of faculty to teach courses has been slow to respond to student demand. Finally, we have uncovered important deviations in grading policies across departments that mean that the same student is given very different grades in different departments. These four facts suggest that there are important inequalities that Columbia's administration should address. Our recommendations aim at helping address these issues.

1. Improve Information Management in Columbia
   Columbia is a complex and dynamic institution and the administration's ability to access and process data is highly limited. As a result, much of the analysis contained in this report could not have been performed even one year ago. The Vice President and Provost need a high level staff person who can oversee data management and produce reports on changing student interests and faculty staffing. This must be a person with quantitative data-handling skills. Moreover, the Vice President would be well served by a standing committee to provide advice on how to meet student demand for courses.

2. **University Expansion**
   A major problem for an administrator trying to address the inequalities undergraduates face is that it is very difficult to shrink some departments below some threshold. Moreover, universities may benefit from having faculty in some areas even if student demand is low. As a result, faculty may quite reasonably argue in favor of continued teaching of certain areas even in the face of waning student demand. Fortunately, university expansion provides a unique opportunity to improve the situation of undergraduates without cutting the size of departments that face low student demand. A 10 percent expansion in the number of undergraduates coupled with a 10 percent increase in the size of the faculty would create 54 new Arts and Sciences FTE lines. If these lines were allocated to departments with high enrollment to FTE ratios, this would go very far towards alleviating inequalities in student access to professors.

3. **Monitoring Arts and Sciences Grading**
   Student evaluation is complex, and hence applying a curve to all courses may not be appropriate. For example, there may be some upper level seminars where all of the students are highly motivated and do superb work. However, it is less clear why the same student should be getting different grades in similar types of courses in different departments. Moreover, when the median grade in a department is an A, it raises serious questions about whether faculty are properly evaluating quality. In light of these concerns, our committee recommends a hortatory approach coupled with improved information about grading:
   a. **Provide Non-Binding Grading Norms:** We recommend that the administration issues a non-binding guideline for departments about how grading across all courses

should be done (e.g. 30 percent A's, 40 percent B's, etc.) so that the average student in that department receives a grade of B+.

b. **Allow Departments to Deviate with Good Reason:** If the average student in a department has a GPA in that department's courses that is lower than 3.15 or higher than 3.5, we recommend requiring the chair to write a letter to the Vice President explaining why grading was done appropriately.
c. **Provide Information to Faculty and Chairs:** The information management person and/or committee detailed in Point 1 could provide information to each professor about how the students in his or her class fared in other courses relative to that faculty member's class. Information for all faculty in a department would be given to the Chair. This would assist faculty in understanding how their grading scale fits into the university norm.

