

Criteria and Processes of ABET 2000 in the Recruitment of New Engineering Students

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Abstract

In response to far-reaching advances in technology and sweeping changes of business practices in the global market environment, the Accreditation Board for Engineering and Technology (ABET) has initiated in the mid-nineties a gradual transition towards new criteria, guidelines, and approaches for the accreditation of undergraduate engineering programs. Collectively referred to as "ABET 2000", the new accreditation requirements reflect the dynamics of the job market, with the purpose of satisfying emerging personnel needs of the industry, as well as the career goals and interests of engineering students. Although the ABET evaluation process is centered on the education of students who are enrolled already in an undergraduate program, many of its elements can benefit also the process of recruiting new engineering freshmen. The College of Engineering and Mineral Resources (CEMR) at West Virginia University (WVU) has initiated a formal, sustained and comprehensive effort to integrate within its recruitment efforts selected ABET principles, guidelines, and practices. A framework of "Total Quality Management" (TQM) is thus established for engineering recruitment, that encompasses all the three key elements of the ABET 2000 criteria – 1) educational objectives, 2) metrics of quality and effectiveness, 3) formal process for outcome assessments and continuous improvement. A powerful synergy exists between the content of information presented to prospective students and their families through the recruitment process on one hand, and the basic ABET accreditation criteria, on the other hand. It spans over a broad range of issues, concerning the quality of students and faculty, the program objectives, the professional component and outcomes, supporting facilities and institutional resources. Such synergy provides the rationale for systematic, measured transition of appropriate concepts from the process of ABET evaluations to that of recruiting engineering freshmen. Furthermore, a well documented assessment process, in terms of quantitative metrics for continuous improvement, as it is fostered by the ABET guidelines, is likely to provide an effective mechanism for evaluating the effectiveness of various recruiting activities.

I. Introduction

The dynamics of contemporary changes in the global economy, in the government regulations, in the modern technologies, as well as in the demographics of the U. S. population, have triggered a systematic reforming process in engineering education [1]. It entails not only major re-alignments of instructional topics and methods, but also updated strategies for student recruiting, admission, services, and development. Detailed accounts of new programs developed and implemented by CEMR at WVU for effective recruiting of engineering students have been presented at previous annual conferences of the

American Society for Engineering Education [2, 3]. The first article described the process and the payoffs of a sustained, pro-active, wide-based, and well-integrated initiative for recruiting new students. The second article highlighted the importance of providing every prospective student and his/her family with personalized, unbiased advice about the entire spectrum of available choices for an education and a career in the engineering profession.

A key element of WVU's approach to the recruiting of new engineering students is the consistent practice of a continuous improvement process, whereby the outcomes of various recruitment activities are measured and assessed regularly, in the context of pre-established objectives. This strategy turns out to be an essential factor in the success of WVU's recruitment initiatives, which has not been emphasized and discussed previously in sufficient detail. It is, therefore, the primary purpose of this article to describe how a framework of TQM, as fostered by the new ABET 2000, accreditation criteria of the Accreditation Board for Engineering and Technology [4], has been implemented at WVU. Gradual integration of selected guidelines and principles formulated not only by ABET, but also by other national commissions or task forces for improving the education in the U.S. [5, 6, 7], has benefited greatly WVU's efforts to recruit new engineering students.

II. Responsiveness to Change

The model of a private business was chosen to serve as the underlying foundation for structuring, guiding and evaluating all the new initiatives for recruiting engineering students at WVU. The customers of such a hypothetical business are high-school students and their parents, both from West Virginia and the surrounding states, extending to New York, New Jersey, Delaware, and Florida. Similar to typical customers in any other business, students and their families shop for the "best deal" when they explore opportunities for college education. Furthermore, similar to any other commercial sector of the business world, different universities must compete for high-quality students by "marketing" effectively their educational products and services. In response to such competitive pressures and facing a steady decline in the freshman engineering enrollment, to a low of 268 students in 1995, CEMR at WVU has established an intensive, multifaceted recruitment program, focused on the customer. While outside factors, beyond the control of the college, such as the conditions of the national economy, or the population demographics in the state of West Virginia, may have led to the decline, it became evident that a concerted, drastic action is required in order to reverse the trend.

