Going the Distance

Best Practices and Strategies for Retaining Engineering, Engineering Technology and Computing Students

Inside

The American Society for Engineering Education invites you to explore promising practices and strategies for retaining students in Engineering, Engineering Technology and Computing (including Computer Science, Computer Engineering, Computer Technology, and related disciplines) programs.

On February 8, 2012, President Obama recognized the commitment of engineering deans to enhancing the retention and graduation of engineering, engineering technology, and computing (EETC) students. The President's Council on Jobs and Competitiveness is committed to increasing the number of graduates in EETC disciplines over the next ten years.[1] Although there is no consensus over the specific number of EETC graduates needed to fill current openings,[2] it is reasonable to agree on the value of retaining those talented students who gain admission to EETC programs.

Individual and Institutional Variables Affect EETC Retention

Education research conducted by EETC faculty has shown a combination of individual and institutional factors contribute to variability in student retention across programs, disciplines and types of students. One conclusion of a pilot study conducted by ASEE was that some variability in retention can be explained by the level of student preparedness for engineering programs. For example, more selective schools tend to have higher student retention than less selective schools. The pilot study also showed a large degree of variability in retention and graduation by race, ethnicity, and gender. For example, the six-year graduation rate of Asian Americans was 66.5%, Caucasians – 59.7%, Hispanics – 44.4%, Native Americans – 38.6%, African Americans – 38.3%, females 61%.

Other studies have shown that a primary reason for the attrition of students from engineering is their perception of a learning environment that fails to motivate them and is unwelcoming; it is neither the students' capabilities nor their potential for performing well as engineers that determines their persistence.[3] The study authors assert that many EETC schools can improve student retention by changing the way they currently operate and adopting best practices and strategies for retaining students.

ASEE asked Engineering, Engineering Technology and Computing deans and chairs of two-year and four-year schools to send us examples of their most successful retention activities.

As part of a larger ASEE study of student retention, ASEE conducted a review of literature and documented over 60 strategies and practices that were identified as effective in retaining students in engineering. We divided these strategies into three groups: student-focused strategies and practices; faculty-focused strategies and practices; and institutional- and departmental-focused strategies and practices. ASEE asked deans and chairs to send us brief descriptions of their most successful departmental and college-wide retention activities in each of the three categories. We provided a number of examples found in the literature. We also asked deans and chairs to send us evidence showing that the practice was effective. We received close to 60 best-practice submissions.

Schools reported multiple efforts to improve retention.

Best practices identified in the literature were used to code those mentioned in each school's submission. The practices cited by schools spanned the full range of retention strategies found in the literature. Most schools took a "holistic" approach to improving retention; rather than focusing on one approach, they pursued multiple strategies. Academic support and enrichment were the most common, followed by research and work opportunities. Frequently mentioned types of support included:

- tutoring;
- mentoring;
- learning centers;
- programs specifically developed for at-risk students;
- programs specifically for first-year students;
- academic advising; and
- career awareness.

Mentioned least often were practices focusing on faculty training and student preparation for graduate school. Almost all schools reported that their specific practices furthered the intangible but important goal of developing a "community" among EETC students and faculty, which contributed to student retention and graduation.

We regrouped best practices and created crosswalk tables showing which schools applied which practices. These tables reveal the breadth of practices reported by schools. The groupings of best practices should not be viewed as exhaustive. Submissions had to adhere to word limits, so schools may not have reported all their efforts to support student retention. Some submissions are included in this report, chosen on the basis of their clarity and supporting data.

Resources

- **American Society for Engineering Education**
  http://www.asee.org
- **Engineering Trends**
  http://www.engtrends.com/IEE/0206A.php
- **National Academy of Engineering**
  http://www.nae.edu
- **Sloan Career Cornerstone Center**
  http://www.careercornerstone.org
- **The Computer Research Association**
  http://cra.org

Sources

1. The Jobs Council. 2011 End of Year Report: Roadmap to Renewal. 2011. http://files.jobs-council.com/files/2012/01/JobsCouncil_2011YearEndReport1.pdf

2. Leonard Lynn and Hal Salzman. Is The President Right When He Says the United States Needs 10,000 Engineers A Year? Why Not Let The Market Decide? 2011. Manufacturing and Technology News http://www.manufacturingnews.com/news/11/1031/engineers.html

3. American Society for Engineering Education. Creating a Culture for Scholarly and Systematic Innovation in Engineering Education. 2009. http://www.asee.org/about-us/the-organization/advisory-committees/CCSSIE

A Summary of Reported Student Retention Best Practices

ASEE invites you to explore the following crosswalk tables showing which schools applied which retention practices.

