AN ANALYSIS OF ENROLLMENT CYCLING IN ChE

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Nationally, chemical engineering BS graduation rates cycle with about a 13-year period and a 2.2-to-1 high-to-low amplitude. The past 1.5 cycles are shown in Figure 1, a plot of the national production of BS ChE graduates from the past twenty years.[1] The numerical value for the abscissa, Academic Year, is the calendar date for the end of the academic year (1990 represents the academic year from the fall of 1989 to the summer of 1990). This study also considered the 20-year history of 30 individual U.S. ChE programs,[2] chosen to represent a diversity of program types. All 30 schools cycle substantially in phase with the national data, and each with about a 5-to-1 ratio. Figure 2 presents a graph of the trends and visually suggests that the BS-ChE rates at all schools appear to cycle in phase with the national data. Local events and the statistics of small numbers make the individual school amplitudes greater than the national amplitude.

In a more quantitative analysis of the data, Table 1 presents correlation coefficients, r, of the BS graduation rate at each school to the national rate. All "r" values larger than 0.34 are significant at the 95% level for the number of data points, and all but 2 of the 30 schools observed have "r" values larger than 0.34. Even schools with smaller "r" values have a BS production rate that is somewhat correlated to the national trend. Coefficient of Variation (CV) results are also presented in the table for each school. CV is the ratio of the standard deviation to the average. All schools have a CV of about 0.4, and this common value indicates that all show the same relative cycling amplitude. There are no trends of correlation coefficient, CV, or cycle amplitude with ChE program size. The data reveal that the phenomenon is national and affects all schools in unison and to the same relative degree.

The cycling is a source of great discomfort, and it hurts chemical engineering education. During periods of peak BS production rates, students who graduate without job offers feel betrayed. Parents also become upset and challenge the

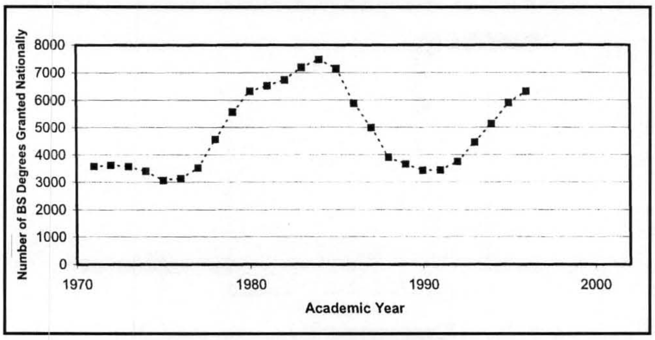

Figure 1. *National BS-ChE rates.*

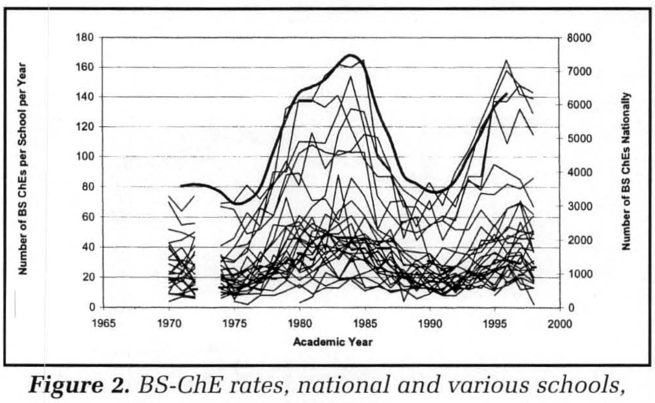

Figure 2. *BS-ChE rates, national and various schools, versus year.*

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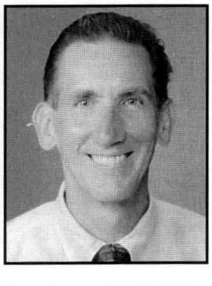

ChE program's adequacy. This is not a good way to generate the alumni allegiance necessary for program development.

At the other extreme, in periods of low BS production rates, State and University administrations often question the need for an expensive ChE program. This often leads to inadequate resources for lab upgrades and difficulty in retaining faculty positions. Both lab equipment and faculty positions are critical for sustained program excellence, especially during peak enrollment periods. Further, during low production periods, industry must inflate entry-level salaries and make an excess number of job offers to attract a sufficient number of employees. While this is advantageous for the new graduates, it results in an uncomfortable salary compression and resource-allocation problem for industry. Finally, during periods of low BS supply, companies withdraw from recruiting at schools, making it difficult to later reestablish on-campus recruiting and to maintain continuity in other forms of industrial support.

