Development of an Extended Campus Chemical Engineering Program

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Abstract

Efforts are underway to establish a new University of Kentucky College of Engineering Extended Campus Program at a location far removed from the flagship campus of the University of Kentucky (Lexington, KY). New chemical and mechanical engineering undergraduate degree programs are being established on the campus of Paducah Community College (255 miles from Lexington) in Western Kentucky, to provide a needed supply of new engineering graduates to regional industrial employers. The model proposed for the extended campus program in Paducah is a unique one. It is the only known set of university engineering programs in the U.S. located on a community college campus, yet administered under the direct responsibility of a main university campus dean. In this case, the Paducah engineering programs are under the responsibility of the dean of engineering at the main campus of the University of Kentucky. Other universities have established remote satellite locations, but these new programs in Paducah are completely independent entities apart from the main campus.

I. Introduction

In 1989-1990, industrial employers in Western Kentucky reported difficulties in recruiting and retaining engineers. This portion of the State is heavily industrialized with the location of a uranium enrichment plant, various chemical complexes, tire manufacturers, and paper processing facilities. There are 35 companies located within a 9-county region that employ between 100 and 2000. These companies employ many mechanical, chemical, and electrical engineers.

A national management research and consulting firm (MGT of America, Inc., Tallahassee, FL) was hired to study the problem. In 1995, MGT issued their report entitled, "Engineering Education Needs and Instructional Delivery Models for Far Western Kentucky." This report indicated modest economic expansions and estimated the region will require 25-30 additional engineering graduates per year over the number currently available through the year 2000.

In November 1995, Kentucky's Council on Higher Education passed a resolution directing three educational institutions to cooperate in establishing ABET-accredited undergraduate programs in chemical and mechanical engineering in the Western Kentucky region. The University of Kentucky (UK) was designated to be the degree-granting institution, with courses supplemented by Murray State University (MSU) and Paducah Community College (PCC). See Figure 1 for location of these institutions.

The Kentucky legislation adopted the resolution and provided $1.5M to start up and administer the extended campus program. In addition, a new engineering building was constructed on the community college campus at a cost of $8.3M (locally generated dollars). The programs were officially started up in the summer of 1997 with 5 students (1 CME and 4 ME students).

II. Program Description

The Kentucky Council on Higher Education Resolution included an explicit directive to UK, MSU, and PCC to cooperate in developing two new undergraduate engineering programs, one in chemical and one in mechanical engineering. In 1996, the Dean of the UK College of Engineering, the Dean of the MSU College of Industry and Technology, and the PCC President jointly assembled a team of approximately 20 faculty and staff to develop these two new baccalaureate programs. This group included a representative from the Kentucky Council on Higher Education and an ABET-knowledgeable member. Among the issues addressed were the following: tuition collection and financial aid matters, commonality in course objectives and expected student outcomes, equipment needs, computers and related infrastructure needs, recruitment and admission details, transfer opportunities, provision of student services, quality control issues, library acquisitions, and use of distance learning technologies.

From an overall organization standpoint (see Figure 2), the UK Dean of the College of Engineering has ultimate responsibility for the Extended Campus Engineering Programs in Paducah. The Director of the Extended Campus Engineering Programs reports to the dean and interfaces regularly with the Associate Dean for UK Extended Campus Programs, who serves as a liaison with the Lexington campus faculty and administration. The director is responsible for routine daily administration of the Paducah-based programs, with department chairs in chemical and mechanical engineering on the Lexington campus responsible for recommendations to university administration for the appointment of new faculty, promotions, re-appointments, and other faculty-related matters. The director is a member of the UK Mechanical Engineering Department and is involved in teaching in the Paducah program. Curricular and quality control of the programs is maintained by a blended faculty composed of both Paducah-based and Lexington-based UK faculty. The director is primarily responsible for staff hiring decisions in Paducah. The director participates in faculty hiring decisions, but faculty offers are made by the respective department chair, located on the Lexington campus.