- **Focus on Student Learning Through Tutoring/Mentoring**
- **Student Programs and Financial Aid**
- **Student Academic Enrichment Programs**
- **Student Research/Work Experience**
- **Curriculum and Class Enhancements**
- **Institutional/Educational Research**
- **Change in Institutional/Departmental Policy**

Focus on Student Learning Through Tutoring/Mentoring

University	Type of School	Tutoring	Peer Mentoring	Learning Community	Learning Center	Peer Study Group	Mentoring by faculty or graduate students
Arizona State University	Engineering		✓				
Boise State University	Engineering	✓	✓	✓			✓
Bucknell University	Engineering	✓		✓			✓
California State University, Fullerton	Engineering and Computer Science			✓	✓		
City College of the City University of New York	Engineering	✓				✓	
Dartmouth College	Engineering		✓	✓			✓
Georgia Institute of Technology	Engineering		✓				
Indiana University-Purdue University Fort Wayne	Engineering, Technology and Computer Science				✓	✓	
The Johns Hopkins University	Engineering	✓					
Kansas State University	Engineering	✓	✓		✓	✓	
Lehigh University	Engineering and Applied Science		✓				
Michigan State University	Engineering	✓					✓
Mississippi State University	Engineering	✓	✓	✓	✓		
New Mexico State University	Computer Science		✓			✓	
The Pennsylvania State University	Engineering					✓	✓
Purdue University	Engineering			✓			✓
Rochester Institute of Technology	Engineering			✓			
Swarthmore College	Engineering	✓	✓				
Texas A&M University	Engineering	✓		✓			
University of Cincinnati	Engineering and Applied Science	✓		✓	✓		
University of Colorado-Boulder	Engineering and Applied Science	✓				✓	
University of Houston	Computer Science	✓					✓
University of Houston-Downtown	Sciences and Technology		✓				
University of Illinois at Urbana-Champaign	Engineering	✓	✓	✓	✓	✓	✓
University of Louisville	Engineering	✓			✓		
University of Nebraska, Lincoln	Engineering			✓			
University of Nevada, Reno	Engineering						✓
University of South Florida	Computer Science and Engineering	✓	✓				✓
University of Southern California	Engineering	✓	✓		✓	✓	
University of Texas at San Antonio	Engineering	✓				✓	
The University of Toledo	Engineering	✓	✓	✓			
University of Wisconsin, Madison	Engineering	✓		✓	✓	✓	
Washington University in St. Louis	Engineering and Applied Science	✓				✓	✓
West Virginia University	Engineering and Mineral Resources	✓	✓		✓	✓	✓

Student Programs and Financial Aid

University	Type of School	Programs designed specifically for at-risk students	Programs designed specifically for first year students	Honors programs	Programs designed specifically for transfer students	Stipend	Scholarships	Fellowships
Boise State University	Engineering	✓					✓	
Bucknell University	Engineering	✓						
California State University, Fullerton	Engineering and Computer Science		✓					
City College of the City University of New York	Engineering	✓					✓	
Georgia Institute of Technology	Engineering	✓				✓		
Indiana University-Purdue University Fort Wayne	Engineering, Technology and Computer Science	✓	✓					
Lehigh University	Engineering and Applied Science	✓						
Michigan State University	Engineering	✓	✓					
Mississippi State University	Engineering	✓	✓			✓		
The Pennsylvania State University	Engineering		✓					
Purdue University	Engineering	✓	✓					
Rochester Institute of Technology	Engineering	✓						
San Diego State University	Engineering	✓	✓		✓	✓		
Swarthmore College	Engineering	✓						
Texas A&M University	Engineering	✓						
University of Cincinnati	Engineering and Applied Science	✓						
University of Colorado-Boulder	Engineering and Applied Science		✓	✓				
University of Houston	Computer Science						✓	
University of Houston-Downtown	Sciences and Technology	✓					✓	
University of Illinois at Urbana-Champaign	Engineering		✓					
University of Louisville	Engineering	✓						
University of Nevada, Reno	Engineering			✓			✓	
University of Pennsylvania	Engineering	✓	✓					
University of Portland	Engineering		✓					
University of Rochester	Engineering and Applied Sciences	✓						
University of South Florida	Computer Science and Engineering					✓		
University of Southern California	Engineering	✓	✓					
University of Tennessee	Engineering						✓	✓
The University of Toledo	Engineering		✓					
Washington University in St. Louis	Engineering and Applied Science		✓					
West Virginia University	Engineering and Mineral Resources		✓					