TABLE 1
Statistics on BS-ChE Data for Thirty Schools and the Nation

School	*Max Number of BS ChE*	*Min Number of BS ChE*	*Ratio Max to Min.*	*Std. Dev.*	*Average*	*CV*	*Ratio of Range to Avg.*	*Number of years of data*	*Correl. Coef., r*
U Michigan	158	41	3.85	39	85	0.46	1.38	29	0.89
Arizona State	48	12	4.00	11	27	0.42	1.31	29	0.82
Cal Poly, Pomona	56	11	5.09	12	32	0.37	1.42	29	0.80
Cal State Long Beach	60	13	4.62	14	28	0.49	1.67	27	0.37
Cal Tech	20	3	6.67	4	9	0.49	1.93	29	0.70
Georgia Tech	165	55	3.00	37	101	0.36	1.09	29	0.95
Kansas State	38	10	3.80	9	22	0.41	1.28	29	0.75
North Carolina State	133	30	4.43	37	75	0.49	1.38	29	0.71
Oklahoma State	62	10	6.20	15	33	0.45	1.59	29	0.77
Oregon State	61	5	12.20	13	33	0.40	1.67	29	0.80
Rensselaer	116	27	4.30	28	63	0.44	1.42	29	0.90
San Jose State	20	8	2.50	4	14	0.28	0.88	29	0.70
Stanford	34	6	5.67	9	16	0.54	1.74	29	0.69
Texas Tech	51	4	12.75	12	28	0.45	1.70	28	0.68
U Arizona	46	11	4.18	11	25	0.44	1.41	29	0.88
U Florida	88	9	9.78	18	39	0.46	2.01	29	0.78
U Kansas	57	11	5.18	13	31	0.41	1.47	29	0.79
U Houston	55	16	3.44	10	33	0.31	1.18	29	0.69
U Oklahoma	71	17	4.18	18	36	0.49	1.51	29	0.95
U Southern Cal	45	8	5.63	10	21	0.49	1.80	29	0.82
U Washington	89	31	2.87	15	60	0.26	0.97	29	0.68
Cal - Berkeley	141	30	4.70	33	78	0.42	1.43	29	0.89
Cal - Davis	61	21	2.90	14	37	0.37	1.09	29	0.84
Cal - San Diego	27	3	9.00	6	19	0.34	1.27	19	0.09
Cal - Santa Barbara	52	8	6.50	11	22	0.50	2.01	29	0.81
UCLA	69	11	6.27	19	32	0.59	1.80	15	0.08
U Texas - Austin	165	46	3.59	32	91	0.35	1.31	29	0.73
Vanderbilt	45	9	5.00	11	24	0.48	1.52	29	0.91
Washington State	34	10	3.40	7	22	0.32	1.07	29	0.63
Yale	20	2	10.00	6	11	0.53	1.65	15	0.84
National	**7475**	**3070**	**2.43**	**1463**	**4859**	**0.30**	**0.91**	**26**	**1.00**

The cycling has lasted as far back as data could be found. Figure 3 shows the BS-ChE history at Oklahoma State University (OSU) from its first graduate in 1921 to the present. The 13-year cycling period is evident since about 1930, after the start-up phase of the program.

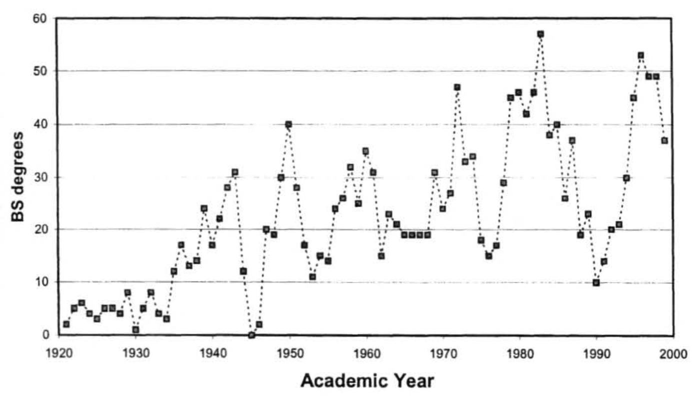

Figure 3. BS-ChE production at OSU.

It appears generally accepted that the number of students who choose engineering is influenced by the job opportunities and the salary levels. In his study of overall engineering enrollments from 1965 to 1995, Heckel[3] reports

> *Engineering enrollment trends are shown to differ significantly from those of undergraduates as a whole and to exhibit little correlation with trends in high school graduation data. Freshmen engineering enrollments show very strong correlation with factors which might indicate to high school students the magnitude of their personal economic gain such as on-campus industrial recruiting*

intensity, annual growth in starting salaries and starting salary levels relative to average salaries of all undergraduates. No correlation between engineering freshmen enrollments and national economic conditions as measured by the Gross Domestic Product or unemployment was found.

Most engineering students seem to make an economically rational decision, seeking to maximize the probability of attaining a high-salary job upon graduation, and this one incentive seems to control trends in engineering enrollments. It appears that in certain engineering programs (aerospace, chemical, materials, and nuclear) the cycling behavior is unusually large.

