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The Challenge of Restructuring Engineering Curricula in Brazilian Private Universities*

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Abstract

Economic changes in Brazil have greatly reduced opportunities for new engineering graduates and have sparked a debate about the direction of engineering education. In this paper, we focus on changes to the engineering curriculum in order to revitalize undergraduate engineering education and produce an engineer who is capable of competing in the emerging global economy. Our chief recommendations are the following:
(1) Decrease the heavy courseload demanded by the current curriculum and increase work outside class, in groups and using computers; (2) professionalize the engineering faculty by insisting on more advanced degrees and fewer part-time instructors; and (3) establish a continuing process for periodically assessing the curriculum to ensure that it offers an integrated plan of study that meets the needs of students and their employers. Our recommendations will require a significant change of the academic culture and the relinquishment of central control currently exercised by the governmental and quasi-governmental agencies that currently regulate the engineering curriculum.

Introduction

In this article we consider changes necessary to update and reform the undergraduate engineering curriculum at the Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS), a large private university in Brazil. Although our discussion is based on data and experiences from PUCRS we believe that most other private universities in our region face a similar situation.

Our paper briefly outlines the current status of engineering education at PUCRS, provides some goals for curriculum reform, examines barriers to reform and provides some concrete recommendations. We conclude that curriculum reform will require both administrative changes, such as changing the duration and content of the curriculum, and changes in the academic culture, such as requiring more homework, group projects and computer assignments.

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The city and region of Porto Alegre

PUCRS is located in the city of Porto Alegre in the Brazilian state of Rio Grande do Sul, the southernmost state of Brazil. In the center of a metropolitan region with extensive industrial and commercial activity, Porto Alegre itself has 1.3 millions inhabitants; about 3.2 million live in the entire metropolitan area. About 19,500 students attend classes at the PUCRS, which is one of the largest private universities in Brazil. The metropolitan area of Porto Alegre has 3 other major universities, including a large, federally funded university.

The student body

PUCRS offers bachelor's degrees in six areas of engineering. Table 1 lists the distribution of students among the degree areas. Automation Engineering is a new program combining the traditional content of Mechanical Engineering with the control and signal processing content of Electrical Engineering; however, because of government and licensing restrictions (discussed later), the program is administered and the degree is awarded in the department of mechanical engineering.

Economic changes in recent years have resulted in a sharp drop in entry-level jobs in most engineering disciplines, with a corresponding drop in engineering school enrollment. At the same time, several new engineering programs have opened within the Porto Alegre metropolitan area. These developments have resulted in a 40 percent drop in enrollment in the Engineering School at PUCRS since 1983. Figure 1 shows the engineering enrollment at PUCRS since 1983.

Degree Program	Number of Students		Percentage of Total
	Male	Female	
Electrical Engineering	772	68	28%
Civil Engineering	606	232	28%
Mechanical Engineering	664	27	23%
Chemical Engineering	207	216	14%
Automation Engineering	188	18	7%
Total	2437	561	100%

Table 1: Distribution of students per degree

The faculty

The engineering school of PUCRS, the *Escola Politécnica* (EPO), has about 150 instructors. Unlike most U.S. institutions, a majority is part-time and few hold a doctorate. More than half hold no advanced degree (considered to be an M.S. or Ph.D.). Figure 2 shows the number of faculty holding each degree in 1996. (The Specialist degree is obtained via a one-year program of graduate-level classes. It contains no research or thesis requirements.)

Although it is common in Brazilian universities to employ faculty members holding only a Bachelor's degree, the administration of PUCRS has recognized a need to improve the professional qualifications of the faculty. Beginning in the mid-1980's, PUCRS set out on a course that will require each faculty member to hold a Master's degree by the year 2000. As the stricter professional qualification process was implemented, a Master's degree-level graduate program was established in Electrical Engineering, which required faculty members to hold a doctorate.