Student Academic Enrichment Programs

University	Type of School	Academic support program or services	Summer Academic Enrichment	Summer Bridge Program (for high school students)	Academic Advising	Skills Building Seminar	Seminar for first year students on what is engineering
Arizona State University	Engineering			✓		✓	
Boise State University	Engineering				✓		
Bucknell University	Engineering			✓		✓	
California State University, Fullerton	Engineering and Computer Science	✓					
City College of the City University of New York	Engineering			✓	✓		✓
Dartmouth College	Engineering				✓		
Georgia Institute of Technology	Engineering			✓			
Indiana University-Purdue University Fort Wayne	Engineering, Technology and Computer Science	✓			✓		
Lehigh University	Engineering and Applied Science				✓		
Michigan State University	Engineering	✓			✓	✓	✓
Mississippi State University	Engineering			✓			✓
The Pennsylvania State University	Engineering			✓			
Purdue University	Engineering			✓		✓	✓
Rochester Institute of Technology	Engineering				✓		
San Diego State University	Engineering				✓	✓	✓
Swarthmore College	Engineering	✓			✓		
University of Colorado-Boulder	Engineering and Applied Science					✓	
University of Houston-Downtown	Sciences and Technology					✓	✓
University of Illinois at Urbana-Champaign	Engineering					✓	
University of Louisville	Engineering			✓	✓		✓
University of Nebraska, Lincoln	Engineering			✓			
University of Nevada, Reno	Engineering				✓		✓
University of Pennsylvania	Engineering			✓			
University of Portland	Engineering				✓	✓	
University of South Florida	Computer Science and Engineering				✓		✓
University of Southern California	Engineering	✓	✓	✓	✓		✓
University of Wisconsin, Madison	Engineering			✓	✓		
Washington University in St Louis	Engineering and Applied Science			✓	✓		
West Virginia University	Engineering and Mineral Resources				✓	✓	

Student Research/Work Experience

University	Type of School	Career Awareness	Introducing undergraduate research experience as early as possible	Research Opportunities with faculty	Internship	Cooperative Education	Research Experience	Giving students practical work experiences in their intended major to apply their learning	Inviting Industry Partners to work on team project	Symposiums with speakers from industry
Boise State University	Engineering	✓	✓	✓	✓		✓	✓	✓	
Dartmouth College	Engineering	✓								
Grand Valley State University	Engineering	✓	✓			✓		✓		
Indiana University-Purdue University Fort Wayne	Engineering Technology and Computer Science				✓					
Michigan State University	Engineering	✓	✓						✓	✓
Mississippi State University	Engineering		✓	✓					✓	
The Pennsylvania State University	Engineering	✓								
Purdue University	Engineering	✓								
San Diego State University	Engineering	✓			✓	✓	✓	✓		
University of Cincinnati	Engineering and Applied Science					✓		✓		
University of Houston	Computer Science	✓								
University of Houston-Downtown	Sciences and Technology	✓								✓
University of Nevada, Reno	Engineering	✓					✓			
University of Rochester	Engineering and Applied Sciences				✓		✓	✓		
University of South Florida	Computer Science and Engineering		✓	✓			✓			
University of Southern California	Engineering	✓	✓				✓			
The University of Toledo	Engineering					✓				
West Virginia University	Engineering and Mineral Resources	✓								

Curriculum and Class Enhancements

University	Type of School	Offering a socially relevant curriculum that emphasizes service learning	New Course Development	Moving design and systems courses and practical engineering laboratories earlier in the curriculum	Emphasis on teaching of undergraduate and undergrad-uate learning	Projects integrated into classes
Boise State University	Engineering	✓	✓	✓	✓	
The Johns Hopkins University	Engineering		✓	✓		
Lehigh University	Engineering and Applied Science		✓	✓		
Michigan State University	Engineering			✓		
University of Cincinnati	Engineering and Applied Science		✓	✓	✓	
University of Houston	Computer Science	✓	✓			✓
University of Louisville	Engineering		✓			
University of Maryland, College Park	Engineering		✓	✓	✓	✓
University of Nevada, Reno	Engineering	✓			✓	✓
University of Pennsylvania	Engineering					
University of Portland	Engineering					
University of Rochester	Engineering and Applied Sciences	✓				
University of Southern California	Engineering	✓			✓	✓
University of Texas at San Antonio	Engineering		✓		✓	
University of Wisconsin, Madison	Engineering	✓	✓	✓		
Washington University in St Louis	Engineering and Applied Science	✓				
Wright State University	Engineering and Computer Science		✓		✓	

Institutional/Educational Research

University	Type of School	Intervention programs that address academic preparation and performance issues	Means to measure student learning outcomes	Tracking persistence and progression patterns for all students/application to help track and manage student retention	Research on what attracted and convinced students to enroll	Create or update a retention plan annually	Early alert and intervention system.
Bucknell University	Engineering	✓					
Indiana University-Purdue University Fort Wayne	Engineering, Technology and Computer Science			✓			
Michigan State University	Engineering		✓	✓			
Purdue University	Engineering			✓			
Swarthmore College	Engineering	✓		✓			
University of Colorado-Boulder	Engineering and Applied Science			✓			
University of Louisville	Engineering	✓	✓				✓
University of Nevada, Reno	Engineering		✓			✓	
University of Notre Dame	Engineering				✓		
University of Portland	Engineering						✓
University of South Florida	Computer Science and Engineering	✓	✓	✓			✓
University of Southern California	Engineering	✓	✓	✓		✓	✓
University of Tennessee	Engineering	✓					
University of Wisconsin, Madison	Engineering	✓	✓				
Washington University in St Louis	Engineering and Applied Science	✓		✓			