If we can understand the mechanism, then we can hope to design a cure. This paper presents data that refute the commonly accepted mechanism, a novel view of the mechanism for cycling, a model that expresses the same behavior as the national data, needs for further study, and possible solutions to the cycling problem.

REFUTING THE COMMONLY ACCEPTED MECHANISM

Enrollment cycling is a symptom: there is a cause, and a successful cure for the cycling must affect the cause. If we accept that the cause is "A" when it is actually "B," and invest efforts to cure "A," we will not alleviate the cycling. This study appears to refute the commonly held cause.

The traditional view is that enrollment swings are demand driven—they reflect student choices in response to the changing ChE job demands by the economy. In this view, low matriculation rates are due to low numbers of job offers in prior years (due to a low economy), and then low matriculation leads to low BS production about four to five years later. There is, however, no correlation of national engineering enrollment to national economic factors.[2] Figure 4 provides additional data and reveals that there is no correlation of the national BS-ChE cycling to the national economy, as measured by the gross domestic product (GDP). In Figure 4, the GDP in constant dollars is plotted with the national BS-ChE production; it reveals that the BS-ChE oscillations are seemingly independent of, and much larger than, changes in the national economy. In addition, economic factors (that would indicate job opportunities for chemical engineers) have shown a relatively steady growth, with neither 2-to-1 cycling nor a regular 13-year period.

One may suppose that while the overall national economy does not cycle, sectors do—and that the employment demand by specific industry sectors causes enrollment cycling for schools that supply those sectors. But if this were true, then Gulf-Southwest schools, which are significantly coupled to the oil and gas industry, would cycle independently of Northwest schools, which are significantly coupled to the pulp and paper industry, etc. Enrollment at all schools, however, regardless of region or orientation, cycles in phase, with the same relative amplitude and with a regular period.

As a supporting refutation of the impact of local school data on school cycling, see Figure 5. Figure 5a plots the ChE freshmen-class size versus the BS-ChE rate at OSU, and Figure 5b plots the same data versus the national BS-ChE rate. The four-year lag led to the strongest correlation for both scatter plots. The correlation coefficient, r^2, stated on each graph, along with the observable closeness of the data to the regression lines, indicates that OSU freshmen-class-size data correlates much better to the national data than to our local data. Figures 5c and 5d reveal similar relationships for the total OSU undergraduate ChE enrollment. Student choices at OSU correlate much better to national data than to local data. The same probably holds true for other schools.

The commonly held view of the cause for cycling is in contrast to data. Let's consider mechanism "B."

HYPOTHESIZED CAUSE FOR THE CYCLING

The mechanism for ChE enrollment cycling hypothesized here is not based on employment demand. It is based on BS-ChE supply. The cycling is supply driven. The cycling causes the cycling. The job market is relatively steady, but when there is an excess supply of graduates there is a low probability of finding a job, and high school students do not choose ChE. Subsequently, when graduation rates are low, there is a very high demand for ChEs, which is exaggerated by industrial competition for the limited supply. This attracts a flood of students. Further, the cycling mechanism hypothesized here is not based on local events; it is based on the national data.

Proposed here: the enrollment process is inherently unstable because of the controllers—the "high gains" in student and recruiter choices.

The hypothesized incentive that drives enrollment for chemical engineering is a perception, by high school students, of the attractiveness and availability of jobs at the national level. Attractiveness includes a combination of factors that appeal to young adults and includes both professional and personal attributes such as salary, social stature,

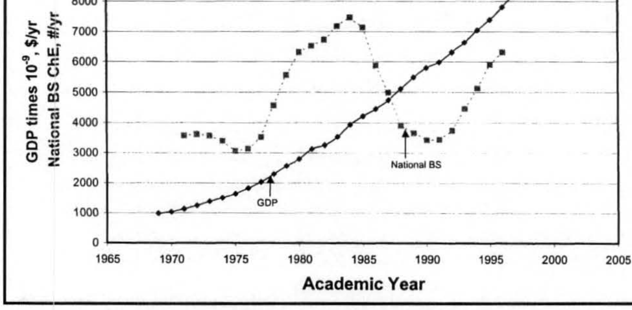

Figure 4. GDP and national BS-ChE rate.