The expected transition towards the concept of "Virtual Campus" [8] and interactive, distance -learning, appears to be slower and less certain today than a few years ago. Undoubtedly, computer networks open up new opportunities for teaching and recruiting, but they also change the dynamics, and even the players, in the competition for new engineering students. Several universities have included opportunities for off-campus courses, or virtual-learning, in a continuous quest to offer unique capabilities and services to prospective students. Although on-line courses seem to be effective for graduate studies and short, intensive-training sessions, their dropout rates are about 10 to 20 percent higher than for conventional classroom instruction of undergraduate courses [9].

The importance of face-to-face, direct interactions between undergraduate students and instructors is commonly recognized and accepted today as vital for a high-value engineering education, with or without the support of “e-learning” [10]. Even when high-quality course notes are posted on the World Wide Web, as in MIT’s “Open Course Ware” environment [11], students may use them merely as repositories of knowledge, but not as formal education channels to meet any degree requirements through distance - learning. The recruiting materials and activities for engineering freshmen at WVU build consequently, a rather balanced and realistic picture of “virtual-learning” opportunities. It is a picture that leverages the benefits of cyberspace as an enhancement, but not as a substitute to classroom teaching. It is a picture of an educational environment that bridges the gap between on-line and off-line instruction, thus utilizing effectively their synergies, as well as their separate capabilities [10].

III. Synergy with ABET 2000

Broad recognition of the need to adapt undergraduate education to new technological developments and societal restructuring has spawned a worldwide wave of reforms in both the curriculum content and its methods of instruction [12]. The Accreditation Board for Engineering and Technology (ABET) has provided a formalized framework for reforming the engineering education in the U.S. by revising in the mid-nineties its own criteria and processes for accreditation of undergraduate degree programs [4]. Collectively referred to as "ABET 2000", or the Engineering Criteria “EC2000 Standards”, the new accreditation requirements reflect the dynamics of the job market, with the purpose of satisfying emerging personnel needs of the industry, as well as the career goals and interests of engineering students.

Unlike the prescriptive format of the old accreditation procedures, that may have stifled sometimes curricular innovations, the new EC 2000 criteria provide a formal, consistent mechanism for importing selected business practices and principles into the engineering education process [13]. They foster a “customer focus” approach for accredited engineering programs, similarly to successful business enterprises whose regular operations are consistently driven by customer requirements and expectations. Academic institutions are in the business of providing high-value undergraduate education to a broad and diverse customer base that includes the students, their families, and their prospective employers. Consequently, the EC 2000 standards emphasize the quality of student education by enforcing a sustained process of measuring educational outcomes, evaluating them against pre-established sets of educational objectives, and improving them continuously through rational changes. Every academic program leading to an engineering degree is empowered to define its specific educational objectives, in accordance with its expected outcomes, its constituencies, and the mission statement of its parent institution. The ABET standards thus allow universities and colleges the flexibility of tailoring their measures of quality and success to their own goals, interests, strengths, and constraints, as they are embodied in the statements of educational objectives and outcomes. This is a critical step in the accreditation process, since the quality assessment of any degree program is performed in the reference to its specific educational objectives and outcomes, as stated in advance.

Although the ABET evaluation process is centered on the education of students who are enrolled, already, in an undergraduate program, many of its elements can benefit also the process of recruiting new engineering freshmen. CEMR at WVU has initiated a formal, sustained and comprehensive effort to integrate within its recruitment efforts, selected ABET principles, guidelines, and practices. A framework of "Total Quality Management" is thus established for engineering recruitment, that encompasses all the three key elements of the ABET 2000 criteria – 1) educational objectives, 2) metrics of quality and effectiveness, 3) formal process for outcome assessments and continuous improvement. A powerful synergy exists between the content of information presented to prospective students and their families through the recruitment process on one hand, and the basic ABET accreditation criteria, on the other hand. It spans over a broad range of issues, concerning the quality of students and faculty, the program objectives, the professional component and outcomes, supporting facilities and institutional resources. Such synergy provides the rationale for systematic, measured transition of appropriate concepts from the process of ABET evaluations to that of recruiting engineering freshmen. Furthermore, a well documented assessment process, in terms of quantitative metrics for continuous improvement, as it is fostered by the ABET guidelines, is likely to provide an effective mechanism for evaluating the effectiveness of various recruiting activities.