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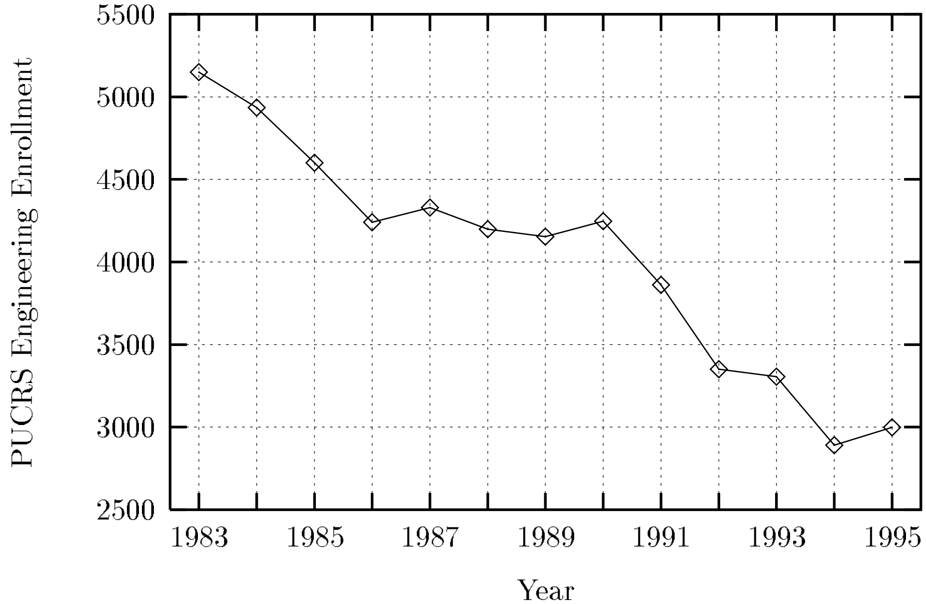

Figure 1: Engineering enrollment at PUCRS since 1983

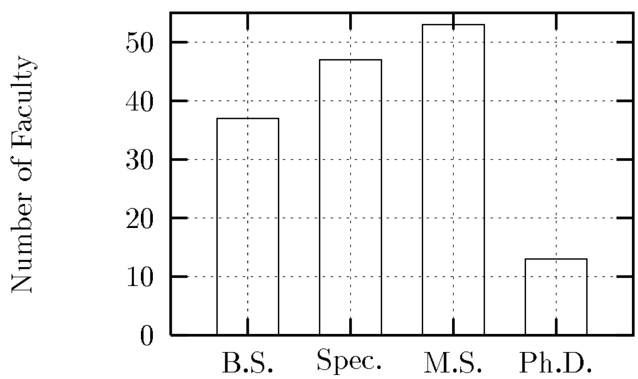

Figure 2: Academic Degrees of PUCRS Engineering Faculty

Tightening of professional qualifications has significantly changed the character of the School of Engineering and especially the Department of Electrical Engineering. A more research-oriented culture has begun to develop that balances the previous exclusive orientation toward undergraduate teaching. The electrical engineering department has begun several new, externally funded research projects, a development which was almost unheard of only 3 or 4 years before.

The rising expectations fostered by these changes have occurred while Brazilian engineering schools have incurred some severe setbacks. As mentioned earlier, the number of entry-level engineering positions has plummeted in recent years, and engineering enrollment has followed the trend. Lower enrollment has resulted in the dismissal of many part-time instructors at PUCRS, and downsizing has created a sometimes difficult atmosphere in which to implement curriculum reform and more general quality improvements.

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The current curriculum

The most striking difference from the student perspective between PUCRS and most U.S. engineering programs is that the average engineering student at PUCRS spends much more time in the classroom. Table 2 illustrates the weekly load of classroom hours necessary to complete the engineering curriculum within 5 years.

Engineering	Semester										Average
Discipline	I	II	III	IV	V	VI	VII	VIII	IX	X	
Civil	34	38	38	32	30	30	28	28	30	22	31.0
Mechanical	28	38	38	32	34	34	28	30	30	26	31.8
Electrical	34	28	32	28	28	29	27	25	23	20	27.4
Computer	34	28	32	28	28	26	26	24	24	26	27.6
Chemical	34	37	34	30	27	28	30	34	27	25	30.6
Automation	30	36	34	30	30	30	26	26	22	22	28.6
Average	32.2	34.2	34.7	30.0	29.5	29.5	27.5	27.8	26.0	23.5	29.5

Table 2: Required weekly classroom hours by semester

This heavy course load is due in part to mandates from the Brazilian federal government, which requires a minimum of 3600 classroom hours to receive an engineering degree; however, at PUCRS the engineering curricula contain significantly more than 3600; for example, the electrical engineering curriculum requires 4110 course hours. In contrast, accredited U.S. institutions typically require from 120 to 132 credits for an engineering degree, which corresponds to about 1800 to 1980 total classroom hours.