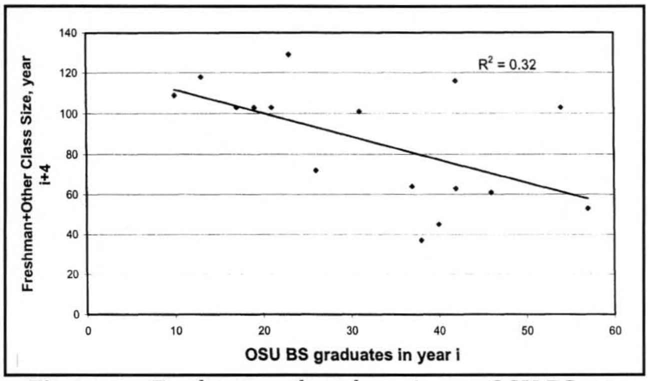

Figure 5a. *Freshman+other class size vs. OSU BS rate (lag 4).*

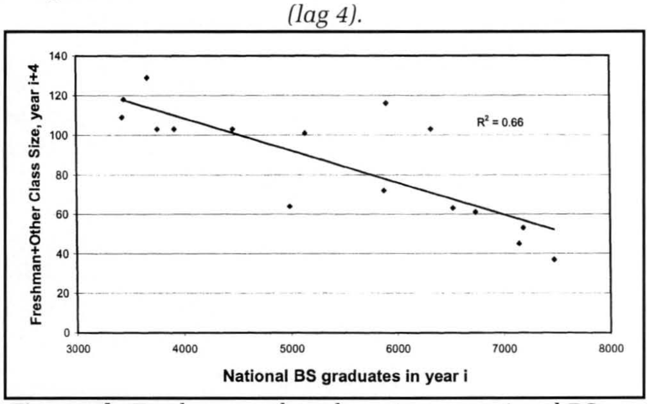

Figure 5b. *Freshman+other class size vs. national BS rate (lag 4).*

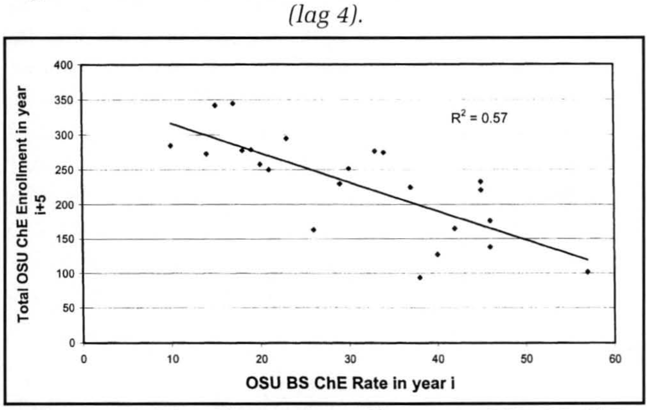

Figure 5c. *OSU ChE total enrollment vs. OSU BS-ChE rate (lag 5).*

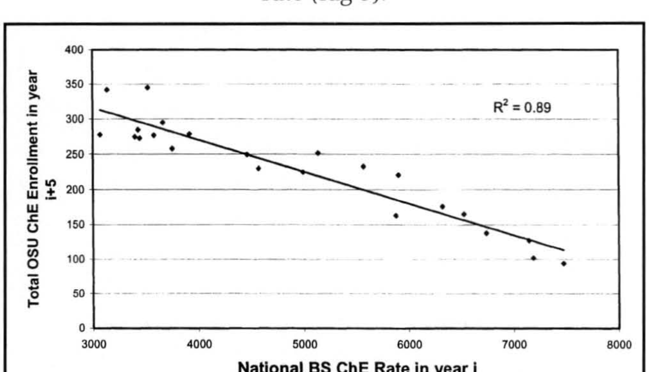

Figure 5d. *OSU ChE total enrollment vs national BS rate (lag 5).*

and academic challenge. Availability of jobs is indicated by the fraction of students who obtain jobs upon graduation, but it is based on recent-past data, not on the projected future.

Informal discussions and analysis with OSU ChE students reveal several features of the decision process that control enrollment. It appears that selecting ChE as a major is sensitive to the perceived incentive of a high salary. Students who can complete a degree in chemical engineering can probably complete a degree in any of a number of chemical science degree programs. These students probably had a chemistry course in high school, but they are not familiar with any of the professions within the chemical sciences, and the marketing material for the various professions promises challenging, enjoyable, and socially important careers. As a result, their main incentive in the choice of a college major is probable entry into a high-paying job upon graduation.

Within the chemical science careers, chemical engineering is the degree program that leads to the highest employment salary. When the probability of getting a ChE job is high, students rush into the program. But the program is very demanding, and when the probability of getting a job appears low, these same students choose other majors in an economically rational decision. One source of data that students might use to make that decision is the employment-upon-graduation data that ChE schools submit each May/June to AIChE, the Council for Chemical Research, and other agencies. The data is nationally compiled and published about a year later, through a variety of private, public, and not-for-profit agencies. When high school seniors begin to consider college choices they have access to this year-old (and older) data. The mechanism proposed here is that employment-upon-graduation data from one year affects the decision of matriculates two years hence and affects the BS graduation rate four to five years later. This suggests a cause of the six-to-seven year swing from high to low BS rate and the 13-year cycle period.