The Extended Campus Programs in Paducah utilize a unique blend of faculty. The lower-division courses are the responsibility of UK, MSU, and PCC, with PCC fulfilling the traditional role with the liberal arts, mathematics, chemistry, and physics courses. MSU and UK are responsible for the upper-division courses. Administratively, to accommodate this requirement, five MSU faculty members have joint appointments within the UK engineering program in Paducah. While the jointly-appointed MSU faculty do not have administrative voting privileges, they are consulted on all matters related to the Paducah program.

The chemical engineering faculty on the Lexington campus formulated 4- and 5-year curricula for the program. The curricula are identical to the counterpart Lexington campus curricula, including the number of credits and all prerequisite requirements. The faculty insisted that first-year admission and upper-division admission (i.e., engineering standing) requirements be the same for the Paducah programs as for the Lexington Campus; hence, engineering courses offered in Paducah are virtually the same as those in Lexington. Common course syllabi, examinations and grading scales are used to assure consistency of educational outcomes at both sites. Faculty in Lexington and in Paducah work together in teaching the same course at both sites. Use of distance learning and teleconferencing technologies complement on-site offerings. Thus, faculties in both Lexington and Paducah are unified with comparable curriculum. Criteria for admission to engineering, admission to engineering standing, prerequisite adherence, and graduation requirements are identical.

Because the programs are hosted by an institution without 4-year degree programs (PCC), all students in the programs will be transfer applicants from other institutions, or at a minimum, will transfer a significant number of credits to UK. (An exception is a small number of students who begin at UK-Lexington, then transfer to UK-Paducah.) Most students will be transfers from PCC, or will enroll at PCC and UK (through Distance Learning Programs) concurrently.

III. Resources

Infrastructure and Budgetary

In 1996, the Kentucky General Assembly authorized funding to UK and Murray State University for program planning and partial funding for program initiation in 1997-98. A Special Session of the General Assembly in May 1997 approved additional funding for PCC to upgrade its existing infrastructure. The Paducah Junior College Board (local development and fund raising agent for PCC) conducted a capital campaign that raised $8.3 million for the construction of a new science and engineering building. Classes began in January 1998 in the new 53,000 square-foot facility, named Crounse Hall (see Figure 3.). The Building dedication was held in April, 1998, attended by approximately 500 local business and political leaders, staff and administration from the three participating institutions, and residents from throughout Western Kentucky. The College of Engineering is assigned approximately 40% of the Building's useable space, including major laboratories for the following: ME engine test room, engineering instrumentation lab, CME engineering equipment lab, CME environmental lab, chemical storage rooms, an engineering computing suite, engineering office areas, and student work areas.

With a full complement of Paducah-based engineering faculty and staff on board, recurring funding at the $1.4 million level (beginning in FY 1999-2000) is sufficient to operate quality BS engineering programs in Paducah and to implement a program of equipment preventive maintenance and replacement.

Library Resources

The aggressive infrastructure development program on the PCC campus, coupled with the $1.15 million expenditure planned in '98-99 for Library upgrade, ensures that the engineering programs

in Paducah will have more-than-adequate library resource availability.

Acquisitions of reference books, journals, and handbooks, and the development of faculty and student library support services are being handled by UK's head librarian and by PCC's library director. The director of UK's library system called the first joint meeting in March 1996 to plan the strategy for development of this facet of the programs. Strategies for using the Internet and facsimiles for supplying requested journal articles were formulated. Using a prioritized list of needed acquisitions, as well as texts and references listed on required CME and ME course syllabi, funding was budgeted in 1997-98 to begin purchases. Books, journal subscriptions, and handbooks were received, catalogued with UK-bookmarks and placed in PCC's holdings. The college purchased a facsimile machine for student use at PCC to receive journal articles from the archives of UK's library. Compendex Index gratuitously extended UK's license for use by the Extended Campus Engineering Programs in Paducah. As the programs develop, a part-time librarian will be assigned to serve the needs of the program.

Off-campus access to the collections is available through the Website of the University Library, where remote users of the library can search the public catalog as well as utilize the multiplicity of Websites that have been pre-selected for their information value. The Shaver Engineering Library in Lexington also has a very active Website which can be used by remote users to search databases and information sources identified specifically for the engineering disciplines. In some cases, remote users are permitted to use commercially produced databases if they have been included as part of the University's site license. In addition, facsimile requests can be made to the Interlibrary Loan Department for document delivery. Other inquiries can be made directly to the Shaver Engineering Library.