To enforce the curriculum requirements, each Brazilian state has an engineering licensing board. One of their chief functions is to review the academic program of engineering graduates. If not strictly in conformance with federal requirements, the graduating student is not licensed and is not permitted to practice engineering or even to be employed in an engineering capacity.

Since new engineering disciplines may take years to be included in official engineering programs, with a corresponding curriculum, the system is unable to respond to technological change. The current list of available engineering disciplines was created in 1976. Under existing regulations, universities do not have the flexibility of reducing the number of classroom hours, and their ability to adjust the topics taught is severely limited.

Goals for curriculum reform

Below are listed our (subjective) list of goals for engineering curriculum reform. These goals are based on a variety of sources including study of engineering curricula of several prominent U.S. engineering schools, the Accreditation Board for Engineering and Technology (ABET) accreditation criteria and several reports, including *Engineering Education 2001*, a report of the Technion's Samual Neaman Institute, *Ideas for Better Education and Training for Engineers*, from the World Federation of Engineering Organizations, Reference [?], and our personal experience teaching undergraduate courses at PUCRS.

A shorter curriculum: The curriculum should be significantly shortened. The heavy load of classroom hours is a barrier to excellence because it substitutes passive classroom hours for more productive group or individual study. Faculty must respond to the reduction in

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classroom hours by requiring more out-of-class activities such as individual homework, group projects and computer exercises.

Part of the problem with course load is due to excessive redundancy and duplication of course material. For example, the ABET-accredited program in chemical engineering at the Cooper Union requires 5 credits of physical chemistry. The chemical engineering program at PUCRS requires 14 credits for the same course sequence, with no obvious benefit from the increased course load. Similarly, the introductory sequence in circuit analysis for electrical engineering at PUCRS requires 14 credits. At the ABET-accredited University of Oklahoma, only 6 credits are required. Many, many more examples could be cited.

Part of the Brazilian bias in favor of passive classroom activities stems from the widespread perception that reducing classroom hours would not be compensated by a corresponding increase in outside study. Some recommendations to overcome this obstacle are discussed below.

Based on the practices of ABET-accredited programs, existing traditions and practices at PUCRS and the recommendations of the Technion Report *Engineering Education 2001* [?], we believe that the undergraduate engineering curriculum at PUCRS should be shortened to no more than 2700 classroom hours, which corresponds to 10 semesters of 18 credits each.

More emphasis on fundamental principles It is not possible to teach enough in a four- or five-year engineering course to prepare for every possible job, nor is it possible to anticipate every new technology. The undergraduate education should concentrate on providing a firm foundation in basic principles of science and engineering, and encourage and reinforce adaptability in their application.

The Technion Report *Engineering Education 2001* [?] divides the fundamentals of engineering into two main divisions: (1) Mathematics and natural sciences, such as chemistry, physics and biology and (2) engineering sciences, such as fluid mechanics, heat transfer and structural analysis. Between these two broad areas, the Technion Report recommends that 30-35 percent of the curriculum be dedicated to mathematics and natural sciences and 35-40 percent be composed of engineering sciences. Currently the engineering curriculum at PUCRS consists of about 25 percent mathematics and science and about 65-70 percent engineering and technical requirements. This includes both engineering science and trade or technical courses such as welding (see below for more on this distinction).

Less training for specific technologies and specialties The engineering curriculum at PUCRS is heavily loaded with courses which seem intended to teach specific engineering technologies, specialties or technical skills. We can list a few examples:

Civil Engineering:	Piping systems in buildings
	Highway drainage
Mechanical Engineering:	Generation and use of steam
	Polymer processing
Chemical Engineering:	Calculations for chemical processing equipment
	Applications of heat in the chemical industry
Electrical Engineering:	Computer interfaces and peripherals
	Antennas

These are not selected topics to be covered in some particular class—they are the *entire* class. Although we would not claim that these are unimportant topics, some priorities must be

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established and distinctions made between the essentials of the curriculum and topics that could be learned in a more specialized post-graduate program or as continuing education.

Regarding the division between engineering fundamentals and specialization and the need to maintain technical currency, the Technion Report *Engineering Education 2001* [?] came down on the side of emphasizing the fundamentals in undergraduate education:

> ...[W]e strongly recommend far greater emphasis on graduate and continuing education. Graduate education is for promoting excellence, for engineering specialization, and for reaching entry-level standards in certain engineering fields. Continuing education is for keeping abreast of developments and retaining adaptability to new conditions[.]