MODEL

A model of this mechanism is developed from a simple population balance on students in each class-year category. It reveals the natural instability of the process, the 13-year period, the BS production rate cycling, and the national coordination. It also produces statistics that match many features of OSU ChE enrollment data. The model for a single school is presented first.

One aspect of the model is the constitutive relation that describes the number of high school students entering the university who declare chemical engineering when they matriculate. This number is a function of the incentive to study chemical engineering. In what follows we use the term α to represent the fraction of university matriculates declaring ChE. In this study we use the number of job offers per BS-ChE graduate as the incentive. We feel fairly certain of three points on the α-versus-incentive curve. When there is zero incentive (zero job offers for any ChE graduate), then there will be no ChE matriculates. When the incentive is at a maximum (experience indicates that this might be three job offers per BS-ChE) then matriculation rates will be at a maximum. At OSU this maximum in matriculation is about twice the nominal value that seems to be 0.006 freshmen ChEs per OSU freshman. So, α(incentive=3)=0.012 at OSU. Finally, a nominal matriculation rate occurs when the incentive is nominal, defining α(incentive=1)=0.006 (at OSU).

We also feel fairly certain of the general shape of the α-versus-incentive curve. Regardless of the incentive, α will not be much greater than 0.012, the apparent maximum. There is only a portion of the population that leaves high school with either the preparation or willingness to study chemical engineering, and regardless of the incentive the remainder will not choose ChE as a major. Consequently, α should asymptotically increase to its upper limit of about 0.012. This feature and the three points define an S-shaped curve, which we model as

$$\alpha = 0.01679 \cdot \exp(-1.0397 / r) \qquad (1)$$

where the variable "r" represents the incentive, the ratio of job offers per graduating BS. The relation is illustrated in Figure 6.

There is no pretense that this equation for α is precise, or that the ratio of job offers per BS is the true and exclusive measure of the incentive to study ChE. It appears to be reasonable. Neither is there a claim that this equation is necessary to stimulate cycling. One could certainly argue that alpha should be based on a moving average of job-offers to BS ratio, and the reader is encouraged to explore such options. In this study any number of reasonable models for α seem to lead to cycling. The feature that is important, however, is that this is a nonlinear, high-gain relation.

The model is composed of a population balance on the number of students in each class-year. The number of entering ChE freshmen is α multiplied by *hs*, the number of high school students matriculating at the university. In what follows, the symbol "N" will represent the number of ChE students, and the modifiers, "1," "2," ..., "5," will represent the class year (freshman, sophomore, ..., through second-year senior). The modifier "R" represents students who are repeating the class-year. Accordingly, Eq. (2) presents a population balance of students taking freshmen courses. The subscript "i" represents the academic year. In Eq. (2), the number of people in the freshman ChE class is the sum of the number of new matriculates plus the number of students who were freshmen last year and who are still taking freshmen-level courses this year. Some are repeating; some are still ramping up from inadequate high school preparation; some are on a reduced course load plan. To reflect both the communications delay in presenting the "job market" to

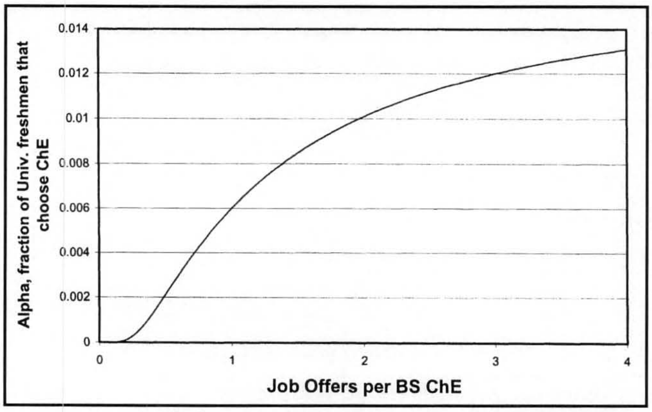

Figure 6. *Alpha as a function of jobs offers per BS.*

high school seniors who are choosing a major and the persistence of the recent-past "job market" history, we use the average value of alpha of the two and three preceding years.

$$N1_i = 0.5(\alpha_{i-3} + \alpha_{i-2})hs + N1R_{i-1} \qquad (2)$$

Based on historical data at OSU, the number of students remaining in the freshmen-level ChE courses in year, $N1R_i$, is approximately 20% of the freshmen in the previous year. The formula used is

$$N1R_i = 0.2\, N1_i \qquad (3)$$

It appears, from data from various sources, that approximately 60% of the ChE freshmen would progress into the sophomore-level class; and at OSU, this number seems independent of either class size or incentive. Transfers into the sophomore level is conceived as students who have spent a year in another major and have been enticed by the incentives to switch into chemical engineering. It appears reasonable to model this as 10% of previous year's α multiplied by *allso*, the total number of sophomores at the university. Including a term for students that repeat the sophomore class, the population balance for students in the sophomore class is