As of July 1998, PCC holds 80 reference and circulating books acquired specifically to support the two new programs, in addition to a solid foundation of basic science and technology resources. Instructors may arrange for materials to be placed on reserve for their students. The Library subscribes to several engineering journals in paper form and many more in electronic form. At any of the 20 public workstations, students may search the online catalog of the library holdings of PCC, UK, other community colleges, and the EiCompendex Web.

Laboratory Facilities

Another interesting and unique feature of the engineering programs at Paducah is that all laboratory equipment for unit operation labs was purchased from off-the-shelf vendors. Since the engineering programs are for undergraduates only, there are no graduate students available to construct and test laboratory experimental equipment as in a traditional university environment. Purchase of the equipment was from a $1.1M start-up equipment allocation appropriated by the State over a 2-year period. Some of the equipment includes a packed distillation column, a double-effect evaporator, CSTR and continuous reactors, gas adsorption apparatus, fluid flow apparatus, liquid-liquid extraction, process control trainer, and various type heat exchangers. The liquid-liquid extraction apparatus is shown in Figure 4.

IV. Faculty and Professional Staff

The Extended Campus Program in Paducah uses a faculty consisting of UK faculty and five jointly appointed MSU faculty for the upper-division course load. The projected UK faculty necessary to staff the program has been estimated to be five resident faculty in mechanical engineering (one position is filled by the program director) and three resident faculty in chemical engineering. This number, supplemented by instruction through use of distance learning technology (especially compressed video or web + compressed video) will be sufficient to offer all four years of both degree programs on site in Paducah.

All of the UK faculty positions, with the exception of the director, will be filled in a special-title series. These positions are primarily upper-division, 9-month teaching appointments. However, because of the nature of the Paducah program, these appointments will involve additional assignments, including student recruitment from local high schools and the business community, undergraduate laboratory and computer software development, assistance with summer job placement, and professional development. The traditional responsibilities involving instruction, academic advisement, and university service also apply. Because of these unique responsibilities and the limited access to graduate students, the expectation for research productivity is less than for the faculty on the Lexington campus, and is usually 10-20% of a faculty member's Distribution of Effort.

The program currently has two resident faculty members in chemical engineering and two in mechanical engineering. Recruitment is underway for two to three additional ME and two CME resident faculty members. This will complete the projected staffing for the program. In addition, there are prospective adjunct faculty and/or lecturers available from the community with appropriate academic credentials, as well as significant and pertinent industrial experience.

The program is now fully staffed with regard to support personnel. The program staff includes an office assistant, a laboratory manager, and a director of student services. The director of student services' responsibilities include interfacing on a regular basis with admissions officers and various other UK staff, such as UK's Distance Learning Programs, engineering student records, and directors of undergraduate studies and staff support in the Lexington-based chemical and mechanical programs. In addition, the director of student services is actively involved in recruiting at local high schools and maintains close contact with pre-engineering advisors and recruiters at PCC.

V. Distance Learning Activities

The Commonwealth of Kentucky has significantly invested in distance learning infrastructure within the last decade. Initial plans were to use the system to deliver graduate-level instruction to parts of the state that were distant from the major research institutions. One of the first compressed video (CV) links to the University of Kentucky campus in Lexington was from Paducah Community College. This link was established to satisfy an expressed need for graduate engineering and education courses. Graduate level courses have been offered in both masters and doctoral degree programs. A cohort class of about 30 students recently completed their EdD degree programs through the use of CV for all course work. There are currently more than a dozen community colleges and regional universities connected with the University of Kentucky CV system. The entire Kentucky Telelinking Network has approximately 140 fully equipped

interactive video rooms.