We agree. This viewpoint has strongly shaped our recommendations.

Greater emphasis on design Design is one of the chief activities of practicing engineers, yet one of the hardest to teach in the university. Many students and faculty members are uneasy with the open-ended nature of most design problems and the lack of clear, closed-form solutions. Furthermore, it is difficult to provide academic design problems that reflect real-world complexity.

Some of the problems of teaching engineering design can be alleviated by adopting several strategies:

- Study design by "reverse-engineering" successful engineering projects.
- Teach about the process of decision making itself. Topics such as optimization and decision making in the presence of uncertainty could be incorporated into the curriculum without introducing any new courses.
- Include open-ended design-related problems throughout the curriculum, to culminate in a capstone design course.

Sequentially integrated curriculum We have repeatedly observed students nearing graduation who are unable to apply what they learned in basic math and science courses to engineering problems.

Judging from the number of papers at recent engineering education conferences on "curriculum integration," this appears to be a universal complaint among educators. Since the engineering curriculum is traditionally divided into classes taught by different academic units, instructors have different priorities and experiences. It should not be unexpected that math and basic science instructors might have difficulty relating their subject material to engineering problems. This ever present problem is often intertwined with administrative issues of control, in which providers of so-called "service courses" jealously guard the prerogative of controlling the content of their own courses.

Another contributor to the problem is the way in which prerequisites are specified. For example, it isn't enough to specify that two semesters of calculus are required to enroll for a course in, say, thermodynamics. In order to truly integrate the curriculum, it is necessary to identify how individual courses relate to each other. We believe that for each course in the curriculum the specific skills to be mastered should be identified, both to enter *and* to successfully complete each course. For example, a mathematical prerequisite for a course in

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control theory might be "to be able to apply Cauchy's Principle of the Argument for any closed contour in the complex plane," a topic which would presumably be covered in an introductory class in analysis. A closely related competency required to pass the control course might be "to apply the Nyquist stability criterion to assess closed-loop stability of a SISO linear dynamic system."

More emphasis on computing Computation should be incorporated throughout the curriculum. Although many of today's students are able to use packaged commercial word processors, only a tiny fraction of PUCRS graduates can program in any programming language. Almost none have been exposed to any of the tools for computer-aided engineering. This has unquestionably hurt PUCRS graduates in the job market.

An English language requirement English is the standard language of engineering, but most PUCRS engineering students don't know it when they graduate. Although some more motivated students recognize the necessity and study independently, most cannot read a technical manual or textbook in English. The Technion Report suggests that one course per year be taught in English.

Barriers to progress

The government requirements

Although it is the Brazilian federal government that mandates the 3600-hour minimum engineering curriculum, it is the state licensing boards that administer and enforce the curriculum requirements.

Engineering graduates are licensed by the state board of engineers upon graduation based on completion of the federally-mandated curriculum. As this article is being written, a new federal law has replaced the old mandate, but the new law has not been implemented by any regulations. In the absence of new regulations, the state boards are continuing to issue engineering licenses under the old criteria.

Political maneuvering is underway to define the requirements for the engineering curriculum under the new law. Since administering the old system is one of their chief functions, the state engineering boards have an interest in maintaining the existing curriculum, with its fixed number of hours and specified content. Universities naturally would like more freedom and so are lobbying in favor of less rigid requirements. As this article is being prepared, the outcome of the debate is still an open question.

The economic climate for engineers

Job placement is a critical concern for undergraduate engineering students because only a small fraction of new graduates are able to find engineering positions. The university does not compile job placement statistics; however, we estimate that only a fraction of PUCRS engineering graduates are placed in engineering jobs.

Because the job market is so difficult, companies that hire engineers are able to demand job experience as a prerequisite for virtually all new positions. The undergraduate curriculum incorporates an engineering apprenticeship during the final year in which employers are matched with undergraduates for part-time work; however, to improve their marketability, students typically seek engineering-related employment before the final year.