$$N2_i = 0.1\alpha_{i-1}\, allso + 0.6\, N1_{i-1} + N2R_{i-1} \qquad (4)$$

The number of people that remain in the sophomore-level classes was also modeled as 20%. The equation is

$$N2R_i = 0.2\, N2_i \qquad (5)$$

The equation for the number of students in the junior year is similar to that for the sophomores. OSU data shows that about 65% of the sophomores proceeded into the junior year, and that this proportion, too, is independent of events. It was also assumed that transfers only accounted for 1% of the previous year's alpha multiplied by *alljr*, the total number of juniors at the university. The equation is

$$N3 = 0.01\,\alpha_{i-1}\, alljr + 0.65\, N2_{i-1} + N3R_{i-1} \qquad (6)$$

OSU data indicate that about 5% of the juniors repeat their junior year. The equation for the number of repeating juniors is

$$N3R_i = 0.05\,N3_i \quad (7)$$

It was assumed that there are no transfers in the senior year. Approximately 93% of the OSU ChE juniors enter into the senior year. The equation that describes the population balance around the senior class is

$$N4_i = 0.93\,N3_{i-1} + N4R_{i-1} \quad (8)$$

It was assumed that only one percent of the senior class would have to repeat the year. The following equation was used to describe the number of seniors that repeat:

$$N4R_i = 0.01\,N4_i \quad (9)$$

OSU data shows that approximately 54% of the seniors would go on to a fifth year where they would take courses off of the critical path that they postponed earlier. The following equation is used to describe the number of students entering the 5th year:

$$N5_i = 0.54\,N4_{i-1} \quad (10)$$

The number of graduating seniors, NG, is modeled as the number of 5th-year students plus 42% of seniors:

$$NG_i = N5_i + 0.42\,N4_i \quad (11)$$

The missing 4% of the seniors seem to drop out of the OSU program for varying reasons unrelated to academic ability.

The number of available employment positions, *Jobs*, is modeled using a random walk starting from a nominal steady-state number. The driver for the walk is a Gaussian-distributed random variable, NID(μ=0, σ), where σ=0.04* *Jobs*. Generated by the Box-Mueller method, the job market equation is

$$Jobs_i = Jobs_{i-1} + \sigma\sqrt{-2\log(r_1)}\,\sin(2\pi r_2) \quad (12)$$

Here, r_1 and r_2 are independently and uniformly distributed random numbers on the interval 0 to .999... This is a simple model, and to prevent some realizations from leading to a negative job market, the lower value is limited to at least one job per year.

There seem to be any number of disturbances or disturbance models that lead to the limit cycling. These include perturbations on the number of high school students or the model's retention coefficients. This simple economic driver was chosen for this example.

The number of jobs offered to BS ChEs may be different than the number of positions available. In a "buyer's market," in times when there are more graduates than there are available positions, companies make one offer for each position. But, in a "seller's market," in times when there are more job openings than there are available graduates, companies often make more offers than there are positions in an attempt to fill all of their positions. The bigger the supply deficit, the more aggressive are recruiting efforts; however, in fear of over staffing, it appears that companies limit themselves to no more than two outstanding offers per open position. Here the variable β represents the ratio of job offers per available position. If it's a "buyer's market," β=1. If it's a "seller's market," this study models β as rising with the square of the ratio of jobs per BS degree, but with an upper limit of 2.

$$\beta_i = \left(\frac{Jobs_i}{bs_i}\right)^2 \quad (13)$$

The number of job offers is then β multiplied by the number of jobs available for that year.

$$Joffers_i = Jobs_i\,\beta_i \quad (14)$$

The number of job offers per BS ChE is then used to calculate the incentive, alpha. Other models for β that express similar behavior produce equivalent cycling behavior.

Initial values for N1, N2, N3, N4, and N5 were chosen to start the class sizes at a steady state, with NG equal to the number of employment positions.

These equations lead to a fractional number of students in any category. In this simulation all values that represented the number of people were rounded to an integer.

SINGLE-SCHOOL MODEL RESULTS

Figure 7 shows the dynamic response of a single-school model, from the initial steady state to the limit cycle, as instigated by one realization of the random perturbations in the job market. Notice that the variation in BS production rate cycles regularly, irrespective of the number of jobs. Notice also that the amplitude of variation in the BS rate is much greater than the amplitude in the number of jobs. This was one realization; any other, independent of driver, shows the same eventual behavior.

Figure 8 reveals the behavior of the number of students in each class year for a smaller school. The population of each class shows a phase lag of one year from the previous class and the expected reduction in numbers due to attrition.