Figure 1

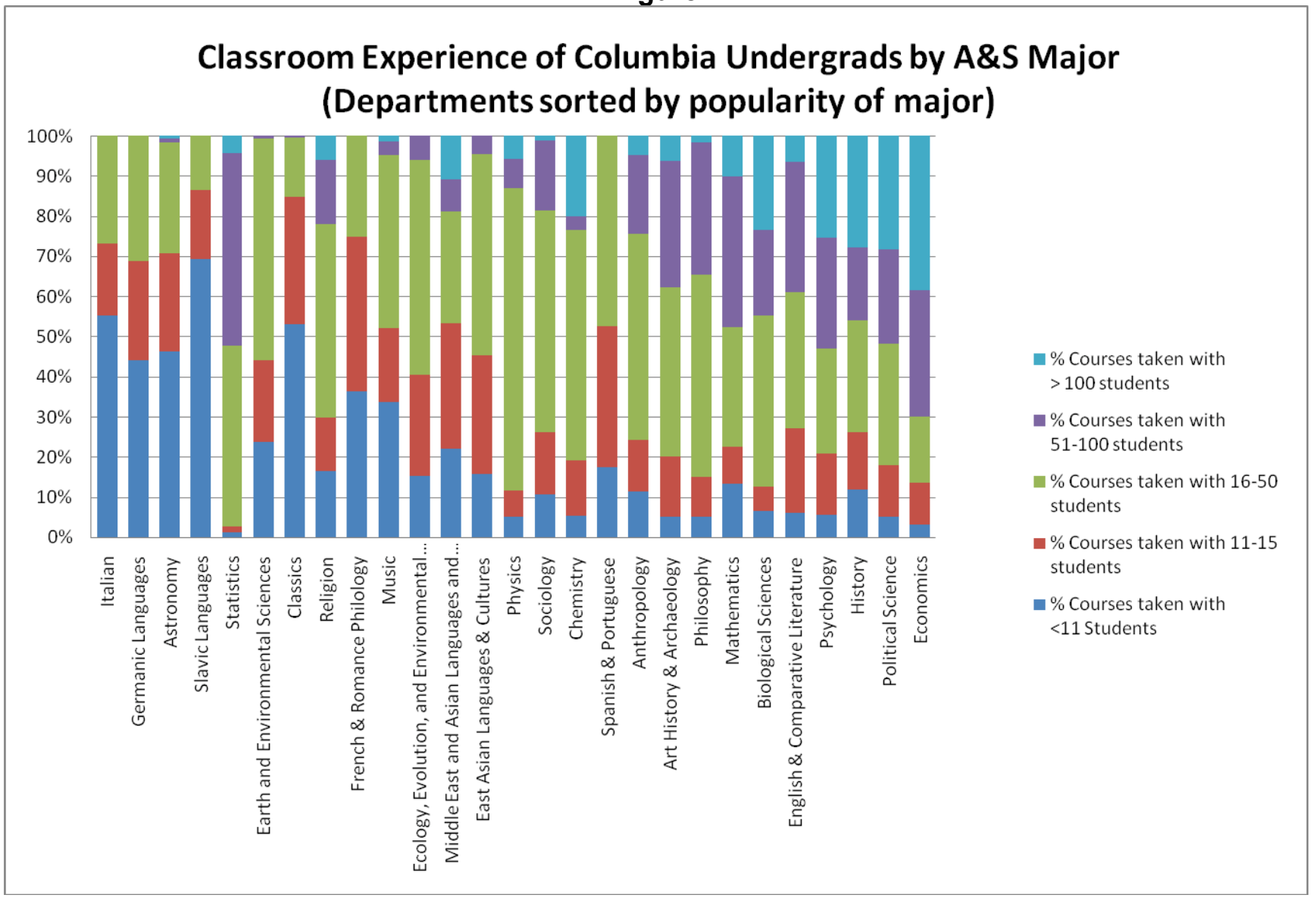

Classroom Experience of Columbia Undergrads by A&S Major
(Departments sorted by popularity of major)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Italian
Germanic Languages
Astronomy
Slavic Languages
Statistics
Earth and Environmental Sciences
Classics
Religion
French & Romance Philology
Music
Ecology, Evolution, and Environmental...
Middle East and Asian Languages and...
East Asian Languages & Cultures
Physics
Sociology
Chemistry
Spanish & Portuguese
Anthropology
Art History & Archaeology
Philosophy
Mathematics
Biological Sciences
English & Comparative Literature
Psychology
History
Political Science
Economics
% Courses taken with > 100 students
% Courses taken with 51-100 students
% Courses taken with 16-50 students
% Courses taken with 11-15 students
% Courses taken with <11 Students

