To Be or Not To Be – A Decision Process for Creation of an ASEE Student Chapter

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Introduction/purpose:

The fairly recent appearance of ASEE student chapters has been lauded by ASEE leadership, and establishment of new chapters encouraged. Student chapters have very different operational concerns than ASEE Divisions, and these concerns must be recognized when considering the formation of a new student chapter. First and foremost is the concept that, as a student organization, an ASEE student chapter should be student-led and student-run with help of the faculty advisor; the consequence is that the constant turnover of students poses a great challenge to the continuity and survivability of the organization.

The decision whether to create a new student section at Tulane University was being made and served as a case study for development of an analytical method to determine the viability of a potential student section. The resulting process should be applicable to other institutions.

Materials/methods:

Variables were constructed to represent what we viewed as important factors in the survivability of a student section. These included engineering school demographics (student population and composition, average residency, academic and research workload, student funding type, number of competing campus professional organizations) along with factors influencing student interest (presence and involvement of ASEE professional members). These variables were compared to a metric, named the chapter survival index, based on measurable outcomes: number of student members, number of meetings, number of events, and number of event attendees. Statistical methods were employed to investigate trends and seek relationships in the obtained data from existing and defunct student chapters.

There are at the current time five active ASEE student chapters. Of these, the chapter at Northwestern University was formed within the past year and has no published information on activities, and the chapter at Broome Community College is composed of all undergraduates which makes comparisons to graduate chapters difficult. The three remaining mature, active ASEE student sections are located at the Universities of Michigan, Texas, and Wisconsin. Three dormant ASEE student sections are associated with the State University of New York at Buffalo, Purdue University, and Virginia Polytechnic Institute & State University.

Data was gathered for the academic year 1999-2000 based on published reports, web site information, and direct inquiry of current chapter officers or engineering school personnel.[1-17] Additionally, the list of all current ASEE student members was obtained to indicate potential student chapter locations; candidate schools were taken in general as those with at least five student ASEE members, and pertinent information for these selected institutions was obtained. Figure 1 presents a list of all variables used in generation and application of the analytical model.

Student Chapter Characteristics:

STLOC	number of local (not national) student members at the school
STCONF	number of student members attending the last ASEE annual conference
MTGS	number of student chapter meetings and events per year
AVGATT	average attendance at meetings/events
AWARDS	number of awards sponsored by the student chapter

University Characteristics:

TOTFAC	total number of faculty in the school of engineering
PCTFMEM	percentage of engineering faculty members who are ASEE members
GDTOT	total number of engineering graduate students
PCTGDFT	percentage of engineering graduate students who are full-time students
PCTPHD	percentage of engineering graduate students who are PhD students
PCTADMIT	percentage of applicants who are admitted for graduate engineering study
AVGRES	average number of years a graduate student is at the school (calculated)
PCTTA	percentage of engineering graduate students supported by teaching assistantship
CLUBS	number of engineering professional clubs/organizations at the school
STASEE	number of national ASEE student members at the school

Figure 1: Regression variable names and descriptions

Results:

We constructed a "chapter survival index" (CSI) for existing, mature student sections as a weighted sum of student chapter characteristics/activities – the intended value range was 0 to 100, with higher values denoting more active chapters. A value of 50 or greater was targeted to suggest probable survival of a student chapter. The exact formula used to calculate the CSI for active chapters was generated by empirical rather than mathematical methods, and is as follows:

$$\text{CSI}=0.5*(STLOC+STCONF)+STASEE+2*MTGS+0.2*AVGATT+10*AWARDS$$

The thought process behind the assignment of weighting factors was based in the desire to recognize not only the number of members but also the time invested in activities. Consequently, the number of meetings and events was multiplied by two and the number of sponsored awards was multiplied by ten to reflect the relative time and effort required by several members to organize and maintain such programs. Conversely, the number of national ASEE student members received even weighting with a bonus of one half for those students who attended the annual conference. Local student members were added at a weighting of one-half to reflect the lesser commitment normally associated with this type of membership, and overall attendance counted at one-fifth to recognize the chapter's ability to gain interest by the general public.