TEN-SCHOOL MODEL RESULTS

The single-school model was expanded to ten schools. In one study, shown in Figure 9, each of the ten schools is independent in the sense that: 1) the "local" student's incentive was purely based on the local incentive (job offers to BS ChEs at that particular school), and 2) the perturbation in the local job market for each of the ten schools was independent of the nine other local markets. The sizes of the ChE programs ranged from an average BS-ChE rate of 12 to 45 per year, and no significant impact on the period of the oscillation was observed. All were about 13 years. Noticeable, though, is that all schools found their own phase in response to the independent realizations of the disturbance, cycling was not coordinated.

To model a national influence, to generate correlation between schools such as is observed in the national data, the calculation of α is weighted to represent both "local" and the ten-school "national" job offers per BS incentive. It was found that the more national influence, the more the cycles became "in phase ." At only a 20/80 national/local weighting, Figure 10 shows that all ten schools become "locked" in phase in spite of independent random behavior in the local job markets, and independent initial behavior.

DISCUSSION

Results of model explorations not shown here reveal that the cycling phenomenon is independent of all reasonable adjustments in model coefficients. There were only two features that seem to have a tempering influence on the cycling phenomena; these being the students' and the employers' response to the jobs/BS ratio—modeled here as alpha and beta. If there is a cure for the cycling phenomena, it seems grounded in tempering human reaction to a perceived personal impact.

This is a simplistic, deterministic model that assumes all students share a common, time independent, region independent stimulus-response mechanism. While this study does not answer many important questions, and while it cannot claim to be a definitive exposition on individual student behavior, it does provide multifaceted, circumstantial evidence of a mechanism that leads to enrollment cycling.

Perhaps characteristics of a degree program that exhibits cycling are:

- *A difficult program, both conceptually and time demanding, that can only be passed by a small number of the population who have the innate ability, self discipline, and adequate preparatory training.*
- *A program with specialty subject matter that is of interest or attraction to a small portion of the population.*
- *A degree that leads to very high starting salary, social status, and/or secure lifestyle.*
- *A degree that leads to a career that is relatively non-understood by the student, and where salary therefore dominates the possible influence of all other possible incentives or connections to the student's personal values.*

If these characteristics lead to cycling, then there may be actions that we can take to alleviate the cycling. One approach would be to collect data on employment based on graduate status four months after graduation, and exclude data on graduates without permanent work status. It appears not that we produce

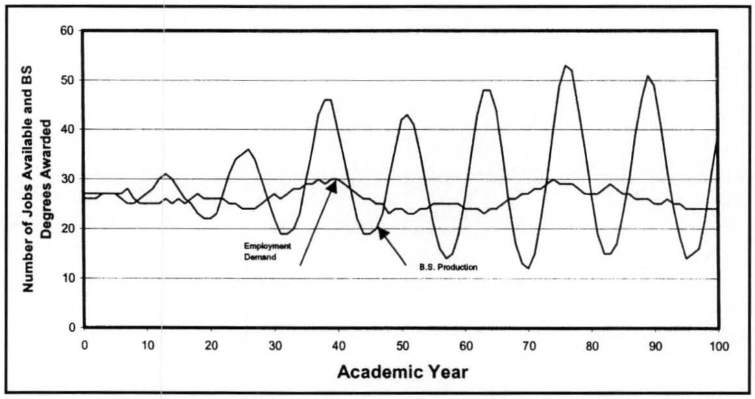

Figure 7. BS degrees awarded and jobs available versus academic year: single-school model.

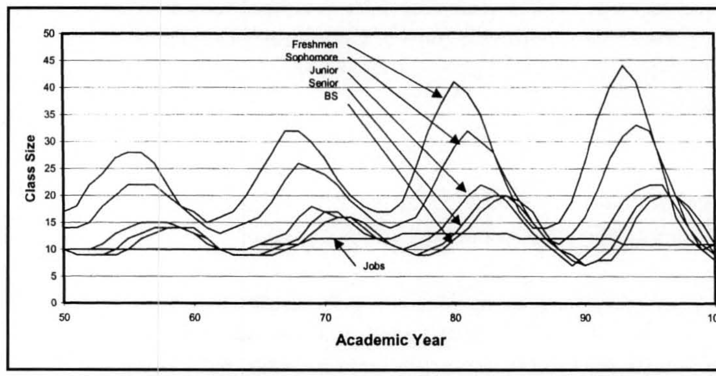

Figure 8. Class size vs time: single-school model.