Figure 2

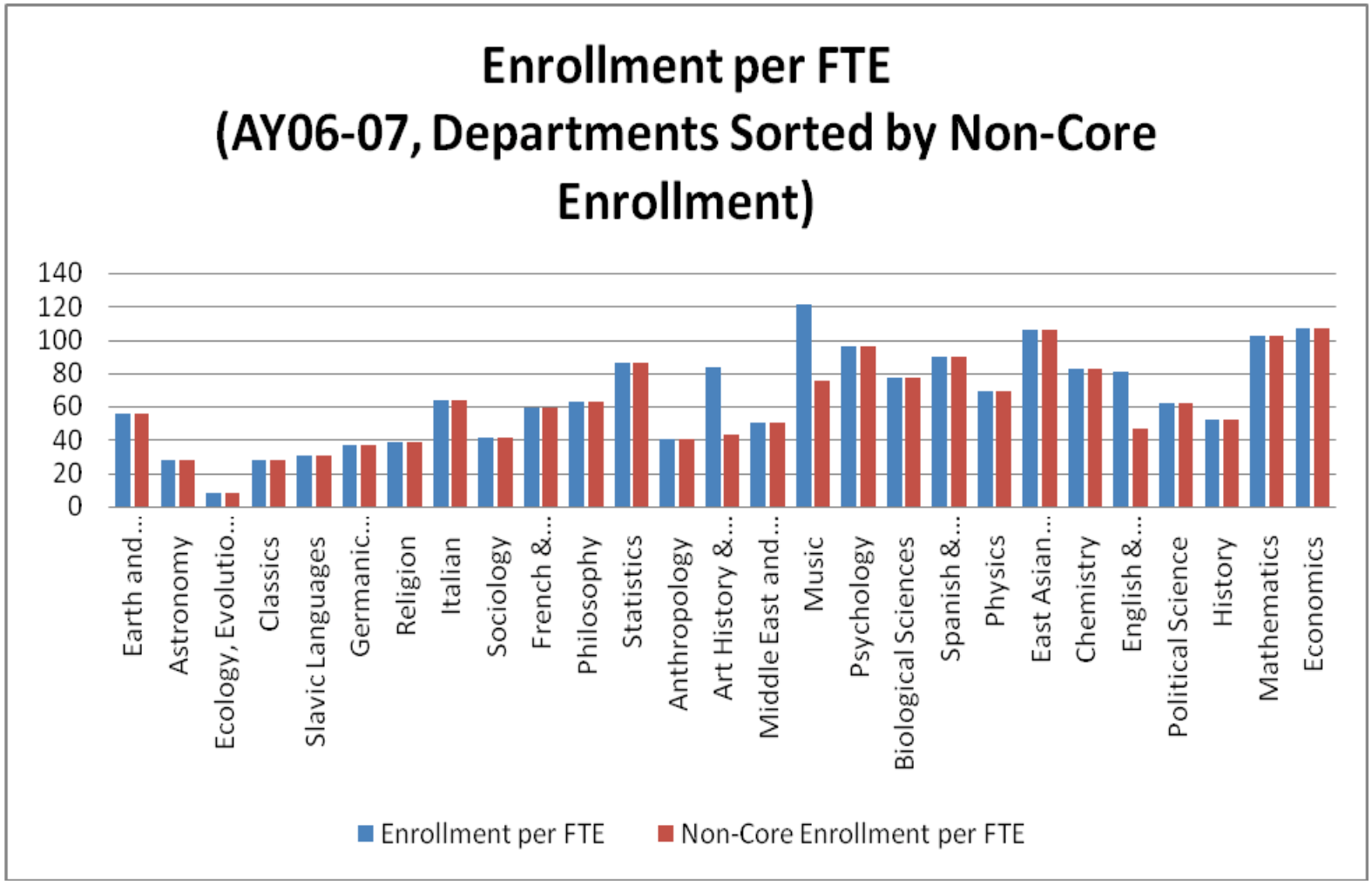

Enrollment per FTE
(AY06-07, Departments Sorted by Non-Core Enrollment)
140
120
100
80
60
40
20
0
Earth and...
Astronomy
Ecology, Evolutio...
Classics
Slavic Languages
Germanic...
Religion
Italian
Sociology
French &...
Philosophy
Statistics
Anthropology
Art History &...
Middle East and...
Music
Psychology
Biological Sciences
Spanish &...
Physics
East Asian...
Chemistry
English &...
Political Science
History
Mathematics
Economics
Enrollment per FTE
Non-Core Enrollment per FTE