Change in Institutional/Departmental Policy and Faculty Development

University	Type of School	Title III or Title V funding	Collaboration between academic affairs and student affairs	Mandatory advising, one-on-one and face-to-face, between faculty and students	Diversity Sensitivity training	Workshop on Teaching	Working with math and physics professors to add engineering content to math and physics courses
Boise State University	Engineering						✓
California State University, Fullerton	Engineering and Computer Science	✓					
City College of the City University of New York	Engineering		✓				
Louisiana Tech University	Engineering and Science				✓	✓	
Michigan State University	Engineering		✓				
San Diego State University	Engineering						✓
Swarthmore College	Engineering						✓
Texas A&M University	Engineering		✓				
University of Cincinnati	Engineering and Applied Science						✓
University of Colorado-Boulder	Engineering and Applied Science		✓				
University of Illinois at Urbana-Champaign	Engineering						✓
University of Louisville	Engineering		✓			✓	
University of South Florida	Computer Science and Engineering		✓				
University of Southern California	Engineering		✓				✓
Washington University in St Louis	Engineering and Applied Science			✓			
West Virginia University	Engineering and Mineral Resources		✓				

Selected School Submissions

ASEE invites you to explore retention strategies used by the following selected schools.

- **Bucknell University, College of Engineering**
- **Purdue University, West Lafayette, College of Engineering**
- **University of Colorado-Boulder, College of Engineering and Applied Science**
- **University of Maryland, School of Engineering**
- **University of Southern California Viterti, School of Engineering**
- **Washington University in St. Luis, School of Engineering and Applied Science**
- **West Virginia University, College of Engineering and Mineral Resources**

Bucknell University, College of Engineering

In a program called Engineering Success Alliance (ESA), Bucknell's College of Engineering works with the Office of Admissions to identify and assist incoming students from disadvantaged urban backgrounds and from groups that are historically underrepresented in engineering. Students enter the school as a supportive cohort, and are provided with additional academic support. The program is evolving, but early data are promising.

History

The Engineering Success Alliance (ESA) is an academic success program that provides students from under-resourced high schools with the skills they need to be successful at Bucknell University in a nationally recognized engineering program. The ESA program was developed to work in partnership with the students recruited to through the Posse Foundation. The Posse Foundation assists universities in recruiting students with strong leadership potential from urban schools in major metropolitan areas. Bucknell works with the Posse Foundation to recruit students from Washington D.C., Boston and Los Angeles.

The College of Engineering has partnered with Parsons Brinkerhoff and other companies to implement a program that aims to become an innovative part of the national effort to increase the diversity of the engineering workforce. The College of Engineering, in conjunction with the Office of Admissions, indentifies incoming students from targeted recruiting programs, such as Posse, and from groups that are historically underrepresented in engineering whose math and science experience may not be consistent with that of traditional engineering applicants. These students are invited to be a part of the ESA prior to matriculation. Indicators that are used to select participants are SAT scores, high school coursework, and underrepresented status in engineering.

Implemented in the fall of 2010, the ESA began by assisting 13 first-year members of the class of 2014. This cohort consisted of eight men and five women. Seven were Hispanic, four were Black, one was Asian and one was Caucasian. A second cohort of 15 first-year students from the class of 2015 was added in the fall of 2011. This cohort consisted of nine men and six women. Seven were Hispanic, three were Black, three were biracial and two were Asian.

The Program

Students who agree to be a part of the ESA participate in an ongoing program during the academic year that is focused on facilitating their transition to college, access to professional development opportunities, and improving their study and communication skills and fluency in the use of mathematics. The program is led by a professional math educator who also serves as director of the ESA. The pedagogy of the program is designed to support its goal of fostering academic success and empowerment. Some students work one-on-one with the ESA director on specific math, study, or organizational skills. There are also peer tutors available to work with students. The ESA program reflects research demonstrating the increased power of positive, community-related activities and instruction over more traditional tutoring and remediation methods. Early efforts to build an academic community among the students have led to a critical program element called "Math Lab," inspired by the Emerging Scholars Program built on the work of Uri Treisman at the University of California, Berkeley. Once or twice a week, students gather to work collaboratively on "challenge" problems in their respective calculus classes as well as non-curricular brain teasers and puzzlers. Math Lab strives to instill a sense of confidence in problem-solving and in teamwork, as well as to support the classroom mathematics courses.

