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Observations on Creating a New Paradigm for Undergraduate Education in Engineering

By

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Background. Franklin W. Olin College of Engineering was founded in 1997 by the F.W. Olin Foundation of New York, NY. The F.W. Olin Foundation is well known in higher education for its longstanding program of philanthropic support dedicated to the construction of new facilities on private college and university campuses—including 78 buildings on 58 campuses over a period that spans 50 years. However, in 1997 the Foundation made the extraordinary decision to end its building grant program and instead to dedicate its remaining funds to the establishment of a new independent institution dedicated to the mission of changing the paradigm for undergraduate education in the field of engineering. This decision was the result of much deliberation, involving consultation with officials at the National Science Foundation, ABET (formerly the Accreditation Board for Engineering and Technology), and numerous college presidents and corporate representatives. It was their conclusion that a great deal of unhappiness existed with the current state of affairs in the preparation of engineering leaders, and although progress was being made with varying degrees of success at many colleges and universities, the best way to accelerate the process of change was to create an entirely new institution. Their vision for Olin College included several Founding Precepts that are very difficult to impose on an existing institution. These precepts include (1) faculty will not be offered tenure, (2) the College will not be organized with faculty in departments focused on academic disciplines, (3) all admitted students will receive full eight-semester tuition scholarships based on academic merit, (4) the College will focus on undergraduate education of engineering students in a residential environment, and (5) the College will be deeply committed to a program of continuous improvement and innovation. Perhaps the most important of these precepts for the purpose of this report is the last one. The remainder of this report provides observations on the experiences obtained in leading the establishment of Olin College.

Quick Facts About Olin College in March 2006. Olin College is located on 70 acres in Needham, MA, adjacent to Babson College, a well-known college of business. The facilities of Olin College consist of more than 400,000 square feet

of attractive new buildings including an academic classroom and laboratory building, an administrative/library/office building, a dining hall and student center, and two modern residence halls on a hilltop. Olin was chartered by the Massachusetts Board of higher Education to offer B.S. degrees in Engineering, Mechanical Engineering, and Electrical and Computer Engineering. The current enrollment is about 300, the current faculty size is about 35, and the current staff size is about 70. Every admitted student receives a full eight-semester tuition scholarship, regardless of family resources. The average SAT score of the entering freshmen is about 1500, about 40% of all students are National Merit Finalists, 45% of the students are women, and the students come from 45 U.S. states and a few foreign countries. Since the College does not receive tuition revenue, its financial model is unusual. About 90% of the operating revenue is derived from investment returns on an endowment of approximately $430 million. The curriculum at Olin College was developed during a unique two-year process of deliberate invention[1] involving 16 founding faculty members. In the second year of this invention process, a group of 30 young students were added as partners in the experimentation and testing of ideas and pedagogies. The resulting curriculum is distinctive and has been described in the engineering literature[2,3]. Olin College's first commencement will be held on May 21, 2006, when it is expected that about 65 students will receive their B.S. degrees. The College has received considerable attention within the world of engineering education, and occasionally also in the national press. An article on December 20, 2005, in the **Wall Street Journal**[4] provides a good overview of the educational approaches used at Olin College.

Why Olin College Was Established. Olin College was established to address a number of systemic concerns about the preparation of engineering leaders in the U.S. For decades corporate leaders have been calling for improvements in the "soft" skills of engineering graduates. These include (1) increased development of communication and teaming skills; (2) greater consideration of the social, environmental, business, and political context of engineering, with particular emphasis on entrepreneurial thinking; (3) a shift from disciplinary thinking to interdisciplinary approaches; (4) improved student capacity for lifelong learning; and (5) emphasis on engineering practice and the process of design. After studying the situation the Olin Foundation felt that the need for improvement was greatest at the undergraduate level, where the rate of attrition is high, and the diversity of students is small. Currently, about half of all engineering freshmen in the U.S. do not graduate in this field. Among those who drop out, the most

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[1] R. Miller et al., *Invention 2000*, first strategic plan of Olin College (attached as an appendix to this report).
[2] M. Somerville et al., *The Olin Curriculum: Thinking Toward the Future*, **IEEE Transactions on Education**, 48(1) 198-205 Feb 2005.
[3] S. Kerns et al., *Designing from a Blank Slate: The Development of the Initial Olin College Curriculum*, **Educating the Engineer of 2020: Adapting Engineering Education to the New Century**, The National Academies Press, Washington, DC , 98-113, 2005.
[4] D. Wessel, *Building a Better Engineer: With No Tuition or Tenure, Olin College Aims to Produce Grads for a Global Economy*, **Wall Street Journal**, Marketplace, p. B1, December 20, 2005.

common reason cited is poor quality teaching. The study of engineering is widely regarded by students as dull, tedious, boring, and exceedingly challenging. It is rarely regarded by students as fun, exciting, creative, or rewarding.