IV. Statement of Objectives

In the face of declining pools of high school graduates in the state of West Virginia (between 1995 and 2005 the number of high school graduates is declining by 25%), and fierce competition from other universities, CEMR at WVU has identified three major objectives for its intensive, comprehensive efforts to recruit new students:

- Effective dissemination of information about the engineering degree programs offered by CEMR.
- Personalized attention and unbiased advice to prospective students and their families.
- Active, sustained and well-planned process of data collection for assessments of recruitment outcomes, and continuous improvement of recruitment activities.

The consistent pursuit of these objectives can be schematically illustrated in the form of a closed recruitment cycle, as shown in Fig. 1, where the outcomes of various efforts are continuously evaluated, and corrective measures, or other improvements are implemented whenever the need arises, or an opportunity is identified. Such a process of continuous assessments and progressive improvements is routinely implemented today in numerous industrial and government organizations, as an essential element of a Total Quality Management (TQM) environment. The benefits of continuous outcome assessments have been quantified extensively in the past, leading to the central role that such assessments currently play in the ABET 2000 accreditation criteria of undergraduate engineering degree programs.

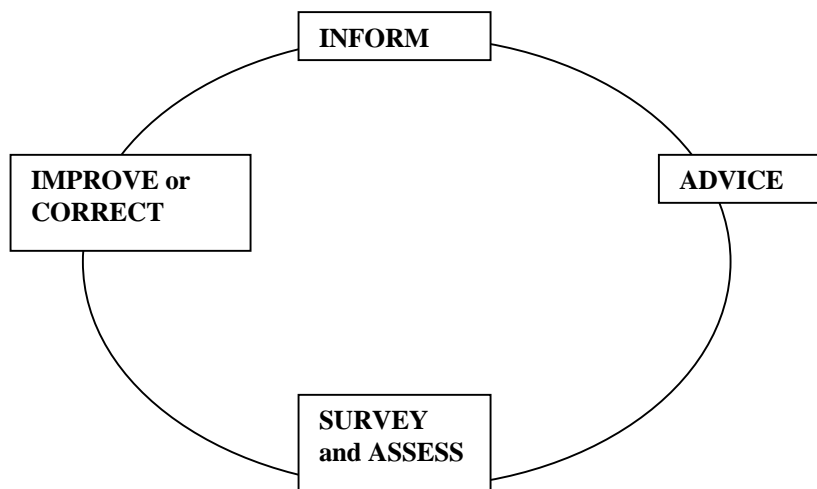


Fig.1 – Closed loop of Recruitment Objectives

The centerpiece of the activities for disseminating proper information about the undergraduate degree programs available at CEMR is a concise, but informative package of facts, based on recommendations received from the faculty, alumni, and contacts with industrial companies, government agencies, or other universities. It emphasizes the collaborative, open, modern learning environment, where engineering design and research are integrated, along with engineering sciences, throughout the curricula, starting with the "freshman experience" in the first semester [14]. The mechanisms utilized for disseminating information to prospective students combine extensive mailings with frequent visits to high schools, and close, repeated interactions not only with student candidates, but also with their parents, other relatives, teachers and counselors. Special attention is paid to the contacts with high-school officials, who exert, usually, a strong influence on the career decisions of their students.

Most prospective students feel rather disoriented and even helpless, when facing the task of sorting through a bulk of information about a wide variety of options for a college education and a professional career. Their own personal interests, strengths, weaknesses, pressures and constraints further complicate their choice of an academic institution and an undergraduate major. One could survey, for example, the reports published periodically in the media about rankings of educational institutions [15], employment markets, or outlook to professional careers, e.g., [16], and feel easily overwhelmed by their high levels of complexity.