In the summer of 2012, a new week-long pre-orientation program named Backstage Bucknell will be added to the ESA program for incoming first-year students. The program, conducted prior to the official first-year arrival date, will focus on preparing the students for the transition to college-level academics and to help students build their support network on campus.

A key component of the ESA program is its Industry Advisory Committee. This committee serves to mentor the ESA students, assist in fundraising for the program, and help provide professional development opportunities for the students, such as internships.

The program will initially be funded by Parsons Brinkerhoff for the first five years at $50,000 per year and then supported by an endowment. The advisory committee and the university play key roles in soliciting support for the ESA endowment through their connections within the engineering industry.

Data

The data for the ESA program is preliminary, since the program is still new, but show a strong improvement in student retention. Before the ESA began, 16 Posse scholars were enrolled in the College of Engineering. The retention rate in engineering of these students was 62.5% and only one student had a GPA above the college average of 3.2. Currently, of the 18 additional students who have participated in the ESA who are also Posse scholars, eight have a GPA above a 3.2. The retention rate of these students is 83%.

Purdue University, West Lafayette, College of Engineering

Purdue University recently implemented a student academic enrichment program aimed at retaining minority students in engineering. The program strategies drew from institutional research conducted by the university showing that social climate and challenges in adjusting to a competitive academic culture contributed to minority student attrition in engineering.

Overview

Purdue University has implemented programs to attract and graduate the very best underrepresented minority engineering talent from across the country since the mid-1970s. A recent program, the Minority Engineering Program Academic Boot Camp (ABC), was launched in the summer of 2005 in an effort to improve retention and decrease the achievement gap between under-represented minority students and the total cohort. Based on simple lean manufacturing principles, the Academic Boot Camp was designed to identify, evaluate, and resolve bottlenecks in the academic process that hinder or prevent the successful matriculation of competent engineers.

History

After benchmarking several first-year engineering bridge programs and reviewing existing documentation on retention for underrepresented students in engineering at majority institutions, the College of Engineering found two key areas where these students needed help:

- Adjusting to a social climate in which minorities find few other students who look like them;
- Adjusting to a fast-paced global academic environment and being ready to compete academically with the best domestic and international students.

Academic Boot Camp (ABC) was developed with a core engineering focus and was offered to engineering students only. Participants are first-time freshmen who will be enrolled in Purdue engineering programs in the fall. The program was designed to expose students to the different pace of learning and level of responsibility for college students (as compared to their high school senior year) and establish a sense of "family" and "belonging" to help minorities adjust to the social climate at a majority university.

Program

Academic Boot Camp participants live in campus residence halls and are exposed to the rigors of freshman-level courses (Chemistry, Calculus, MATLAB and English), which are taught by graduate students and reviewed by professors. The material covered simulates the first-semester experience. Students are taught how to maximize accountability for time management and helped with socialization, study and test-taking skills, and managing homework, quizzes, projects, and exam schedules. The expected outcome: Students realign themselves to be successful in the Purdue College of Engineering global academic environment.

Data

Data show students in the Academic Boot Camp (ABC) have a higher first-year retention rate than non-ABC students.

	F'04	F'05	F'06	F'07	F'08	F'09	F'10
1st Year ABC		80%	81%	89%	82%	95%	87%
1st Year Non-ABC	67%	76%	75%	81%	76%	83%	74%

University of Colorado-Boulder, College of Engineering and Applied Science

The University of Colorado-Boulder's retention strategy revolves around building a community in the engineering program. Since 1987, the college has provided a shared living environment for engineering students. A second, smaller dorm houses engineering honors students.

History

The College of Engineering and Applied Science (CEAS) at CU-Boulder has a quarter century of experience with community-building programs in campus residence halls, which have led to higher retention rates. These efforts began in 1987 with the introduction of the Quadrangle Engineering and Sciences Living and Learning Community (aka the "Quad").

Program

The Quad's goal is to provide a shared living environment for engineering and applied science students, and current offerings include on-site supplementary calculus work groups, a computer lab equipped with most programs needed for engineering classes, free drop-in tutoring every weeknight, late-night breakfasts before important midterm exams, and an ongoing workshop series. CU-Boulder requires first-year freshmen to live in the on-campus residence halls their first year, so the Quad program is geared toward that first-year student.

In the past few years, the Quad community has blossomed through close collaboration between the CEAS's First-year Experience Coordinator (a new position created in November 2008), and the Quad Residence Hall Director.

Living in the Quad is optional and costs students an additional $130 per year. Over 300 engineering freshmen lived in the Quad during the 2010-2011 academic year.