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A 1996 survey of PUCRS engineering students showed that the average number of hours worked per week increases sharply as students approach graduation. Figure 3 illustrates the changing distribution of work hours as a function of program year. In the first year of studies, nearly 70 percent of students work 2 hours or less per day with only about 15 percent working full time. By the fifth year of studies, the percentages are almost reversed with about 60 percent of students working full time and less than 10 percent working 2 hours or less per day. When asked why they were working, nearly half mentioned the need for professional

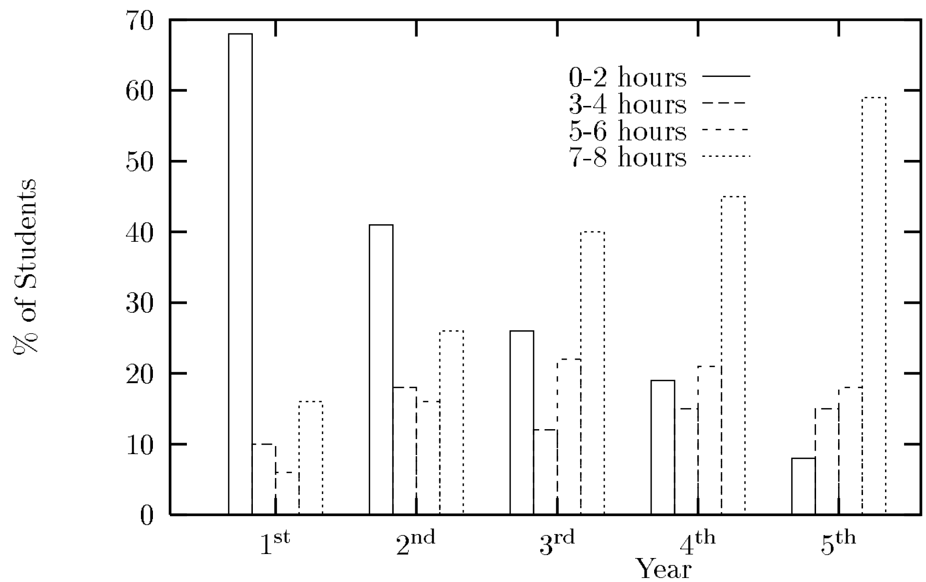

Figure 3: Number of Hours Students Work Daily in each year of the Engineering Degree

experience. About 15 percent worked to pay for school. We investigated other possible motivations for the high rate of outside work. Students were asked to agree or disagree with statements from the following list:

- I work to support myself or to support my family.
- I work to pay tuition (but would not need to work if I were to receive a student loan to pay the tuition).
- I work to acquire professional experience, but I don't really need the money to survive.
- I work because school leaves me with too much free time.
- I work because of the required professional training.

The survey results are shown in Figure 4. About 60 percent of the students report that they work to support themselves and their families or to pay tuition. Presumably because of the very high number of classroom hours demanded by the current curriculum, very few students work because of too much free time.

A high level of classroom hours combined with a full-time workload usually results in poor student performance. More than just affecting individual achievement, there is a widespread perception that work experience is more important than studies. This affects how professors teach and evaluate student performance. Students frequently expect that absence from class and failure to complete assignments may be excused if work-related. The situation creates

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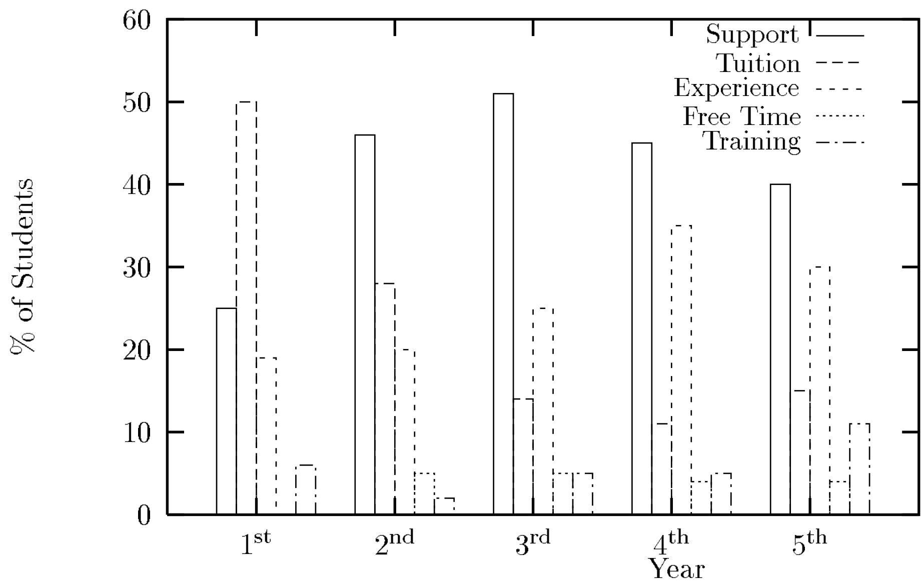