A structured approach of multiple decision criteria is followed at WVU for guiding student candidates towards their best educational and professional career choices. All major factors are considered simultaneously in this process of selecting a particular profession or undergraduate education program, even though they are not all equally important, and not all can be quantified in the same way. The conventional approach to formalizing the simultaneous consideration of multiple decision criteria is to assign a relative "weighting factor" to each of them, so that these factors add all up to 1 (or 100)

for the complete set of criteria [17, 18]. While these weighting factors reflect the perceived importance of every criterion, relatively to each other, they reflect merely the perspective of the "conventional wisdom", which may, or may not, agree with the particular interests, constraints, or objectives of each and every person contemplating the choice of a professional career and, or an educational institution.

V. Metrics of Recruitment Outcomes

The effectiveness of the efforts to distribute, or convey, useful information about CEMR's undergraduate degree programs to prospective students and families is measured primarily, in terms of the number of people reached for this purpose, their diversity and geographic distribution. The annual recruiting cycle starts in the summer, when the College Board and the Educational Opportunity Service provides CEMR with a current list of high-school students who are interested in the study of engineering, and have qualified for admission into the college. This information is used to update the computer database maintained by CEMR's recruiting office, that includes about 36,000 names of prospective students and high-school personnel, mainly mathematics/science teachers and counselors, from West Virginia and twelve other states. A brochure describing CEMR's undergraduate programs is mailed in the summer to the entire distribution of this database.

Frequent visits are conducted throughout the year to various high schools in the region, to initiate and maintain close contacts with students, their families and teachers. Such interactions are established, usually, in response to phone calls from the school for classroom visits, or for participation in "career days". Invitations to attend "College Information Nights" offer another opportunity for direct interactions with high school students and officials. A wide range of other off-campus recruiting activities include participation and displays at the state conference of Mathematics and Science teachers, the West Virginia state fair, as well as numerous local public events, such as parades and festivals. CEMR's facilities and personnel are accessible every day to students and families who wish to visit and acquire information about its academic programs. Scheduled, on – campus, events include a formal "Open House" offered twice during the academic year, as well as annual hosting of the TEAM+S competition. Between the months of March and May, the CEMR can be visited as part of the "Day on Campus" program, by any group of students from K through 12. Detailed records of the number of potential students who could, possibly, be reached through such activities, provide a credible measure of their effectiveness relative to each other, as well as an assessment of trends associated with the cost-payoff ratio of each type of activity.

VI. Assessment and Improvement Process

Consistent and structured record- keeping is an essential requirement for a successful process of continuous improvement. During the last seven years, CEMR has maintained and expanded consistently a rather extensive documentation of various initiatives for recruiting engineering students, the outcomes generated by every activity, and the actions devised for their improvement. Partial results of this effort have been brought up and

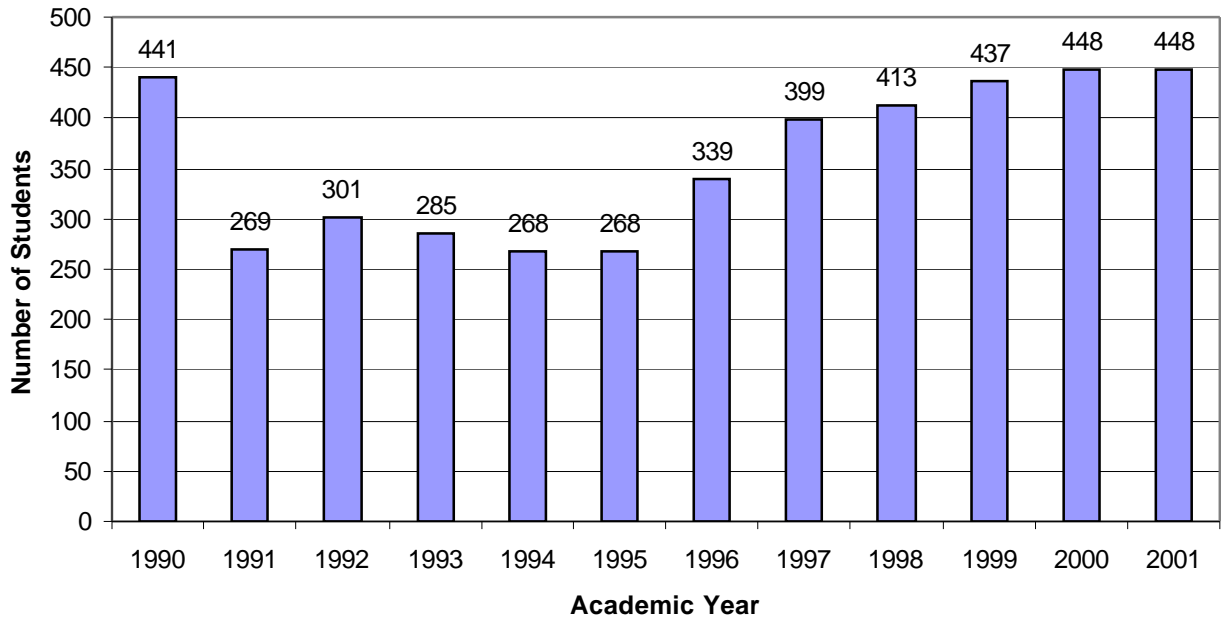
discussed in previous publications [2, 3]. At the heart of the outcome assessment process lays a systematic effort to record and survey each recruiting initiative separately, in order to correlate its cost and execution characteristics with its payoffs in terms of measurable metrics of effectiveness, which are compatible with the objectives stated above. The main relationships between the objectives, corresponding activities, their outcomes, and metrics in the student recruitment process at CEMR are summarized in Table 1 below.