As a check, these weightings were applied to the existing chapters and the results evaluated. At this time, the chapter at the University of Michigan is arguably the most active student chapter, therefore the CSI for that chapter should be near the target index maximum, 100. Also, characteristics for a mythical successful student chapter were created and the desired success threshold value of 50 obtained from the final equation; this section would have 10 paid ASEE members, twice that number of local members, send two students to the annual conference, have one event each month of the 8-month academic year and four organizational meetings, and have an average attendance of 25 people at their meetings and events. Note that an award program was not assumed to be a necessary component of a successful chapter. By targeting the weighting factors according to these two bookends, this formula produced CSI values between 48 and 96 for the three existing, active graduate student chapters. When applied to the other two active chapters, this algorithm yielded CSI values of 102.5 and 34.5 for the chapter at Broome Community College and the new chapter at Northwestern, respectively.

The three dormant chapters have no chapter activities by definition, and using the chosen formula to determine CSI for dormant chapters produced only the number of student ASEE members at each school. An assumed functional minimum CSI value of 20 far exceeded the obtained CSI's for each of the three dormant chapters. Additionally, since student membership was to be an input to any ensuing mathematical analysis, skewing of this magnitude could cause many problems and was deemed inappropriate. To avoid such difficulties while still maintaining relevance, CSI values were assigned to each dormant chapter according to the number of years it was active:

$$\text{CSI}=20+3*(\textit{active years})$$

This formula yielded values ranging from 23 to 35 for the three dormant student chapters. These values were not utilized to generate regression coefficients, but they were used in the selection of regression equations once coefficients were created.

Stepwise linear regression was initially used to generate coefficients relating the input variables to the CSI for the three mature student sections. In stepwise linear regression, all possible input variables are initially included in the regression. Coefficients are calculated, and the product of each coefficient with its corresponding variable is called a term. Standard error is generated for each term as well as the entire equation, and the variable associated with the term having the highest error is tossed out. The process is repeated until only one term remains. Ideally, the most relevant input variables survive to the end of the process.[18]

Linear regression has mathematical fits if similar variables are included in the calculation, therefore correlation coefficients were calculated for all input variables and input cases prior to running the regression. Variables with a correlation coefficient (r) higher than 0.997 were considered to be redundant and were not run simultaneously in any regression equation; this value corresponds to a p=0.05 level of statistical significance in correlation for one degree of freedom by t-test. Obtained correlated variable pairs are shown in Figure 2, along with the calculated correlation coefficients. For the three input cases composed of the active student sections, this restriction on input variables alone limited the number of variables in the regression to a maximum of seven at any time.

Variable #1	*Variable #2*	*r*
TOTFAC (total engineering faculty)	*PCTGDFT (% full-time graduate students)*	*-0.998*
TOTFAC (total engineering faculty)	*AVGRES (student average time in residence)*	*-0.998*
PCTFMEM (% faculty ASEE members)	*STASEE (number of ASEE student members)*	*-1.000*
PCTADMIT (% admitted graduate students)	*CLUBS (number of graduate/professional societies)*	*1.000*

Figure 2: Highly correlated regression input variables

The small number of cases in the regression poses a mathematical quandary. Regression of more variables than cases may be invalid, and regression of the same number of variables as cases yields an almost exact fit. To ensure mathematical validity for this study, the maximum number of variables included in equation generation was restricted to two, one less than the number of cases. To generate these smaller equations, multiple linear regression was employed; all possible combinations of input variables were created for each term size, from two to one, and ranked in order of obtained error.[19] To include as many variables as possible in the final comparisons while maintaining mathematical validity, a simple average of four two-variable equations was employed to obtain the chosen final regression equation. The final equation choice was based upon error for not only the three input schools but also for the dormant chapters and the new Northwestern University chapter as check cases independent from equation formulation.