Figure 4: Reasons why students work.

pressure on instructors to water down the material, to avoid outside assignments and to generally demand little from students except classroom attendance. The curriculum itself recognizes, supports and perhaps even encourages the trend toward more outside work activities by decreasing the classroom hours as students advance through the program (See Table 2).

Student attrition

Attrition is a natural part of the academic process; however, excessive attrition is usually cause for concern. Recent studies show that in American colleges up to one third of the students abandon their university programs during the first year [?]. In 1996, the Escola Poliécnica undertook a study to discover the cause of a perceived high attrition rate. Figure 5 shows that between 1990 and 1994 one-sixth of the total student body leaves the engineering school. Unfortunately, statistics are not collected to allow us to determine in which years (if any) the drop-out rate is concentrated. In another study to identify the causes that led the students to abandon the school, we sent a questionnaire to all the students that left the school in 1995. We asked these students to rate in terms of importance the factors that contributed for their decision on abandoning the career of Engineering. Eleven reasons were offered and each respondent could classify it as an important (or not important) reason for given up Engineering. The results are shown in Table 3.
Considering the general economic climate in Brazil, the high importance of economic reasons does not come as a surprise. What is interesting is the importance of difficulties with the class schedule, which reveals that a number of students leave the school because they cannot reconcile their study and work schedules. Another important result from this study is the importance that students gave to “too many classroom hours in the program” as a reason to giving up engineering.

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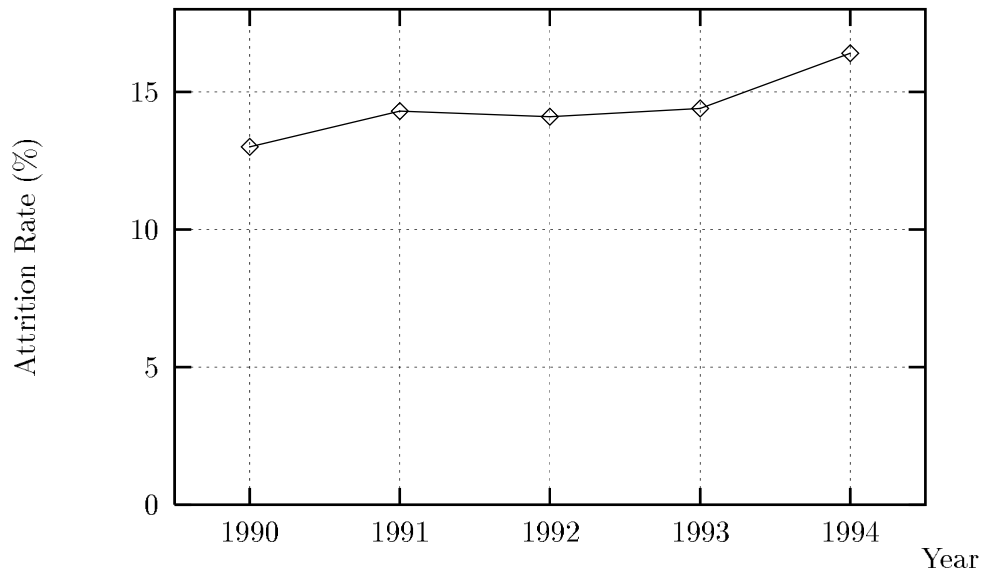

Figure 5: Overall engineering student attrition rate

Reason	Not Important	Important
Economic reasons	25.2	74.8
Not satisfied with curriculum	73.6	26.4
Professors not qualified	77.0	23.0
Lack of previous knowledge about degree	81.8	18.2
Lack of pre-requisites to follow classes	84.9	15.1
Unsatisfied with teaching methods	80.9	19.1
Inadequate laboratories and classrooms	84.0	16.0
Too many classroom hours in the program	54.5	45.5
Difficulties with class schedule	43.0	57.0
Moved to another city	83.6	16.4
Poor prospective for employment in engineering	78.2	21.8

Table 3: Reasons for dropping out before graduation

Vestibular

Perhaps the single most important institution in Brazilian higher education is the *Vestibular*, the college entrance examination. It would be difficult to overstate the importance of the vestibular, both from the standpoint of students and of the universities.