Table 1–Basic Elements of Continuous Improvement Process for Recruiting New Engineering Students at WVU

OBJECTIVES	ACTIVITIES	OUTCOMES	METRICS	TRENDS	CHANGES
Dissemination of Information	Collect Data on Graduates	Database of Candidates	Number of Names/Entries	Increasing to 36,000	Added Info. Resources
	Mail Brochure on Programs	Initial Contact and Exposure	Number of Follow-ups	Steady at about 2%	Yearly Updates
	Correspondence to High Schools	New Students and Referrals	Applications by school	Amplified Interest	Expanded coverage
	Visits to High Schools&Events	Heightened Interests	Inquiries from each visit	Better students	More often and schools
Advising for Career Choice	Spring-Telethon by the faculty	Personal attention/advice	Students reached/helped	Limited results	Short, but frequent
	Visits to WVU	On-site advice & highlights	Number of students/families	Dominant factor	Open-door practices
	Open-House / Visitation Days	Interactive displays&talks	No. of attendees and follow-ups	Increasing to 400	Optimal Timings
	Orientation sessions	Early exposure and screening	No. of attendees and decisions	Increasing rates of retention	New Pre-engineering Option
Surveys and Assessments	Questionnaires tailored to event	Feedback on specific issues	Accuracy, time and relevance	Shorter, Frequent Surveys	Enhanced clarity and focus

The ultimate metrics of effectiveness for any student recruitment program is, obviously, the total enrollment figure in each freshman class, and the trend of its variations from one academic year to the other. The enrollment of engineering freshmen at WVU decreased steadily from 1990 to 1995 reaching a low of 268 students. In 1995 a decision was made to implement a recruiting program. The number of incoming freshman has risen steadily since this program was initiated, from a low of 268 students in 1995 to a high of 448 students in 2001 (a total increase of 67%), which is the single most credible assessment of its level of success. Furthermore the steady rise in enrollments, despite a decreasing pool of graduates from West Virginia high schools, demonstrates clearly the payoffs of the continuous assessment and improvement strategy that underlies WVU' s recruitment process (see Fig.2 below). A complete evaluation of the recruitment process must assess separately each activity and its expected outcomes, in order to estimate its effectiveness, identify its strengths or potential deficiencies, and decide on corrective or improvement actions.