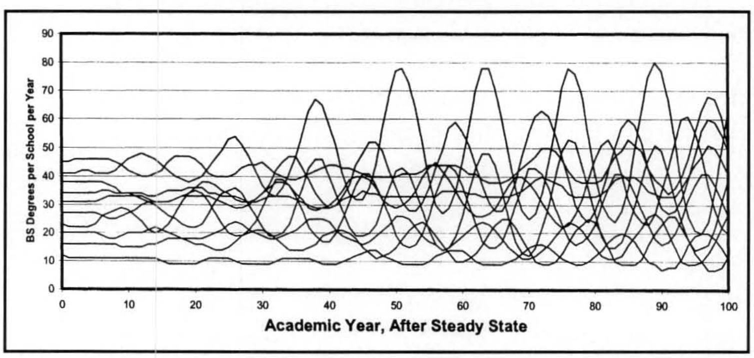

Figure 9. BS production rate simulation: 10-school model, local influence only.

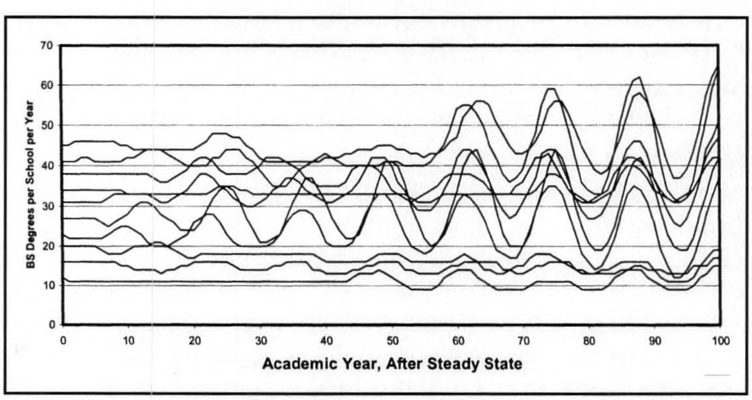

Figure 10. BS production rate simulation: 10-school model, 20% national influence on enrollment.

too many BS graduates; it appears that we produce more than are demanded by on-campus recruiters. Most of those unemployed upon graduation find jobs within several months after graduation, when they are free of the capstone course demands and have the time to search for employment. Some others choose graduate or professional school. If the employment data reflected employment rates about four months after graduation, then the apparent probability of landing a job might always be attractive, and cycling might be tempered.

Additionally, perhaps professional societies and government agencies that are accountable for rational system behavior and educational excellence, could shape the awareness of the societal benefits that come from chemical engineering, and thereby have the career appeal to personal values other than just economic gain. Then, fewer matriculates would be so greatly influenced by the apparent job demand, and enrollments would be more level.

Another tempering action might be to reveal this cycling phenomenon to high school students and counselors so that they make matriculation decisions based on the future, not the recent past, job market.

The model and data presented here provide indirect evidence to support the mechanism; but there is no direct, credible evidence to validate the hypothesized mechanism, the human response, or to evaluate possible cures. It appears that questions such as the following need to be answered.

- *What are the general characteristics of degree programs, or characteristics of the people, or nature of the environment that lead to cycling? Is there a commonality of cycling phenomena for degree programs with those common characteristics?*
- *What is the primary incentive for high school and transfer students to choose ChE as a major?*
- *What is the model for the fraction of college-bound students choosing ChE as a function of that incentive (alpha in this study)?*
- *Is it possible to shift the ChE enrollment incentive to other professional or conscience attributes (social stature, commitment to the environment, commitment to human health, commitment to improve U.S. competitiveness, etc.) by a marketing campaign, and thereby reduce the number who choose ChE for probable salary, and thereby reduce the cycling amplitude?*
- *What mechanisms create the information that becomes the basis for student choices? Are they professional society surveys of job salary and job satisfaction, professional society surveys of the number of students with jobs upon graduation, etc?*
- *What mechanisms convey the information that becomes the basis for student choices? Are they hearsay, older siblings, friends, family, local employers, high school counseling pamphlets, Internet data banks, Department of Labor statistics, Society Publications, etc?*
- *What is the industrial recruiting response to over- and under-supply of BS-ChE candidates for the number of job openings (beta in this study)?*
- *How do students, parents, faculty, administrators, and employers view the effects of the cycling? What is the magnitude of the cycling problem (perhaps as indicated by the economic and personal impacts on society)?*

CONCLUSIONS

Maximization of probable high-salary employment remains accepted as the driver for student choice for enrollment in chemical engineering. However, data refute the commonly held view that the "economy," the industrial job market demand for BS-ChEs, is responsible for ChE enrollment cycling. Hypothesized here, the perception of job opportunities by college matriculates is influenced more by enrollment swings than the economy. Changes in the supply of BS-ChEs dominates the supply-to-demand statistics, and hence enrollment. Enrollment cycling is supply driven. A primitive model of the mechanism expresses multiple aspects of national and local data. The model reveals that the dynamic system is inherently unstable, that enrollments tend to a limit cycle, and that student and recruiter response to the supply-to-demand for BS-ChEs is the source of the instability. A better understanding of this mechanism may lead to solutions; but, since national statistics appear to drive the perception, it appears that any cure must be implemented by the agencies that create national perception.

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