Once regression coefficients were obtained for the input variables based on the three existing student sections, CSI's were calculated for all schools of interest and designated CSIR -- CSI from regression. A bar graph showing obtained values for all schools of interest is shown as Figure 3. The chosen composite regression equation yields results with a standard error of 13.7 index points:

$$CSIR=0.0176*GDTOT+0.0898*PCTTA-0.0173*CLUBS+2.2165*STASEE-1.3930*AVRES+0.0689*PCTPHD$$

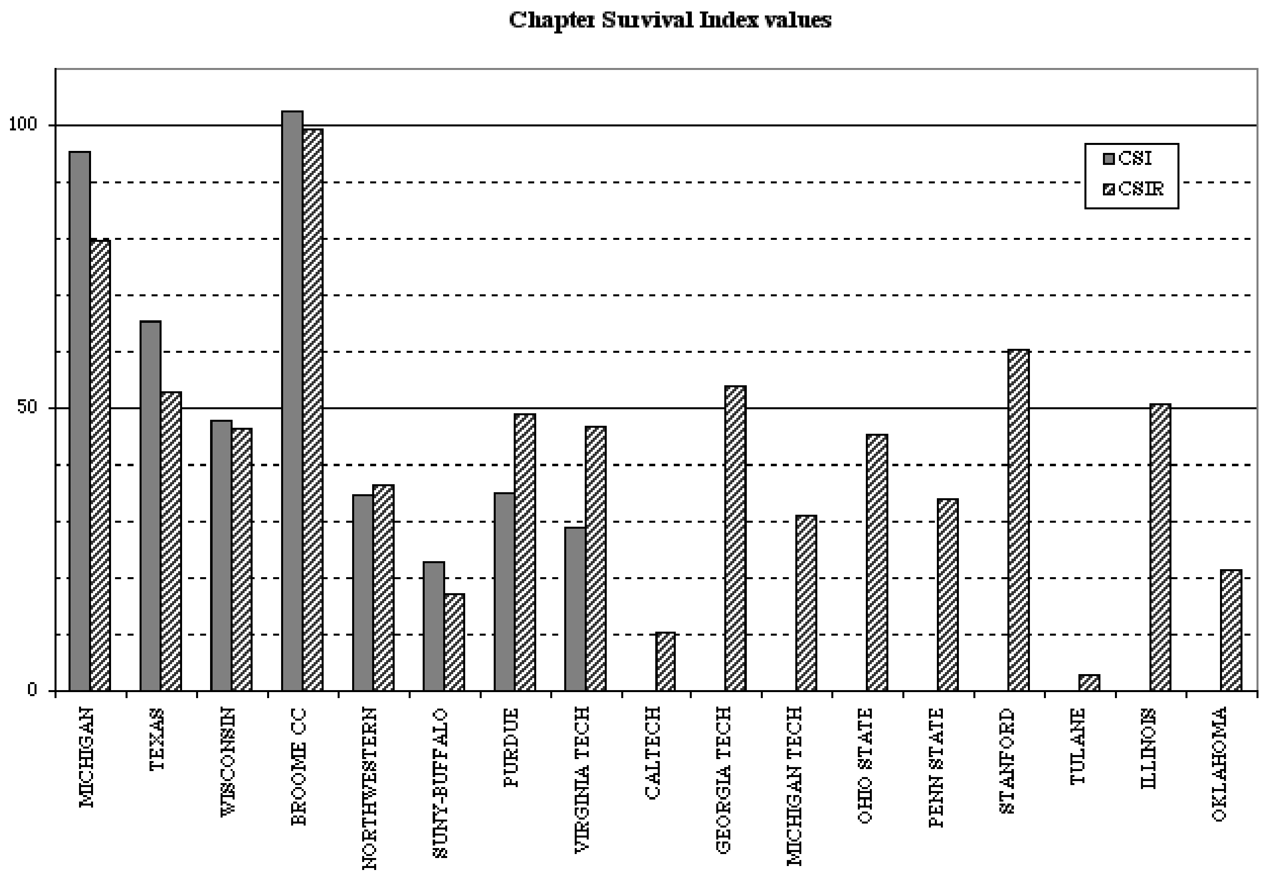

Figure 3: Original and regression-calculated Chapter Survival Index values for all schools of interest

Conclusions:

Through use of a multivariable equation obtained by regression, we are able to accurately calculate an index of ASEE student chapter activity level based solely on university characteristics which are relatively easy to obtain. Comparison of obtained index values to a threshold value can be used to (1) to indicate locations for potential successful student chapter creation, (2) to point out existing chapters which may require outside intervention to survive, and (3) to avoid wasting effort trying to start a chapter in an environment which is not conducive.