As an extension of the engineering programs on the UK campus in Lexington, it was obvious that the use of CV would be instrumental, especially in the early development of the Paducah programs. The first engineering courses were taught in Paducah via CV, originating from Lexington and from MSU. There are typically 2 to 4 courses transmitted by CV each semester between the Lexington and Paducah campuses, with courses originating at each location. These courses have proven invaluable to the Paducah programs as on-site faculty members are hired. The availability of the CV courses from Lexington has permitted the first upper-level students in the program to progress at their scheduled pace even when a faculty member with a particular specialization had not yet been hired in Paducah. This linkage has also permitted the areas of specialization of the new faculty members in Paducah to complement the areas of the faculty in Lexington. For example, one jointly appointed MSU faculty member with a specialization in basic manufacturing methods now regularly teaches an introductory manufacturing class via CV from Paducah to Lexington. His availability has permitted the ME department to fill a recently vacated position with a faculty member having a more specialized manufacturing background.

There are obviously some problems to overcome with this application of compressed video, as with any new technology. One important issue is the availability of a knowledgeable facilitator at remote sites to provide help with homework and course questions. While the instructors are encouraged to provide several of their lectures from the remote site, it is difficult to provide the same level of course support at both sites that would be needed prior to examinations and major project due dates. Graduate students will provide CV course facilitation in Lexington, while the Paducah-based faculty members and post docs will facilitate courses in Paducah.

Distance learning courses have been received by the students with mixed results. Just as in live classroom instruction, there are varying degrees of instructor effectiveness. However, a CV course has the potential to let the technology interfere with effective course delivery. The instructors can control all three cameras at each location, as well as being able to show computer generated images and videotapes. While the multimedia possibilities are necessary to provide a range of instructional activities, most courses are still centered around the traditional lecture format. Switching cameras between the instructor and the text images requires a constant mental effort. Lapses can result in the students at the remote site seeing a blank page for periods of time when the instructor may be answering a question or explaining concepts to the live class. Students in a small (< 10) CV class also lose the potential for anonymity that is possible by sitting in the back of a larger class. While this should be viewed positively, some students are somewhat uncomfortable “being on camera” where they think the instructor or the students at the other site may scrutinize their actions or appearance. Student evaluations have indicated little difference in how a CV course is received between the live class and the remote class. We are continuing to evaluate the differences between a CV class and a conventional live class in terms of student outcomes and overall course effectiveness.

As the full complement of on-site faculty is hired at Paducah, there will be less dependence on distance learning for required courses. Several courses, such as introductory manufacturing, lend themselves to this method of delivery when complemented with lecture notes and materials made available on the Internet. These courses will likely be continued as CV offerings, along with

somewhat unique technical electives that may originate from either location. The plan for the long term is to focus on a relatively small number of required courses for delivery by distance learning technology, permitting limited resources to be targeted toward upgrading courses already well taught with these media.

VI. ABET Accreditation

Since the engineering programs at Paducah are distinct from their Lexington counterparts in terms of location, facilities, administration, and support services, the programs will seek distinct ABET accreditation (a decision not made unilaterally by the institution but determined ultimately by the accreditation agency). With the goal of achieving accreditation status at the earliest opportunity, college task forces have been working with ABET staff and ABET-knowledgeable consultants to ensure that program development is progressing toward this goal. The Paducah programs recently held an ABET planning committee meeting, which was attended by representatives of all three participating institutions to initiate work toward the goal of ABET accreditation.

Current program objectives are similar to those of the programs on the Lexington Campus and have been reviewed by the respective department faculty. However, these objectives will be reviewed periodically with modifications made, as appropriate, as the programs evolve. The objectives, of course, will be based on the ongoing practice of' continuous improvement, which includes formal collection of input from constituencies.

UK engineering programs were evaluated under the new ABET Engineering Criteria 2000 in November 1998. In August 1999, the college was informed by ABET that all of the undergraduate programs in the College had been re-accredited. If the Paducah programs are accredited distinctly, an accreditation visit could be requested for the new programs soon after there is sufficient amount of data from graduates and other stakeholders for each Paducah program.

VI. Comparative Programs

Programs in Kentucky

Within Kentucky, the University of Louisville and the University of Kentucky have ABET-accredited programs in chemical engineering. The University of Louisville engineering program does have distinct differences from the Paducah program, e.g. advanced-level accreditation versus basic accreditation, mandatory co-op, urban location, and geographical separation. For comparison purposes, data from the University of Louisville's chemical engineering BS degree program and from UK's Lexington-based programs are presented in Figure 5 and Figure 6, respectively. Figure 7 offers a comparison of the related engineering program degrees offered by UK Lexington, UK Paducah, Murray State, and Paducah Community College to give an overall perspective of the size of the programs offered by each institution.