In recent months, these issues have become widely recognized outside the engineering community. In his recent book *The World Is Flat: A Brief History of the Twenty-first Century*, Thomas Friedman notes that the global competitiveness of the U.S. depends heavily on technological innovation while many Asian countries are making progress in this area at alarming rates—enabled by Internet technology. This thesis has also been endorsed by the *National Innovation Initiative* report by the Council on Competitiveness, and the recent *Rising Above the Gathering Storm* report by the National Academy of Engineering. In his Sate of the Union Address earlier this year, President Bush announced the *American Competitiveness Initiative* which identifies the need to encourage American innovation and "*increase investments in research and development (R&D), strengthen education, and encourage entrepreneurship and innovation.*" These reports lead to the conclusion that a substantial improvement in the preparation of technological innovators is a growing national need. Olin College was created to address central aspects of the educational needs associated with this national challenge.

While many engineering schools have been making changes in their educational approaches to address these concerns, progress has been slow. One likely contributing factor to the slow pace of change is the traditional departmental structure and reward systems within most academic institutions. In an attempt to test this hypothesis and accelerate the process of change, the Olin Foundation decided to found an entirely new institution with the specific charge to rethink the way engineers are prepared, improve the educational environment and outcomes for engineering students, and develop a new educational process that is authentically committed to continuous improvement and innovation. In doing this the Foundation hopes to avoid the need to found yet another new institution in the future to address similar problems.

SOME EARLY OBSERVATIONS

As noted, Olin College is still in its infancy. As a result, there hasn't yet been enough time to conduct controlled experiments to formally evaluate the many new ideas that have been developed. The task of invention from a blank slate requires simultaneous decisions on the selection of hundreds of important variables and intense efforts to coordinate and balance the effects during initial deployment. In contrast, the task of careful evaluation requires conducting controlled experiments in which only one variable at a time is assessed. Therefore, at this stage in our development, most of what we have to report is in the form of early observations rather than final assessment results.

1. **Students are more capable than expected**. Perhaps the most important conclusion we reached in our experimentation with bright engineering students is that they are far more capable of independent learning in truly challenging situations than we expected. During the "Olin Partner Year" when 30 students worked closely with our founding faculty on educational experiments, we found that students rarely failed to achieve specific results under pressure when challenged to do so in small teams. We also found that they make highly responsible and remarkably mature and insightful colleagues in making important fundamental decisions in many aspects of the educational enterprise. We suspect that students are frequently under-estimated as partners in the educational process in other institutions. Furthermore, when students are better challenged and given real responsibilities, they appear to become much more engaged in their own learning process, learn faster and more deeply, and become more committed to completing the program.

   For example, we asked five students who had recently graduated from high school (but had never taken a college course) to design, build, and demonstrate a pulse oximeter (a medical instrument for measuring the oxygen content and pulse rate of a patient's blood) within five weeks. They had never heard of the instrument, but were eager to attempt the challenge. We told them to search the patent literature in the library where the inventor must have described how the device is made and how it works. We told them that if they get stuck, we are here to answer questions. We expected to learn something by watching them get stuck on the electronics or the fabrication challenges, but instead they didn't fail as expected. Through a process we called "guided design," in which a faculty member helped point them, they answered most of their own questions. Within five weeks they produced a working prototype that calibrated well against a hospital instrument! In the process, they not only learned enough about the device to build and operate one, but they achieved an enormous sense of achievement and genuinely enjoyed the intense experience. None of the students were fooled into believing that they had learned all they need to be electrical engineers, but instead they now have a heightened sense of curiosity and interest about transistors and circuit design that tend to motivate them later in courses in this area.