Fig. 2 - Freshman Enrollment in the Fall Semesters



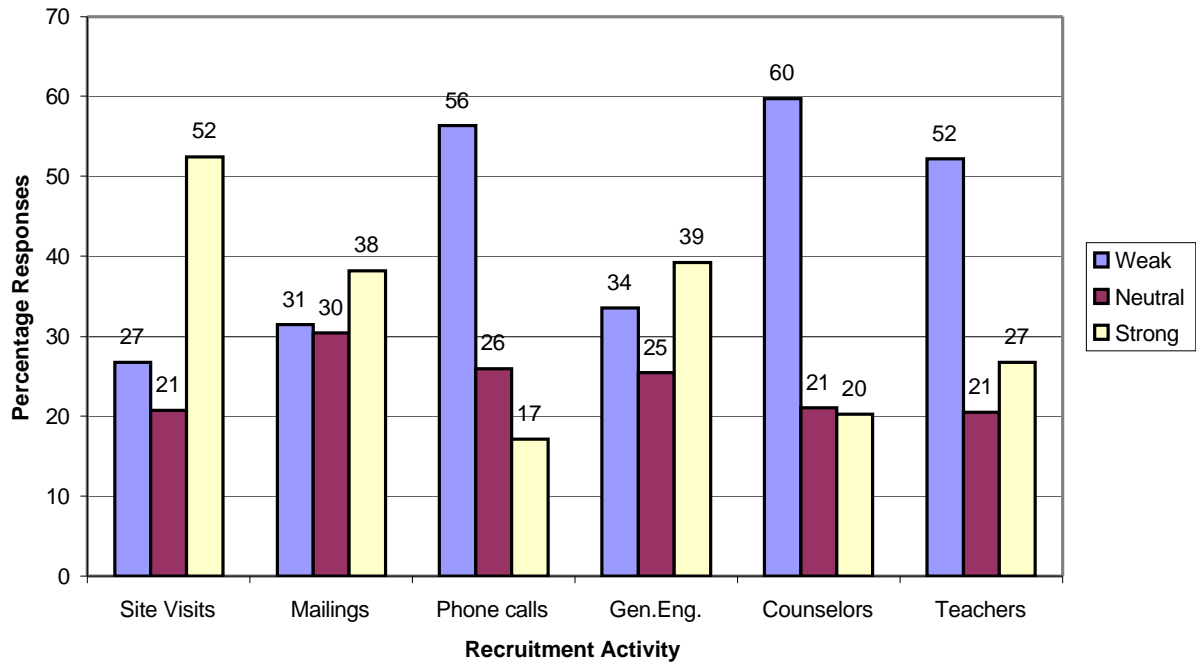
VII. A Sample of Results and Actions for Continuous Improvement

During summer orientation sessions for incoming freshmen and their parents, the attendees are asked to fill out questionnaires about the various factors that played a role in their decision to choose WVU in general, and CEMR in particular, for engineering education. These surveys are valuable tools of outcome assessments, since they point towards the most effective aspects of the recruiting program, from the viewpoints of both students and parents. In general, they indicate that mailings and visits often play a dominant role in the college selection process, though the other activities also bring significant contributions in numerous cases. Consistent with results from previous years [2, 3], more than half (52%) of the 385 freshmen surveyed in 2001, confirmed the importance of their exploratory visits to the WVU campus, whereas close to 40% considered the mailings from WVU, as well as the availability of a General Engineering program in the freshman year, as dominant factors in their decisions to study engineering at WVU (Fig.3).

In response to such feedback, the number of visitation days to the WVU campus has been increased while the programs of these visits has been expanded, both in quality and in efficiency. The written material distributed through regular mailings is updated and improved continuously, both in content, and in its presentation formats. It is interesting to note in Fig. 3 that only about one third of the students consider the visits, the mailings,

and the General Engineering option of marginal importance, but more than half express the same opinion about their high school counselors and teachers.

Fig.3 - Relative Importance (percentages) of Main Recruitment Approaches, based on Surveys of 385 Incoming Freshmen in Summer 2001



Students and parents express frequently disparate views regarding the ratings of major considerations, or constraints, in their college selection process. The parents appear to appreciate more strongly than the students the value of an early, customized advice regarding the decisions on educational tracks and professional careers. As indicated in Fig. 4, the parents appear to value even more than the students the relative importance of site visits and the General Engineering program, while reaffirming the futility of phone calls and the ambivalent effectiveness of mailings.

Many decision criteria employed by prospective students and their parents in the process of selecting a major and an institution of undergraduate education can be considered, but not controlled, in the continuous improvement process of a recruitment program. Such factors as geographic location, the influence of relatives and friends, or tuition costs are obviously, beyond the control of recruiting personnel. They could, however, be utilized and highlighted properly in a successful recruitment strategy, along with such possible incentives as scholarships, Co-Op options, tuition costs and payment schedules. As shown in Fig. 5, cost and location are important reasons for choosing a WVU program for engineering education, but the importance of scholarships is not conclusive, whereas such other factors as the Co-Op option, or the influence of relatives and friends are not perceived by the students surveyed as to be important tools for recruiting new students.