Due to the geographic separation of the two UK programs (255 miles from Lexington to Paducah) and the local stimulus for program creation, the programs in Paducah are not considered unnecessarily duplicative. Additionally, as the programs in Paducah develop, innovative courses, new approaches, and delivery modes are envisioned.

It is not anticipated that the Paducah programs will adversely affect enrollment in similar programs. In fact, the two new programs might even *increase* participation in engineering education through heightened awareness of engineering opportunities in the region. And, as reported in the MGT study, while Kentucky high school seniors historically have a relatively typical interest in engineering as a college major, enrollment in engineering education from Western Kentucky is much lower. Establishment of engineering programs in Paducah should result in a marked increase in engineering enrollment among students from the Western Kentucky Region.

Other National Programs

The model proposed for the Extended Campus Programs in Paducah is the only known set of engineering programs located on a community college campus but administratively under the direct responsibility of the main campus dean and corresponding chair. The closest example known in the U.S. is the branch campus of Washington State University (WSU) in Richland, WA. This

"Tri-Cities" campus is approximately 156 miles from the Pullman campus and offers undergraduate degrees in mechanical engineering, electrical engineering, and computer science. In addition, a BS program in manufacturing engineering, to be administered by the WSU School of Mechanical and Materials Engineering, is currently under development for the Vancouver Campus. Similarities with the programs in Paducah include the following: approximately the same number of resident faculty; planned use of distance learning technologies (to the appropriate level); distinct accreditation action sought; one dean and chairperson per program (located on main campus). Major differences between the Tri-Cities and the Paducah programs exist in that WSU employs a campus dean at each of the branch campuses; by design, branch campuses can teach *only* upper-division courses; there is a split financial system, such that the department chair and academic dean have programmatic responsibility but little/no financial control; and branch campuses have selected (and limited) MS degree production.

VIII. Summary

The University of Kentucky is using an extended campus concept to develop new programs in chemical engineering in Western Kentucky to provide engineering graduates as well as further engineering educational opportunities for local industries in the area. The programs are located on the Paducah Community College campus, which is 255 miles from the Lexington campus. Based on Kentucky Legislation three institutions are involved in the Paducah programs (University of Kentucky, Murray State University, and Paducah Community College), with the University of Kentucky being the degree-granting institution.

This program is unique in the following areas:

1. Programs are resident on a community college campus.
2. The Dean of the University of Kentucky College of Engineering in Lexington is responsible for administration.
3. An integrated faculty from three institutions serve as the resident faculty.
4. Resident University of Kentucky faculty are appointed in a special-title series.
5. Distance learning (where appropriate) will remain part of the programs.

The programs started in the summer of 1997 with 5 students (1 CME and 4 ME). In the fall semester of 1999 there were 89 total students enrolled in the engineering program. Of these, 21 are CME students. Five chemical engineering students are on-track to graduate in May 2001.

The basic infrastructure has been established (engineering and science building, library resources, laboratories, and staff) to ensure a successful program.

Since the chemical engineering program at Paducah is distinct from the Lexington campus, the program will seek separate ABET accreditation. Accreditation will follow the new ABET Engineering Criteria 2000. Experience gained during ABET's 1998 visit under Criteria 2000 should be of significant value, since the programs are administered by the same chairs as the sister programs in Lexington.

Figures

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William E. Murphy is a Professor of Mechanical Engineering with the University of Kentucky and Director of the Engineering Extended Campus Programs in Paducah. Dr. Murphy received his BS degree from the University of Kentucky and his MS and PhD degrees from Purdue University, all in Mechanical Engineering. He is a member of the ABET EAC and a past ABET Director representing ASHRAE. He is a licensed Professional Engineer in Kentucky.

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G.T. Lineberry is Associate Dean for Extended Campus Programs and Professor of Mining Engineering with the University of Kentucky. Dr. Lineberry received his BS and MS degrees from Virginia Tech and his PhD degree from West Virginia University, all in Mining Engineering. He is author/coauthor of over 60 journal articles, conference proceedings, and book chapters, and was a section coordinator and contributor to the SME Mining Engineering Handbook (2nd ed).