   As a result of this and many similar experiences, we developed a team-based project-centered educational approach at Olin College that is a little like learning to "swim in the deep end." Each semester students spend at least 25% of their time in team-based design/build projects in which they are expected to "do" first and then "learn" later. More traditional approaches in engineering have assumed that students need several years of prerequisite course material in physics, math, and circuit design before attempting any such challenging projects.

The principle of engaging students in learning by discovery is now deeply woven into the fabric of the Olin educational environment. Furthermore, student involvement in designing and shaping many other dimensions of the institution has also been institutionalized to a greater extent than many others would think is either possible or wise. Students are routinely invited to serve on nearly all major administrative committees, and they are even involved in the selection of incoming freshmen in the admission process, as well as the selection of new faculty during their interview process. In fact, when recruiting our first several classes of incoming freshmen, we told them: "*When people ask you where you are going to college, tell them you are building your own!*"

This experiment worked so well (as have nearly all of our subsequent efforts in this area) that I suspect the principle is generalizable beyond engineering to other disciplines as well. Bright and creative students love a challenge, and appear to be far more capable of success in challenging situations than is typically assumed.

We have come to believe that engaging students as junior partners in the design and implementation of the educational process was one of the most important decisions we made. They are far more capable than we expected, their insights are often enlightening, they are absolutely fearless in identifying opportunities for improvement, and this deep engagement in the design of their learning environment appears to produce a great enhancement in motivation to learn independently.

2. **Not having tenure did not seriously hinder faculty recruitment**. Tenure is such a deeply imbedded aspect of faculty employment that we worried whether the decision not to offer tenure, combined with the absence of graduate programs, would make it impossible to attract faculty candidates with recognized national achievement. Our primary criterion for the selection of faculty members is the demonstrated ability (or potential) to provide truly inspirational teaching at the undergraduate level. Of course, engineering is a rapidly evolving field[5], and you can only teach what you know. Therefore, it is essential that faculty members in science, math, and engineering maintain a serious lifelong commitment to continued intellectual vitality in their field. So, Olin College also requires all faculty members to develop an individual program of research, invention, entrepreneurship, artistic endeavor, scholarship, or other creative activity that will lead to nationally visible achievement in their field. While the rate of production of such research and related activity may be lower at Olin than is typical at a major research university—and there is no pressure at Olin for faculty members to obtain substantial external

[5] "*If I take the revenue in January and look again in December of that year 90% of my December revenue comes from products which were not there in January*." Craig Barrett, Chairman of the Intel Corporation.

research contracts to support graduate students—the quality and impact of the contributions are expected to be comparable to those at major research universities.

In spite of these concerns, our experience for the past six consecutive years in faculty recruiting has shown that we are able to attract a distinguished and capable faculty without offering tenure. In fact, although nearly all of our faculty appointments are in some area of engineering, science, or math, where competition from industry is often substantial, we have averaged more than 100 resumes per faculty position in our recruiting efforts. In nearly every case we have succeeded in attracting our first choice faculty candidate. (In those few instances when this has not been the case, the most common reason is the high cost of living the Boston area and not the absence of tenure.) Furthermore, these faculty candidates have had excellent qualifications by any standard. Many of our faculty members turned down tenured appointments at major universities to join us. Even those who are too early in their career to obtain an offer of tenure often turned down tenure track appointments elsewhere.

To illustrate the caliber of the faculty members at Olin, not only do all of them have Ph.D. degrees, but these degrees are nearly all from the nation's most respected and recognized premier research universities. Several of our faculty members left positions at one of these universities to join Olin. They brought with them substantial national credentials, including: President of the American Society for Engineering Education, President of the IEEE Education Society, NASA Medal for Distinguished Service, NASA Medal for Exceptional Scientific Achievement, Rhodes Scholarship, Fellow status in national professional societies, numerous teaching awards and other professional awards, editorship of several major scientific journals, senior leadership positions in corporate and government research laboratories, experience leading large funded research programs, authors of large numbers of reviewed journal articles in premier technical journals, etc.

It is important to note that this success has not been obtained by simply providing excessive compensation. We benchmark our faculty salaries and benefits with highly competitive engineering schools across the U.S., and our average faculty salaries are less than 5% above the benchmark[6].