A newer residential housing community sponsored by the CEAS is Andrews Hall Residential College, home to over 200 students in the Engineering Honors Program (EHP) and other selected groups. The EHP was founded by a CEAS faculty member who lives with his family in Andrews Hall. Students who are accepted into the EHP must live in Andrews Hall in their first year and are encouraged to remain through senior year. The EHP costs each student an additional $850. Andrews Hall also houses students from CU's five-year Engineering GoldShirt Program for motivated and talented engineering students who arrive needing additional preparation, and some students from our BOLD Center, a diversity-building unit within the CEAS.

Data

The CEAS recently conducted an in-depth look at its fall 2010 cohort of 715 first-year freshmen. The data show that the first-year retention rate of students living in the Quad or Andrews Hall exceeded that of students who lived elsewhere on campus (86.4 percent and 86.0 percent, respectively, vs. 78.0 percent for those students who lived elsewhere).

Retention rates in these programs are higher than the college-wide averages. For example, the second-year return rate of students entering in fall 2010 was 83 percent college-wide (vs. 88 percent for EHP students, 84 percent for GoldShirt students, and 89 percent for BOLD students in Andrews). The third-year return rate of students entering in fall 2009 was 84 percent for EHP, 81 percent for GoldShirt, and 69 percent for BOLD students in Andrews, compared to a 10-year college-wide average of about 67 percent.

It is not necessarily the residence experience alone that is correlated with increased retention – being part of a supportive community helps as well. For example, the fall 2006 EHP students had no common residence hall experience, yet have the highest retention of any group (23 of 25 retained into the 6th year, with 22 of them having already graduated).

Over all, of the 378 students from these groups who entered between the fall of 2006 and the fall of 2010, 321 (or 85 percent) are still in our college or have graduated from our college. (Another 27 students are still enrolled at CU-Boulder in another school or college on campus.)

While the EHP students have strong academic credentials coming in, and thus may be expected to be less likely than average to leave engineering for performance reasons, the other two groups (GoldShirt and BOLD) have students who are more at risk, on average, compared to the overall population, of not persisting in engineering, and yet they have continued at or above average rates. And from the fall 2010 freshman cohort, Quad students' GPA at the end of freshman year was 2.96 on average, compared to 2.87 for those students not living in the Quad or in Andrews Hall (thus not much difference academically between the Quad and other non-Andrews freshmen).

The school attributes higher retention rates to community-building activities and support provided in the Quad and Andrews residence halls and programs.

University of Maryland, School of Engineering

University of Maryland's A. James Clark School of Engineering revamped its first two years of classes by encouraging and incentivizing the school's best teaching faculty from all departments to teach the most fundamental courses. Since the program began in 2005, first- and second-year retention rates of engineering students have increased by about 10 percent, and the five-year graduation rate by five percent.

Program

The Clark School Academy of Distinguished Professors was established to reexamine and revitalize the freshman and sophomore programs in engineering offered at the University of Maryland. The resulting Keystone Program seeks to improve student success and retention within engineering by providing an environment and support structure that fosters student development during the most formative first two years of their engineering studies, while at the same time inspiring and challenging students with the array of opportunities that an engineering educati on affords. Additionally, the program encourages and incentivizes the Clark School's best teaching faculty members from all departments to teach the most fundamental courses.

Keystone is responsible for teaching many of the first and second-year engineering courses. Students from many departments must take these courses to complete their degree requirements, as these serve as a foundation for their later discipline-specific coursework. Keystone also oversees a tutoring center, mentoring program, and undergraduate teaching fellow program.

The seemingly obvious practice of placing dedicated teaching faculty into first- and second-year courses began in 1998 with the initial offering of an integrated statics/mechanics course. These courses were taught by faculty members from many departments who were screened beforehand to ensure they were competent teachers.

The Keystone Program officially formed in 2006 under then-dean Nariman Farvardin and was made possible by donations from corporate partners, individual alumni donors and funds reallocated by the dean. Six of the Clark School's best teaching faculty members were given the title "Keystone Professor." A Keystone Professor receives a renewable three-year appointment, supplemental funds to support their teaching, additional classroom support personnel, and a two percent base salary increase over and above any merit pay increases. Keystone Professors teach one section of a Keystone Course each semester and are responsible for ensuring high-quality offerings. Core math and science courses taught outside of engineering cannot be used to "weed out" prospective students. Keystone has taken the lead to ensure that the content and quality of these course offerings are in alignment with the Clark School's educational standards.

The Keystone Program has an annual budget of $450,000. Half this amount supports a small central office. The remainder is used to hire classroom support personnel (25 percent); to provide branded Keystone faculty members with supplements to support their teaching endeavors (10 percent), and for laboratory maintenance/improvements (15 percent). Salaries of the 15 current full-time Keystone faculty members are paid entirely by their academic departments and from research activities. Since students from all departments enroll in Keystone Courses, all departments provide resources (for example, faculty and teaching assistants) to Keystone consistent with their commitment levels prior to when Keystone was formed.