Fig.4 - Relative Importance (Percentages) of Reasons Provided by 240 Parents in Summer 2001 for Selecting Engineering education at WVU

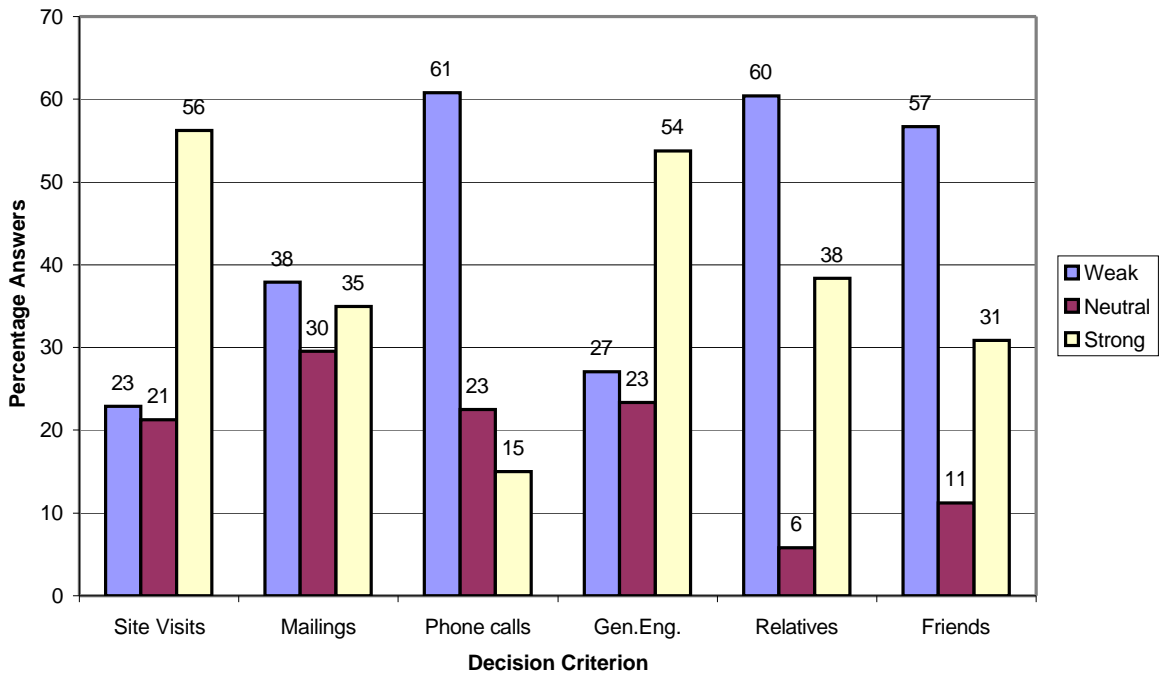
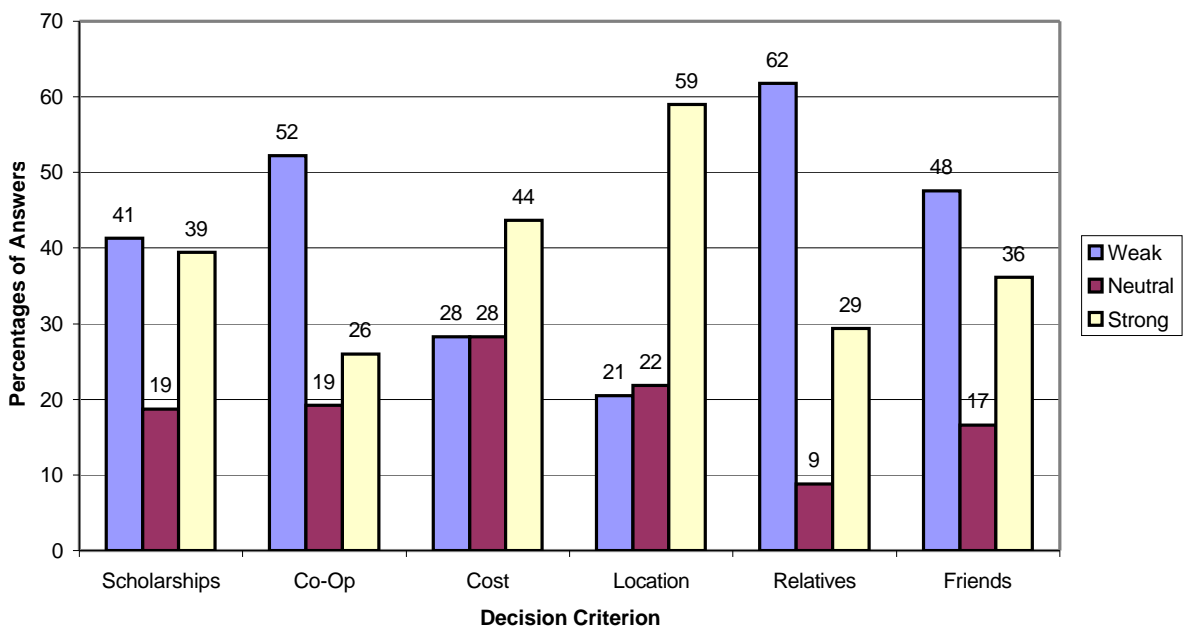