BONITA LYKINS
Bonita Lykins is Director of Student Services for the UK College of Engineering, Extended Campus Programs in Paducah. She received her BA degree in English and history and MAEd degree from Murray State University with additional post graduate work in educational administration. She has over 30 years experience in public secondary education.

Figure 1. Commonwealth of Kentucky

Figure 2. Organizational Chart

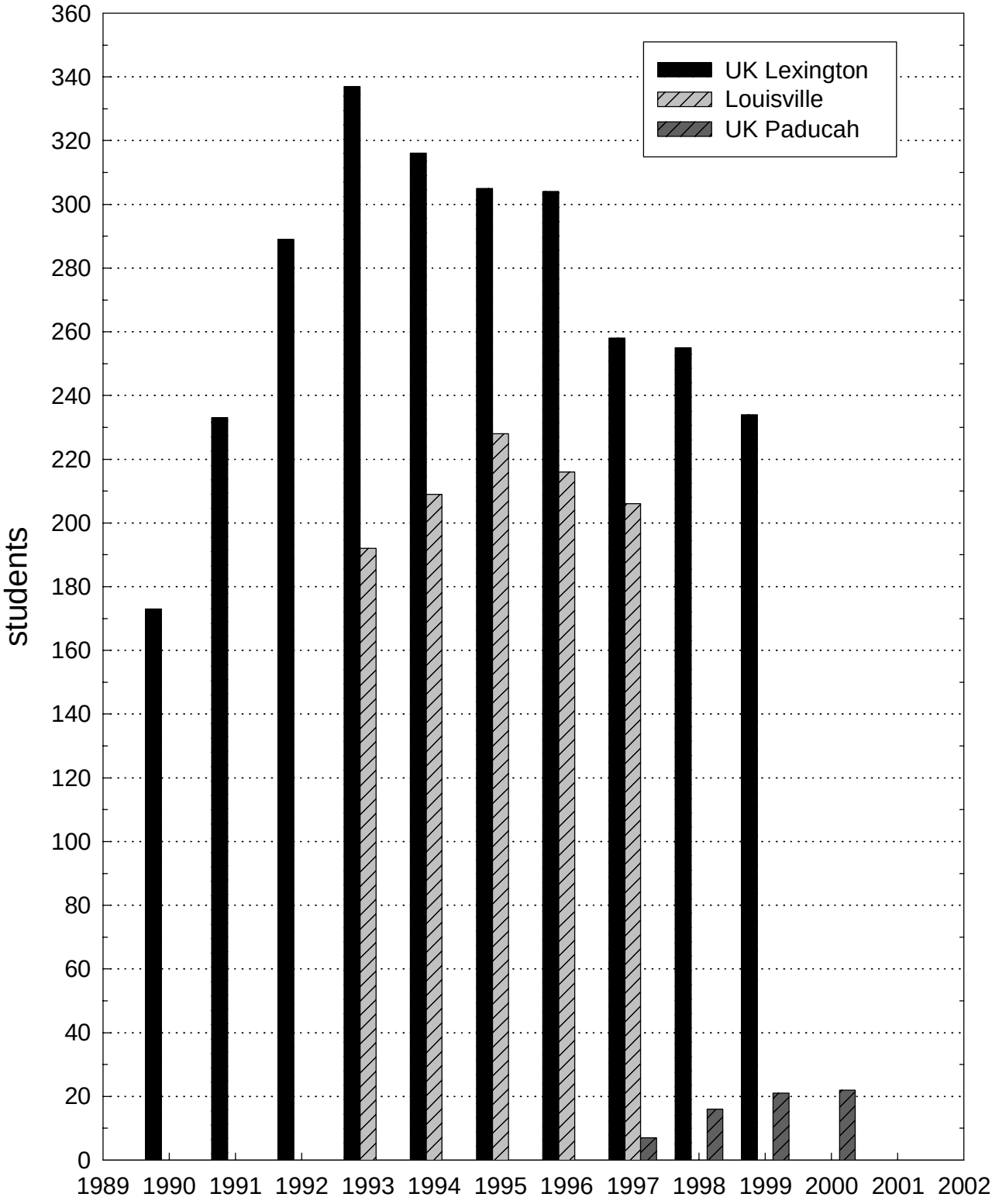