It was our intent from the start to attempt to improve upon the traditional tenure system whenever possible. The evolving model for faculty

[6] While we were successful at recruiting an exceptional group of founding faculty members, and we rarely failed to recruit our top choice among candidates, we did notice that we encountered more than average difficulty in recruiting faculty members in mid-career who just recently earned tenure at a traditional institution.

employment at Olin College involves fixed term contracts of varying durations. We do not employ rolling contracts. The most common faculty contract term is five years. However, slightly longer or shorter terms may be awarded when it is in the best interest of the faculty member and the College.

An example of an innovation in the area of faculty employment that we are experimenting with is the establishment of two faculty ranks beyond the traditional ranks of assistant professor, associate professor, and professor. At Olin, any faculty member who has achieved the rank of professor may be considered for promotion to the rank of senior professor. This involves a discussion with the dean of faculty about undertaking a project of mutual benefit and significant scope (about 5 years of work). At the conclusion of the project, the outcomes are reviewed by peers both within and outside the College to determine whether the achievement merits promotion to senior professor. A final determination is made by the provost, president, and Board of Trustees. Also, any senior professor may undertake a similar project, with the added aspiration that achievement of a successful outcome will lead to enhanced national and international visibility of the faculty member and the College. This process may lead to promotion to the rank of distinguished professor.

The key ingredient in this new process of faculty promotion is the opportunity to engage each faculty member at later stages in his/her career to develop proposed major activities of mutual benefit, and then to agree that objective assessment of the results of these activities will be used to determine the outcome. Since we have relatively little experience with this approach, we may need to review and revise it in the future.

Finally, Olin College firmly believes in the concept of shared governance and academic freedom and responsibility. We do not believe that it is necessary to provide a traditional tenure system to achieve these goals, particularly within a college of engineering.

3. **Continuous improvement and innovation requires attitude shift and continuous assessment**. Few things are more predictable about the next few decades that the accelerating rate of change we can expect. This change comes from many sources, including the rapid development of India and China in the world economy and the increasing speed with which technological advances change our world—including the way children learn. Both of these trends appear to be inevitable, and both are likely to affect our lives in profound ways. Preparing students for this new world is a great responsibility.

   In my 25+ years as a faculty member at four institutions in three different geographic locations, I have come to appreciate the special contribution

that higher education makes to our society. The pursuit of truth no matter where it leads, aided by academic freedom and the responsibility to share new knowledge openly and freely, has enormous power for good. The very survival of our democratic society depends on an educated and thoughtful population. Our system of higher education has done a better job of providing this foundation of knowledge and critical thinking than any other throughout history.

However, at Olin College we have undertaken to apply these principles of free inquiry and critical thinking to the very organization and operation of the college itself in an attempt to explore potential opportunities for improvement. While the traditions of higher education have generally served us well, only through questioning and experimentation are we likely to determine whether further improvements are possible. The scope of our efforts and seriousness with which we are undertaking this challenge are illustrated by our decision to form multidisciplinary faculty groups rather than discipline-based academic departments, and to use renewable faculty contracts rather than a traditional tenure system. We are perhaps the only undergraduate college in America with a Vice President for Innovation and Research to lead our efforts in innovation, assessment, and continuous improvement.

Innovation and continuous improvement require certain cultural attitudes and commitments. First, an implicit humility is required to embrace the notion that improvement is always possible, and that we can always learn from others outside our community. Listening to those outside academia has not always been the strong suit of American higher education. In addition, continuous improvement is only possible if continuous assessment is employed to guide the process. We must be willing to expose ourselves to review and measurement, and to take the time to learn from our mistakes. Finally, and perhaps most importantly, continuous improvement requires openness to change. At Olin, one of our five personal core values is openness to change. We have already found that it is the most challenging of our values.

To embrace a new culture of continuous improvement and innovation requires a shift in attitudes relative to the mainstream in higher education. The ideal environment is one in which each member of the community is independently motivated to seek personal improvement. This internal motivation should cause individuals to take the initiative to continually seek feedback from others, to continually monitor metrics for personal improvement, and ultimately to be willing to occasionally make bold changes in actions and behaviors to produce a new outcome. Unfortunately, when assessment is imposed externally without the community commitment to improvement, the results are rarely desirable. We have been working to follow the three steps outlined above to develop

this new culture. Most external visitors to our program almost immediately recognize this emerging new culture, so we believe we are making progress.