This study was ripe with preconceived notions, most notably in the initial creation of index values and input variables for the subsequent regression analysis. Quantifying the success of a student chapter is a dicey proposition at best. Assigning value to differing activities, membership, and participation was completely subjective. In relating chapter success to university parameters, it was proposed that an ASEE student chapter would compete primarily with other engineering professional societies for membership and participation. It was also thought that at schools offering both MS & PhD degrees, the majority of student members of ASEE would probably be PhD students interested in academic careers.

When deciding upon the input variables to be used in the analysis, the connection between variable and index for some variables was not known, but instinct dictated some expected trends. It was thought that the percentage of ASEE faculty members should positively influence student interest in the organization, and that a larger number of student ASEE members should facilitate and feed the manpower needs of a student chapter. Since it was thought that the most likely candidates to join a student section would be PhD students, both the percentage of PhD students and the percentage of full-time graduate students were thought to aid in creating an atmosphere conducive to a student section. Also, the total graduate population was seen as an additive factor since an overall critical mass of graduate students has been suggested as a necessary requirement for sustaining a student chapter.[20] Conversely, the number of other available professional clubs and societies was conjectured to detract from the number of people available to join and actively participate in a new ASEE student chapter; although it may be argued that the other organizations have a different focus than ASEE, it must also be recognized that graduate students have a finite amount of time to share among all their endeavors. Relations for the remaining variables were not so clearly predictable. Average residency could be either additive due to reduced turnover of the student membership, or subtractive because of long-suffering students who might be more closely focused on their research. Likewise, total faculty size could provide more potential resources for the chapter, or less interaction with students due to the sheer size of the engineering school. The lower percentage of admitted students could reflect selectivity in admissions and therefore a more committed student body; many times, this more often reflects whether the school is publicly or privately owned. A high percentage of students on teaching assistantships may reflect an interest and involvement in teaching, but it may also show higher time demands on the graduate students.

It appears from the analysis that our notions were not unreasonable. It was possible to obtain an index equation additive and subtractive in several of the expected variables. The chosen equation increases with higher graduate population, higher percentage of teaching assistantships, higher proportion of PhD students, and larger membership in ASEE, while decreasing with a higher number of competing clubs and higher average graduate student residency.

While faithful calculation of the CSI's at the schools with mature, active chapters was reassuring, the real interest was the CSIR's for the other schools in the study. The average CSIR obtained for all schools in this study was 39.9, with a standard deviation of 19.9 points. For schools with dormant sections, SUNY-Buffalo's index did fall below the mean but Purdue's and Virginia Tech's indices exceeded it, showing that this process is not yet an exact science. Northwestern's index fell just below the mean as well, possibly indicating challenges for the newly formed chapter there. The highest index value at a candidate schools was obtained for Stanford University and was greater than one standard deviation above the mean value, indicating a significantly supportive environment for the creation of a student chapter there. And despite the enthusiasm of the authors, a CSIR more than one standard deviation below the mean suggests that an ASEE student section would not thrive at Tulane University under the current conditions.

It is important to note that this analysis is based on a very small number of example cases – there are only three thriving (graduate) student chapters, one new chapter, one junior college, and three dormant chapters. The chosen candidate schools were selected primarily on the basis of ASEE student membership, and since this was a parameter utilized in the calculation of CSIR, the mean index value was probably skewed high for this group of schools. A more thorough regression and inclusion of more input variables might lessen the skew.

This approach is a work in progress, but it is at least an initial attempt to quantify the problem. Index formulation and regression equation generation can be revisited after more student chapters are in existence and more data is available.

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