The vestibular is a sequence of examinations in Physics, Chemistry, Mathematics, History, Biology, Geography, Portuguese Language, Brazilian Literature, and Foreign Language. Admission to the university is entirely based on performance on the vestibular. At PUCRS, it is administered twice per year, immediately before each semester. Candidates who score sufficiently highly usually begin attending classes immediately, although in special circumstances enrollment may be delayed.

At PUCRS and at other Brazilian universities, the vestibular process is fair and scrupulously controlled to prevent abuses. It creates a simple admissions process that is easy to administer and it admits students based on an objective criterion.

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Despite some advantages, we believe that the effects of the vestibular are, on balance, overwhelmingly negative:

- It discourages academic achievement in pre-college education.
- It rewards "cramming" and fosters an expectation that sustained effort is not important.
- It prevents the development of a national student body.
- It demands a certainty of career choice before many students are sufficiently well-informed to make such a choice.

Pre-college academic achievement Colleges and universities in the U.S. typically review high-school transcripts in the process of selection for admission. College-bound high school students understand that their performance counts and will affect their ability to be admitted to the university of their choice. In contrast, most Brazilian institutions do not consider anything but vestibular; no consideration whatsoever is given to pre-college academic performance.

Cramming Most college-bound students of sufficient means attend the *cursinho,* a one year cram course for the vestibular. Offered through private companies, the explicit goal of these courses is to prepare students for the vestibular. The educational value of the cursinho is dubious at best. The long-term educational interests of the student would certainly be better served by a more rigorous course of study as part of the regular school curriculum.

Development of national student body One striking difference between Brazilian and U.S. universities is in the geographical diversity of the student body. Prestigious U.S. institutions invariably draw students from the entire country and from abroad. The country's best students and the country's best universities seek each other out for the mutual benefit of both. In Brazil, the vestibular not only does not contribute to a geographically diverse student body, it actively inhibits the possibility.

Since each university administers its own vestibular, a student with an interest in a distant university would be required to travel to the university, stay for up to a week to submit to the exam, and be prepared to begin classes immediately if selected. Furthermore, it is likely that more than one institution of interest would be offering the vestibular at the same time, making it literally impossible to take both sets of exams.

Faced with such uncertainties, the prudent student will stay close to home and submit to the vestibular only at nearby institutions, rather than seek out a university education based on quality or the presence of special programs.

Career choice Before submitting to the vestibular, students must decide on a major. For a majority of students it means having to decide on a lifetime career at the end of high school, at the age of 17 or 18. Scores are only compared among candidates listing the same major, and once admitted, students are generally required to stick to the same major until graduation. Transfers to other majors are extremely difficult and usually require re-submitting to the vestibular as a newly incoming student. Even transfers between different majors in engineering are restricted. One result is that some engineering students who have little aptitude or desire for engineering remain in the program to avoid having to go through a new vestibular to be admitted to a different program.

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Perhaps the most devastating criticism of the vestibular for engineering at PUCRS is that it isn't selecting anyone. There are more positions available than candidates and virtually anyone who wants can enter the engineering program, a condition that has persisted for several years.

Part-time Faculty

Despite the existing directives concerning upgrading faculty qualifications, a majority of engineering faculty members have not yet achieved an advanced degree. In many case, some of these instructors have loyally taught the same course for many years and there is great reluctance on the part of administrators to enforce higher professional standards.

Coupled with questionable faculty professional qualifications is the problem of depending on many part-time instructors, who may teach only one class per semester. Table 4 show the distribution of faculty members based on number of hours taught (40 hours doesn't necessary indicate that 40 classroom hours are taught, only that the faculty member is full-time.) Table 4 shows that only about one-fourth of PUCRS engineering faculty are full-time.

Number of Hours per week	Percentage of Faculty
Less than 10	22.2%
More than 10 and less than 20	31.4%
More than 20 and less than 30	13.6%
More than 30 and less than 40	6.4%
Full time (40 hours)	26.4%

Table 4: Summary of part-time faculty hours

Most part-time instructors work full-time in either the state-owned companies, private industries, or have their own engineering offices. Although some bring valuable working experience to the Engineering programs and most have good intentions, working 40 or more hours per week outside the university and teaching few hours at night does not allow them to participate in departmental activities, to consult with students outside of class, or to keep current with recent developments.