Fig. 5 - Relative Importance (Percentages) of Financial / Social College Selection Criteria Provided by 385 Incoming Freshmen in Summer 2001



By in large, the students seem to be more prone than the parents to let elements of randomness guide, or influence the process of choosing one career path or another, at one institution of higher learning or another. This observation may be linked, to some extent, with the nationwide high rates of attrition in the freshman year (about 30% of the incoming students), as well as with the high percentage of engineering students who remain still undecided late into the freshman year. A survey of incoming engineering students at WVU reveals that the percentage of students who are undecided as to the major field in which they choose to specialize drops from about 75% during the summer orientations, to only about 50% by the middle of the freshman year. While an overwhelming proportion of about 95% of the new students assert that orientation seminars to various engineering disciplines help them to understand the profession better, over two-thirds of the freshmen reply usually, that such seminars do not affect their own career choices. In response to the trends noted above, CEMR at WVU has initiated a "Pre-Engineering" program that will assist students interested in pursuing an engineering education, through a framework of early preparation and orientation towards an engineering discipline of their choice

The parents of engineering students in the 2001 freshman class provided about 240 comments about their particular reasons for enrolling their sons or daughters at WVU, of which over one third are related directly to personal contacts with its representatives, either through separate, face-to face meetings, orientation seminars or telephone conversations. There were, approximately, 72 cases (30%) where the parents had merely accepted their son or daughter's decisions to attend WVU, which were often based on non-academic considerations such as athletics, heritage, geographic location, dorm rooms and class sizes. It is interesting to observe that, so-called traditional criteria for choosing an institution of higher education did not weigh heavily in the parents' replies, with only about 20% outlining the reputation, quality, and diversity of the academic programs, about 13% mentioning family links or contacts with friends and alumni, whereas only 2% referring to the financial assistance offered by the institution.

Conclusions

The competitive environment of the business world is spreading gradually, to the field of high-level education, where many universities struggle to expand and enhance their student population through innovative, aggressive methods of recruiting, complemented by high-quality educational programs. An essential key to success in such a competitive and challenging enterprise is the TQM approach, fostered by the ABET 2000 criteria, and practiced in recent years extensively in many industrial sectors. The College of Engineering and Mineral Resources at WVU lives up to this challenge by "marketing" effectively its resources and approaches for undergraduate education, through a sustained, pro-active, wide-based, and well-integrated initiative for recruiting new students. Its fundamental backbone is the principle of continuous assessment and improvement, applied to a process that is intended to mesh essential elements of a high-value engineering education, with personal interests, abilities, needs, and concerns of prospective candidates. The remarkable successes that such a recruitment program have yielded so far at WVU prove unequivocally that the required levels of resources,

institutional support, personal commitment and dedication are worthy "investments" in the future growth and viability of its engineering curricula.

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