Our efforts to learn from those outside our community are apparent in many forms. First, during our first few years of invention of the curriculum, we took the time and trouble to visit or host visits from 35 other colleges or universities around the world, and 20 corporations. We looked for innovative models of success, and we asked many questions about what is working well, what is not, and what the anticipated needs of the future may be. We created a President's Council of advisors that includes 20 prominent academic and corporate leaders, and we make unusual efforts to listen well and use their advice in making strategic decisions[7]. Our faculty committees in charge of each of the three B.S. degree programs have created external advisory committees, and several other programs within the College have also begun to use this model. Of course, our faculty and staff are also frequently engaged in national meetings and visits to our corporate and academic colleagues.

The second step in our program involves assessment. We believe that unless you are willing to submit to objective measurement—when appropriate measures can be developed—it is unlikely that you will make consistent progress. As in many other colleges, student feedback is solicited on every course at the end of every semester for use in improving the process of teaching. In addition, every student is required to make a public presentation (either by providing a lecture or a poster presentation) for evaluation by both internal and external evaluators at the end of every semester[8]. Each January we convene a retreat involving all faculty members to review evidence of the effectiveness of our evolving curriculum, and to propose any needed improvements. Our process of fixed-term contracts for faculty members also requires a formal periodic review of each faculty member's achievements and future potential before each contract renewal throughout their career. We also employ nationally normed assessment tools (such as the National Survey of Student Engagement developed at Indiana University) to monitor the effectiveness of the learning environment. But perhaps the most distinctive use of assessment at Olin College is our commitment to the use of 360-degree

[7] While many schools use advisory councils, we have developed a process of engaging our council through a series of strategic white papers that frame a short list of key questions through intense small-group discussion with faculty, students, and staff at meetings on campus twice each year. Each attendee is then asked to provide a thoughtful letter in response after the meeting that can be shared with everyone in the community.

[8] This event is call the Olin Expo, and involves about 300 student presentations over a 2-day period. The event occurs at the conclusion of final exams, and is evaluated by about 50 corporate visitors in addition to our faculty, staff, and student peers. The evaluations become part of each student's portfolio and are used as evidence of successful achievement of the nine required competencies for graduation.

staff and faculty evaluations. At Olin, we believe that it matters not only what you achieve, but also how you achieve it. As a result, very early we adopted a set of core values that are expected to govern the interaction between members of our community. All members of the faculty and staff are evaluated periodically for performance in teamwork and interpersonal skills, using the core values as a guide. This evaluation of each employee involves confidential assessment by a broad cross-section of the community, including faculty, staff, students, and administration.

The third and final step in our program involves willingness to change. Change is never convenient, comfortable, or efficient, and it usually involves taking risk[9]. Therefore, determination and courage are important ingredients in this step. At Olin, we completely revised the curriculum within two years of its initial creation. While we struggle with change like everyone else, we have become sufficiently accustomed to it that we also must throttle back the rate of change, for example, to enable our students to make reliable plans for their future academic coursework.

4. **Not having departments improved focus on education and promoted diversity of thought**. One of the Founding Precepts of Olin College is that it will not organize the faculty into departments focused on academic disciplines. Currently, all of our faculty members meet together as one large group, and they discuss issues and make decisions as a single body. In addition, this large group usually also involves a wider group, including the dean of student life, the librarian, the registrar, all lab technicians, and any additional adjunct or teaching personnel and administrative staff. There is an effort to reduce barriers between members of the community based on status or rank, and treat all members of the community as colleagues. This is not the norm in higher education.