The reduction of classroom hours must be complemented by increased faculty availability outside of class. Continuing reliance on part-time faculty will defeat this goal.

Recommendations

Reduce the number of hours required for graduation to 2160. This number corresponds to eight 18-credit semesters.

Continue to use existing specialization courses to supplement undergraduate education. Many of the technical and specialized course should be moved into the one-year specialization courses. This would require minimal administrative adjustments, since the entire apparatus is already in place for specialization courses. The advantage of this arrangement is that the hodge-podge of technology and training courses currently offered in the undergraduate curriculum could be coherently combined into variety of focused specialization courses.

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Enforce the established requirements for profession qualification of the faculty. Since many of the part-time faculty are also those who have not completed an advanced degree, dismissal of faculty without sufficient professional qualifications should also alleviate some problems and conflicts that arise from an over-reliance on part-time instructors.

Reduce the dependency on part-time faculty. Part-time faculty are an economic necessity for PUCRS and will not be completely phased out. A complete phase-out would not be desirable because the industrial outlook provided by many part-time instructors is valuable; however, the current reliance on part-time faculty is excessive and should be reduced and the professional qualifications of those remaining must be upgraded.

Modify the mission of state engineering boards. The boards are concerned that curriculum reform may eliminate existing curriculum standards and leave engineering practice unregulated. These groups can continue to enforce quality standards for the engineering profession by changing focus. Rather than enforce a system of standards based on fixing the content and duration of the engineering curriculum, the mission of the state boards should be modified to include more results-based evaluation.

It should be pointed out that the federal government has recently taken steps in this direction. A national exit exam for graduating students has been introduced on a trial basis in selected fields, including civil engineering. The test is to be used to assess the performance of universities. Although we are hesitant to endorse a one-time exam as the route to meaningful curriculum reform, at least the concept of measuring outcomes (as opposed to inputs like number of classroom hours) has established a foothold. It would be extremely undesirable to promulgate the negative effects of the vestibular by instituting a similar exam at the end of the undergraduate program. Some institutions have already started to offer pseudo-cursinhos as cram courses to prepare the students for the exit exam.

Establish a standing curriculum committee in each engineering department. The purpose of the committee would be to periodically evaluate the curriculum to ensure that it meets the needs of the university's main customers, its students and their employers, and to establish a channel of communication with other academic units that supply "service courses" for engineering. Through the curriculum committee, the contents of each course could be analyzed and integrated throughout the four-year basic program and into the specialization courses. The committee would also be responsible for performance monitoring to confirm that each course's performance objectives are being met.

Eliminate the vestibular. The university should institute a selection process that selects students based on a record of achievement, not on a one-shot test score. This would permit the recruitment of a national student body. Similarly, universities should liberalize the requirements for change of major.

Establish departmental advisory boards composed of engineers and experts from outside the university. Nearly every U.S. engineering department has such an advisory body. Input from industry, the potential employers of PUCRS graduates, must be a factor in shaping the curriculum. Furthermore, the networking that arises from these kinds of industrial-academics contacts should lead to better job opportunities for PUCRS graduates.

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Monitor and assist engineering graduates in job placement. The best guarantor of the success of the PUCRS undergraduate program is a high job placement rate. Even in a difficult economic situation, PUCRS should at least strive to have the highest placement rate among competing institutions in order to attract the best students. Such an effort should begin by collecting placement statistics.

With a higher placement rate, the pressure on undergraduate students to work would be lower, resulting in overall better academic performance.

Conclusions

We have outlined a course of action to reform the engineering curriculum at PUCRS, a large private university in Brazil. The proposed reforms require actions of government and quasi-governmental agencies and of the university itself that would overturn some longstanding but destructive practices in Brazilian higher education. Many of these practices developed in isolation and perhaps at one time met the needs of prospective engineers and their employers.

Unfortunately, the evidence indicates that Brazilian engineering graduates are, on average, not competitive in the emerging world market. We believe that this problem can be addressed by comprehensive reform of the undergraduate engineering program, led by reform of the curriculum. We believe that the recommendations contained in this article constitute a reasonable set of steps necessary to begin the reform process.

References