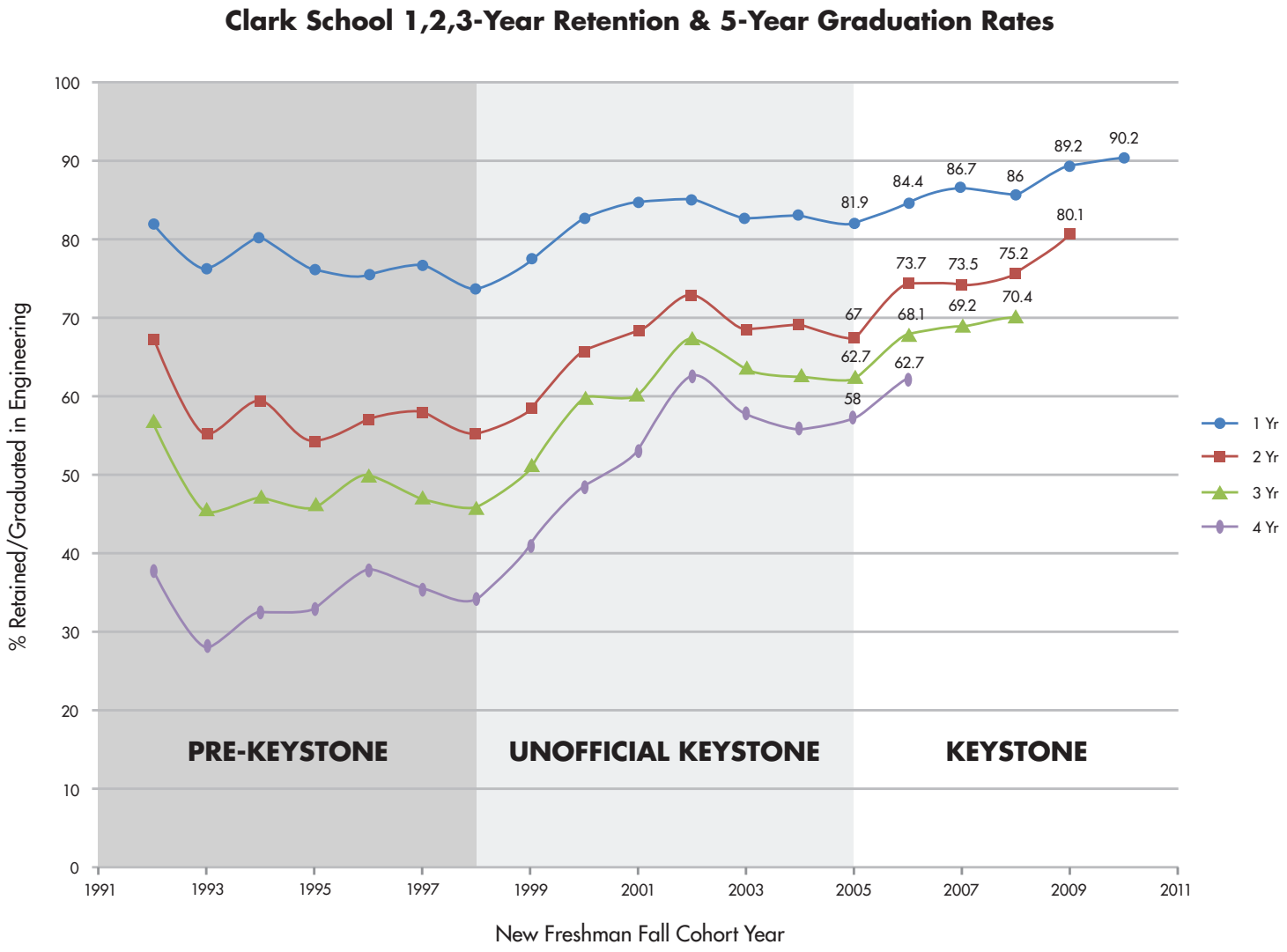
Each Keystone Course has a course leader who is responsible for making certain that all faculty assigned to the course are synchronized. All courses are commonly taught – that is to say, students from any section understand that they are receiving the same information (albeit in different ways) on any given day regardless of the section in which they are enrolled. This ensures quality and the consistency of student experiences.

Keystone represents a transformational leadership investment aimed at building a culture that rewards teaching excellence and that values early undergraduate engineering education. The secret to Keystone's success has been its ability to challenge, support and enlighten students with the prospects and rewards of a career in engineering. By properly balancing challenge and support, Keystone has motivated students to complete their intended degree programs.

Data

Significant accomplishments have already been made, with one-year retention rates up 8.3 percent and two-year retention rates up 13.1 percent between fall 2005 (pre-Keystone) and fall 2010, the most recent data available. Four-year graduation rates rose 8.9 percent during the same period.