Figure 3

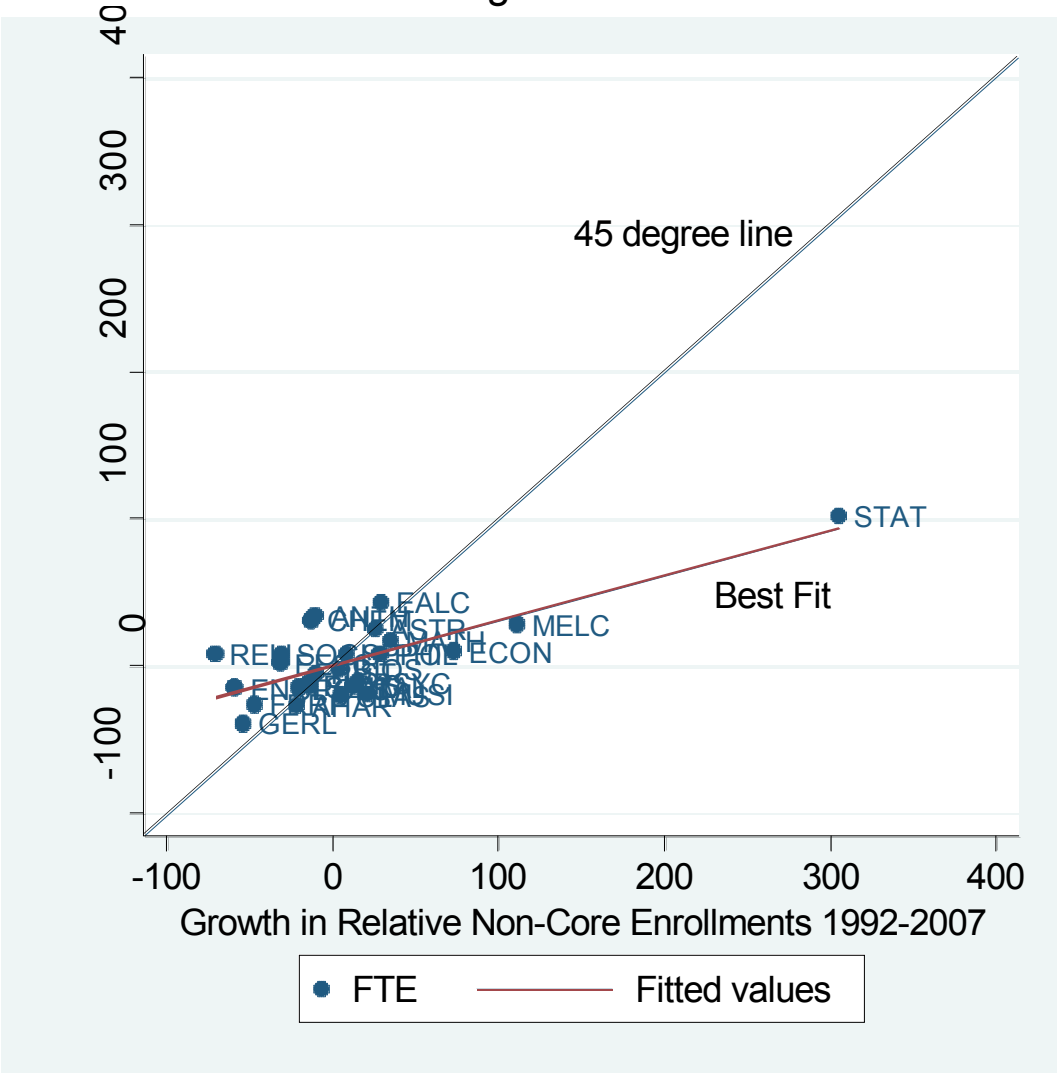

45 degree line
Best Fit
STAT
MELC
ECON
FALC
GERL
-100
0
100
200
300
400
Growth in Relative Non-Core Enrollments 1992-2007
FTE
Fitted values