   Overall, this feature of the academic culture at Olin College has served our purposes well. Among the outcomes caused by this organizational structure are (1) every faculty meeting is focused on the educational program and its support, (2) the wide range of professional backgrounds represented in the group promotes an unusual amount of cross-

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[9] N. Machiavelli, *The Prince*, (1513) "...And it ought to be remembered that there is nothing more difficult to take in hand, more perilous to conduct, or more uncertain in its success, than to take the lead in the introduction of a new order of things. Because the innovator has for enemies all those who have done well under the old conditions, and lukewarm defenders in those who may do well under the new. This coolness arises partly from fear of the opponents, who have the laws on their side, and partly from the incredulity of men, who do not readily believe in new things until they have had a long experience of them..."

disciplinary discussion, collaboration, and cooperation, (3) the involvement of such a wide range of people often promotes better execution of complex activities through mutual understanding, cooperation, and "buy in," and (4) occasionally, the inclusion of people with limited background in a topic causes longer than expected discussions that center on fundamental questions. While possibly less efficient, these conversations often result in better shared understanding of goals and objectives, and sometimes profoundly different and better outcomes[10]. In this way, the involvement of everyone in a "town meeting" approach to faculty meetings promotes a genuine diversity of thought that is rare.

One challenge presented by the interdisciplinary organization of the faculty is the potential lack of emphasis on mentorship of young faculty members by senior colleagues within the same discipline. In addition, the nearly flat organizational structure causes amplification of administrative burdens for the dean of faculty. These challenges are manageable with a faculty size of 35, but would probably require some changes in approach for a faculty of 70 or larger.

5. **Selecting the right people Is central to changing the outcomes.** One of the most well known concerns about engineering graduates is that their communication and interpersonal skills are frequently regarded as too weak. In fact, the need for improvement in communication skills and teamwork in engineering graduates has topped the list of requests for improvement from industry and accrediting agencies for decades. Other concerns about engineering graduates and engineers include the need for more creativity and innovation, entrepreneurial thinking, and well-rounded interests.

   On the other hand, within colleges and universities the high attrition rate among engineering students is often linked to student perceptions that the subject is very difficult and un-motivating[11] and that the overall quality of teaching is low, often involving complaints about the communication skills of the teacher. Many institutions are engaged in efforts to changes these outcomes.

[10] For example, when the first founding faculty at Olin were first assembled and asked to rethink the way engineers are educated, one person raised a hand and asked, "What is an engineer?" and then "What does every engineer need to know?" Such fundamental questions are extremely rare within any department of engineering faculty. The lengthy discussion which ensued between the faculty (which included chemists, physicist, mathematicians, etc., in addition to engineers) led to the development of a much more coherent and consistent curriculum, and a wide understanding of the goals and objectives of the program.

[11] The study of engineering typically involves advanced topics in natural science and mathematics, excessive amounts of homework in comparison with other more popular disciplines, and rarely provides a sense of immediate relevance to important human needs.

Like others before us, we at Olin College have postulated that the most effective way to address these problems may be to begin by attracting people who have high levels of ability and motivation to communicate well and work well in teams. As a result, we have focused our efforts on the process for selection of entering freshman students, and also on the selection of faculty members, in an effort to address these concerns. (One of our goals is to select only those people who are "better" than we are in some important way.)

Engineering freshmen have long been selected for high ability in math and science. In fact, many students in engineering were first introduced to the field by a high school teacher or counselor who noticed these particular abilities. Math and science ability has become so prominent in the selection criterion for engineering students that other factors—such as inventiveness or communication and teamwork—are in effect much lower in importance. The result is that math and science ability, more than anything else, has become the defining characteristic for those entering the profession. Therefore, it seems reasonable to assume that an increased emphasis in the admission process on interpersonal communication, teamwork, inventiveness, and entrepreneurial thinking should improve the presence of these characteristics in engineering graduates.

This is not a new idea. Others have also reasoned that selecting students for the additional abilities of interpersonal communication and teamwork would be desirable. However, the major challenge in attempting to implement this strategy is the lack of convenient and reliable metrics. The verbal score on the SAT exam does not seem to be well correlated with these desired traits. Neither is any other written exam. As a result, corporations—who search for engineering employees with these same traits—have long required a personal interview with each candidate in an attempt to assess these areas. (Even with a personal interview it can be difficult and elusive to accurately identify the desired attitudes and behaviors.) Therefore, implementation of this strategy requires a substantial increase in the investment of time and resources in the selection process for entering freshmen.

Since we regard this problem to be of substantial importance, we have developed a selection process for entering freshmen that is specifically designed to identify those candidates who demonstrate the desirable personal characteristics. (Of course it is also of high importance in our selection process that each student candidate obtains a thorough exposure to Olin College so they may determine from their perspective whether they fit well with our program. The selection must be mutually desirable.)