Figure 5. Chemical Engineering Enrollment at Kentucky Institutions

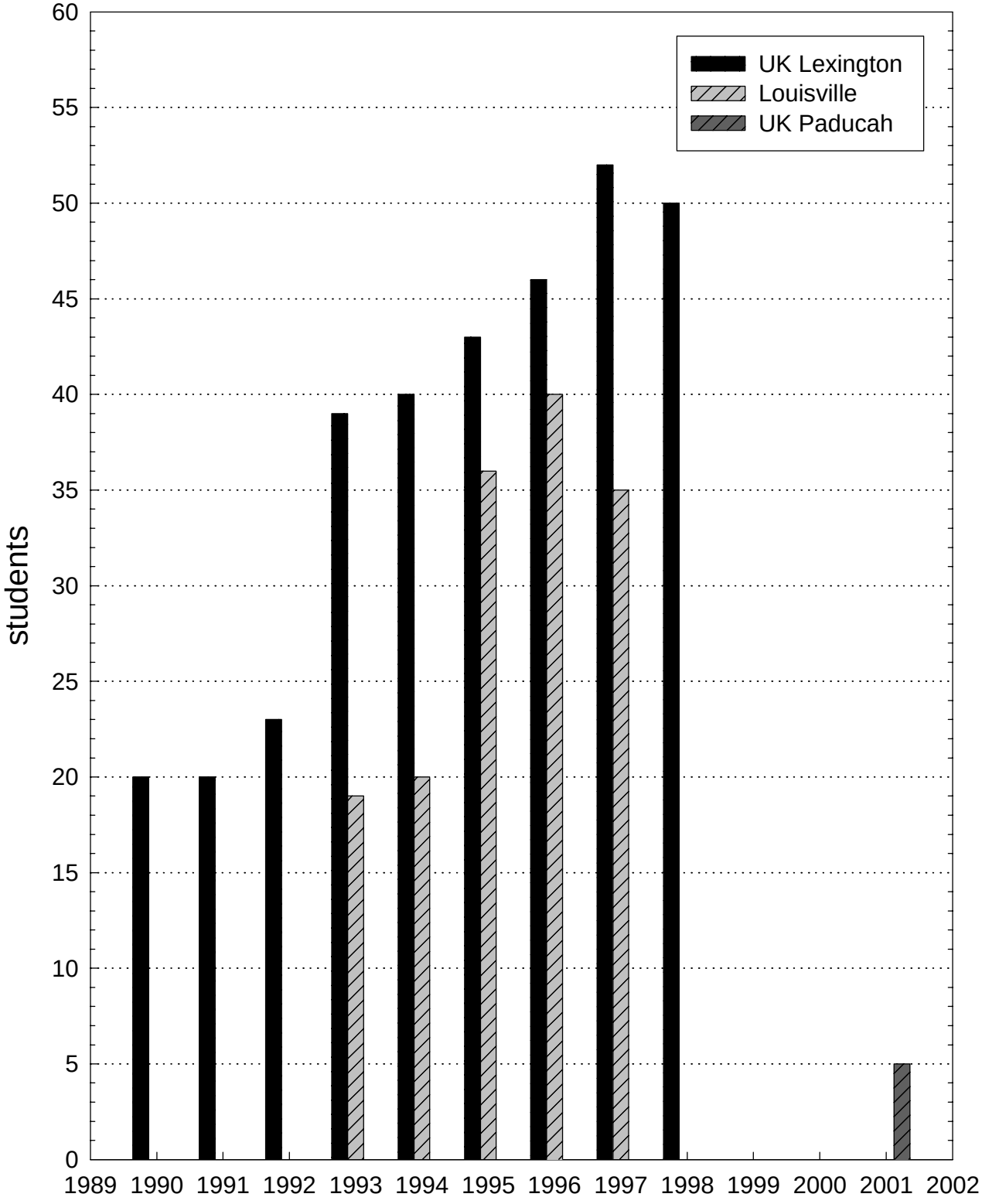

Figure 6. BS Chemical Engineering Degrees at Kentucky Institutions

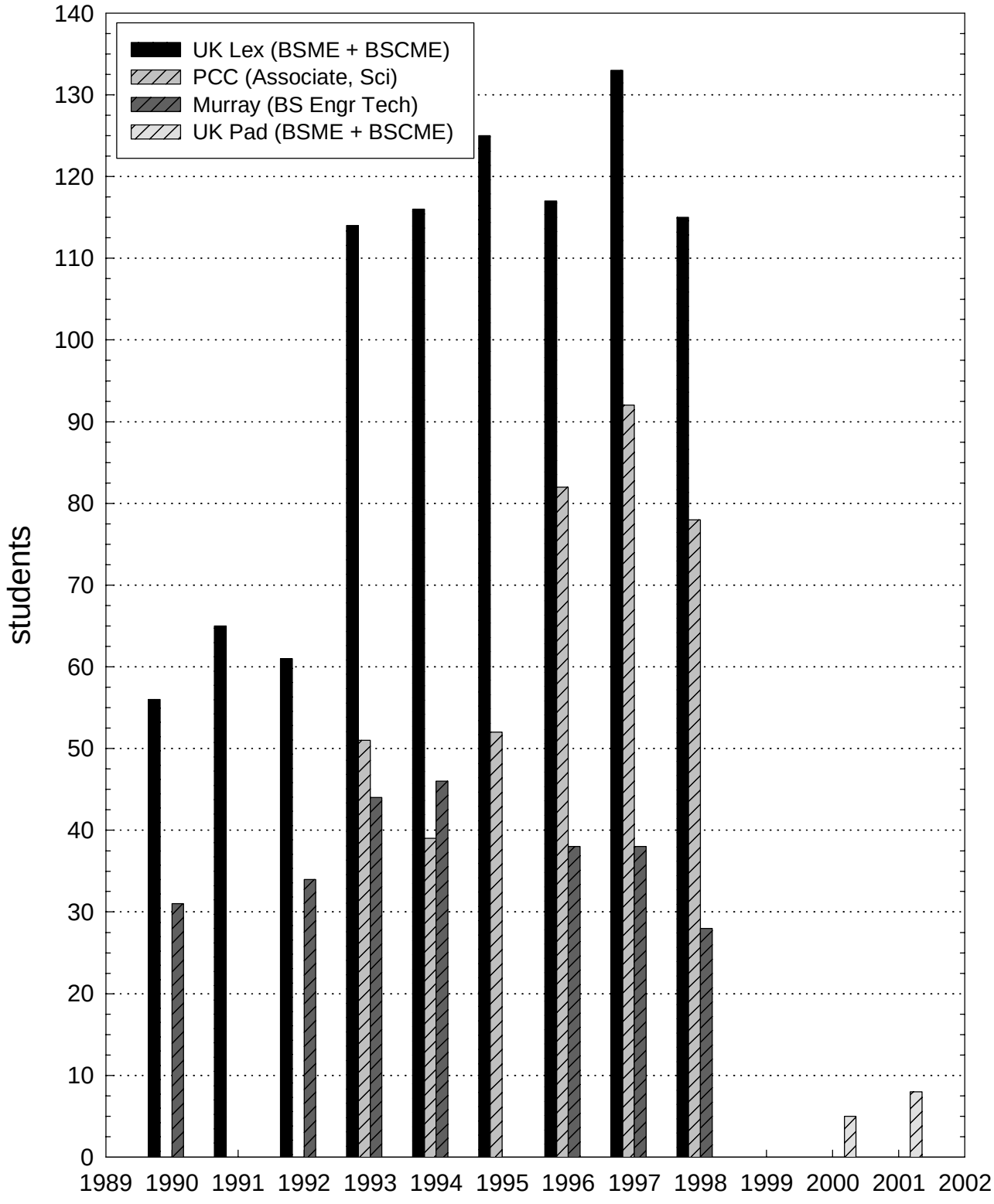

Figure 7. Degrees Granted By Participating Institutions