Figure 4

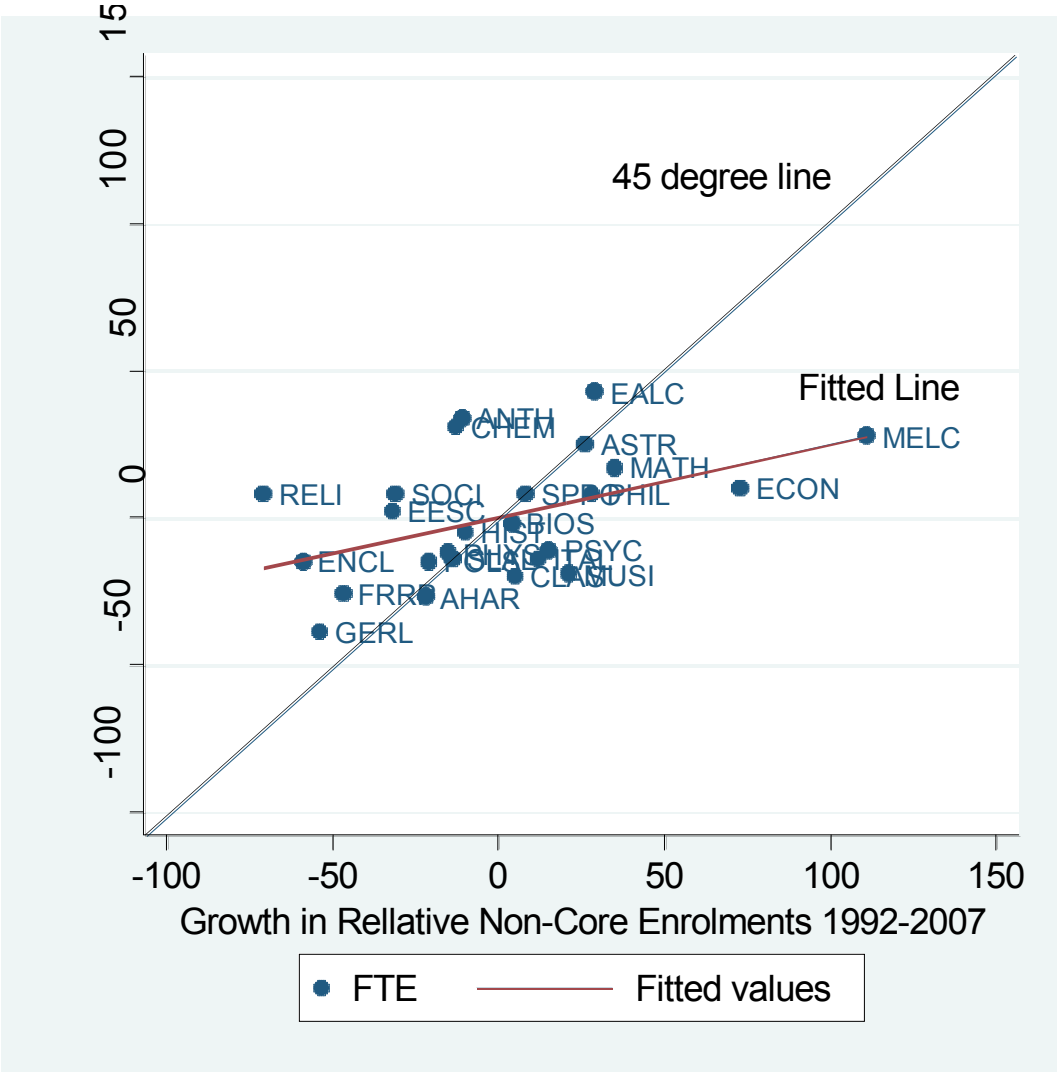

15
100
50
0
-50
-100
45 degree line
Fitted Line
EALC
ANTH
CHEM
ASTR
MELC
MATH
RELI
SOCI
ECON
EESC
BIOS
HIST
PSYC
ENCL
FRRS
AHAR
GERL
-100
-50
0
50
100
150
Growth in Rellative Non-Core Enrolments 1992-2007
FTE
Fitted values