Our freshman admission process is similar to that used in industry to select new employees. First, the written applications and supporting materials of all applicants for admission are screened thoroughly by a selection committee of faculty and staff to select a subset of applicants who are considered well qualified. The selection committee attempts to insure that any of the applicants chosen at this stage is very well prepared to succeed in our coursework. These chosen applicants are called "candidates" and their written materials are no longer of primary importance.

All of these candidates are invited to participate in a two-day on-campus interview process to determine the right "fit". The interviews are considered by Olin as a requirement for admission. These interviews take place on one of two "Candidates' Weekends" in late February or early March, and the College helps subsidize the travel expenses of those candidates from distant locations to insure high rates of participation in the event. An great effort is made during these weekends to involve a large fraction of the faculty, staff, and students of the College in meeting and interviewing the candidates and their families. In fact, the event is regarded as among the most important activities of the year, and is planned for months in advance.

Upon arrival for the interviews all candidates are regarded as equally qualified for admission. During the weekend each candidate is randomly assigned to a small team of other candidates and asked to participate in a fun group design project (as an "ice breaker"), a small group discussion of controversial world issues, and then interviewed alone with the admission committee about their non-technical interests. This provides an opportunity to observe each candidate in a variety of situations involving group and teamwork activity, over an extended period of time. Of course, the process also provides an opportunity for each candidate to learn a great deal about Olin College, its programs and people—including the cohort of students who might become classmates and teammates—so that candidates are able to make an informed decision about whether Olin is a good fit for her/him. This is very important to us.

We have been using this selection process for the past five years. We believe it has been effective in attracting a group of engineering students that are noticeably different from the mainstream. The generally high level of aptitude for teamwork, communication, inventiveness, and other characteristics that results from this selection process forms a uniform foundation for our educational environment, and enables a number of distinctive curricular approaches that depend on this. It is hard to over emphasize the importance Olin College has placed on the Candidates' Weekend events and the selection of the freshmen class.

Similarly, Olin College has developed a selection process for potential new faculty members that is distinctive and is aimed at improving the outcomes for the undergraduate engineering learning environment. Each faculty candidate is asked to make two presentations, one which is intended to measure the ability to demonstrate inspirational teaching at the undergraduate level, and one which is intended to illustrate the level of achievement and ability in research, invention, artistic endeavor, entrepreneurial activity, or other creative effort. Students are consulted in the selection process for faculty members in order to insure that the selection includes the opinions of those who are best able to determine whether the candidates have the ability to make the subject relevant, engaging, and inspiring in the learning environment.

We have also been using this process for selection of faculty members for the past five years. We believe it has resulted in the selection of a faculty that is unusual in its uniform ability to communicate, inspire, and engage undergraduates in the study of engineering.

Through this experiment we have become convinced that the culture that results from assembling the right people for the purpose of learning is more important to the learning outcomes than the curriculum. Culture—which is sometimes described as “obedience to the unenforceable”—is a powerful force for determining educational outcomes. It is shaped to a large extent by the attitudes and behaviors of the members of the community. This is of such great importance that we believe it justifies large investments in the process of selection of new members of our community.

RECOMMENDATIONS

The work facing the Commission is of great national importance, and extends far beyond engineering education. Although the experiences at Olin College are limited, some of the fundamental observations reported here may be of use in more general validity. In particular, I suspect that students in general may frequently be capable of achieving more than is currently expected of them, provided they have proper support. Further, engaging students more directly in the design of their environment and in their own education may provide substantial benefits in learning and motivation. In addition, promoting a culture of continuous improvement and innovation within colleges and universities may be the most effective way to consistently improve the competitiveness of educational outcomes. Finally, I am frequently struck by the importance of the desire and commitment of the teacher in affecting learning outcomes. There are a multitude of reasons why each of these challenges are difficult to address in existing educational systems, and unfortunately I don’t have any simple suggestions for making rapid improvements in all cases.

It is natural that I would be most concerned about the need for improvement in the math and science preparation of our country. As the Department of Education struggles with ways to address this, it would seem obvious that closer cooperation with the National Science Foundation would seem to be an important first step in the process. I would recommend that the DOE and NSF consider working together more closely—perhaps joining forces—to address this problem of growing national concern.