Table 1

Ten Departments with Greatest Shrinkage and Growth in Relative Non-Core Enrollments (Spring 1986-Spring 2007)

Department	Growth in Non-Core Enrollments Less A&S Average
English	-81%
Astronomy	-77%
French & Romance Philology	-68%
Sociology	-66%
Germanic Languages	-54%
Religion	-50%
History	-29%
Slavic Languages	-29%
Art History & Archaeology	-27%
Spanish & Portuguese	-22%

Table 2

Ten Departments with Greatest Growth and Growth in Relative Non-Core Enrollments (Spring 1986-Spring 2007)

Department	Growth in Non-Core Enrollments Less A&S Average
Anthropology	12%
Chemistry	15%
Mathematics	20%
Economics	52%
Biological Sciences	52%
Music	76%
East Asian Languages & Cultures	167%
Earth and Environmental Sciences	245%
Middle East and Asian Languages and Cultures	268%
Statistics	731%

Table 3
Mean and Median Grades by Department

Department	Mean Grade	Median Grade
Chemistry	3.16	B+
Economics	3.18	B+
Electrical Engineering	3.30	B+
Biological Sciences	3.31	B+
Physics	3.31	B+
Mathematics	3.32	B+
Computer Science	3.32	B+
Applied Physics and Applied Math	3.33	B+
Mechanical Engineering	3.34	A-
Psychology	3.35	A-
Political Science	3.38	A-
Chemical Engineering	3.38	A-
Philosophy	3.38	A-
Ecology, Evolution, and Environmental Biology	3.40	A-
Sociology	3.40	A-
Religion	3.43	A-
Statistics	3.43	A-
History	3.44	A-
Civil Engineering & Engineering Mechanics	3.45	A-
Industrial Engineering & Operations Research	3.49	A-
Art History & Archaeology	3.49	A-
Biomedical Engineering	3.50	A-
Earth and Environmental Engineering	3.54	A-
Earth and Environmental Sciences	3.54	A-
English & Comparative Literature	3.55	A-
Astronomy	3.56	A-
Classics	3.58	A-
Spanish	3.63	A-
Anthropology	3.64	A-
East Asian Languages & Cultures	3.65	A-
Middle East and Asian Languages and Cultures	3.67	A-
German	3.67	A-
French	3.71	A-
Italian	3.74	A
Slavic	3.75	A
Music	3.82	A

Table 4

Grades Given to Students of Identical Quality

Department	Expected GPA	Expected Letter Grade
Chemistry	3.15	B+
Biological Sciences	3.28	B+
Economics	3.33	B+
Chemical Engineering	3.36	B+
Ecology, Evolution, and Environmental Biology	3.36	B+
Physics	3.37	B+
Psychology	3.39	B+
Applied Physics and Applied Mathematics	3.41	B+
Mathematics	3.41	B+
Electrical Engineering	3.42	B+
Computer Science	3.45	B+
Philosophy	3.46	B+
Statistics	3.48	B+
Mechanical Engineering	3.49	B+
Earth and Environmental Sciences	3.52	A-
Astronomy	3.55	A-
Industrial Engineering & Operations Research	3.57	A-
History	3.57	A-
Classics	3.58	A-
Religion	3.59	A-
Biomedical Engineering	3.59	A-
Political Science	3.60	A-
Sociology	3.61	A-
Civil Engineering & Engineering Mechanics	3.65	A-
English & Comparative Literature	3.68	A-
Earth and Environmental Engineering	3.68	A-
Anthropology	3.69	A-
Middle East and Asian Languages and Cultures	3.72	A-
East Asian Languages & Cultures	3.72	A-
Slavic Languages	3.75	A-
French & Romance Philology	3.77	A-
Germanic Languages	3.78	A-
Italian	3.80	A-
Spanish & Portuguese	3.83	A-
Music	3.89	A