While Keystone is a relatively young program, the supporting data available indicates that the model is effective. The authors whole-heartedly believe in this approach and believe the program should serve as a national model for increasing engineering retention and graduation rates.



University of Southern California, Viterbi School of Engineering

Viterbi School of Engineering's retention efforts build off of university-wide data collection and retention initiatives. The school has achieved high retention and graduation rates through pre-enrollment efforts, strong advising, early detection of performance problems, and associated student academic support.

Overview

Achieving a high level of student retention demands that engineering schools make data-driven decisions about students, faculty, and curricula. This means compiling the right data, learning to analyze it in a timely way, and deciding on a course of action.

In the USC Viterbi School of Engineering, responsibility for school-level retention initiatives rests with Engineering Admissions and Student Affairs. The school hired a full time Retention Coordinator in 2005. Students are admitted with retention in mind. Faculty members are involved in school-level initiatives through the Freshmen Academy program; the Merit Research Program; and the Division of Engineering Education, founded in 2007.

Much is accomplished by linking school and university resources. The USC Viterbi School of Engineering Senior Associate Dean for Admissions and Student Affairs serves on a University Retention Task Force. An annual evaluation of retention data is executed each November by the University. Simultaneously, a review of strategies is completed by the school. Spring surveys of all Viterbi freshmen and sophomores focus on programmatic experiences.

Pre-enrollment Efforts

Work with some groups of engineering students begins prior to enrollment. Established in 1975, a first for a California private institution, the Center for Engineering Diversity (CED) sponsors a four-week, pre-enrollment Summer Institute for all incoming freshmen from underrepresented groups. Students are exposed to research practices by working in engineering laboratories with faculty members and graduate students. Parents are invited to hear from the CED staff concerning how to best support their students in engineering. Current freshmen are uniquely open to advisement. USC Viterbi School of Engineering freshmen are monitored and advised relentlessly. Freshmen are advised centrally by the school. Four to five freshman academic advisers coordinate with advisers in the students' academic departments. Part of this effort is enabled by a key university-wide undergraduate advisement database that tracks all academic activities for every undergraduate student, and which the Viterbi School has opted to replicate for use with graduate students. Faculty members are strongly urged to report midterm grades for undergraduates, and most do.

Tutoring

Early detection of performance problems draws an advisement response from staff members specifically dedicated to retention. Problems are individual, but can be addressed successfully once identified. The Viterbi Academic Resource Center (VARC) provides peer tutoring services and supplemental instruction for gateway courses. One-on-one and group tutoring sessions are provided free of charge. A writing consultant is available to assist with the General Education curriculum.

Viterbi students begin their formal USC careers in Freshman Academies. These hands-on, topical, substantive, project-oriented, team-based experiences engage students and provide them with an immediate view of macro-level engineering. All of the instructors are tenure-stream faculty, and half are female. Upper division undergraduates serve as course mentors.

Exposure to Engineering

Programs need to be in place to help new undergraduates simultaneously adjust and perform. The Viterbi School's Freshman Year Excellence program includes, among other features, a spotlight series that focuses on education about the engineering professions, relying on young alumni to explain to freshman what graduates need to understand about their fields. Undergraduates are encouraged to "explore, succeed, and connect." The experience will be extended to the sophomore year.

The key element of the experience is the community building needed to create a genuine cohort, because cohorts develop coping skills individuals cannot. This is particularly important in the complex metropolitan environments in which many research institutions are located. At USC, the focus extends beyond the freshman year. Founded in 2005, the Klein Institute for Undergraduate Engineering Life (KIUEL) focuses on activities that enhance student life outside the classroom. Capstone design innovations relate capstone courses to societal themes and needs.

Student Adjustment and Intervention

Student problems can be as fundamental as identifying priorities. An unwillingness to accept minor, early adjustments is likely to lead to larger, more disruptive changes later. Each student must be made to understand that his or her decisions have an ultimate audience of one, and that a capacity to adjust is a form of competitive advantage. Sometimes interventions are external, such as providing supplemental instruction. The Center for Instruction in Mathematics for Engineering Students (CIMES), founded in 2004, is a collaboration between the USC Viterbi School of Engineering and the USC Dornsife College of Letters, Arts and Sciences that places full-time engineering faculty members in several sections of the College's calculus sequence. In many fundamental, traditionally difficult courses, Viterbi upper-division undergraduate students are hired to sit in on lectures and then offer weekly, voluntary discussion sections. The Departments of Mathematics, Biology, and Chemistry have followed suit, and this has been very helpful.

Data

Southern California University shows high and consistently increasing retention and graduation rates from 1998 to 2009.

Table 1 - USC Viterbi Return Rates and Graduation Rates - Engineering

Cohort	(Fr-So) Return	(So-Jr) Return	(Jr-Sr) Return	4-Year Graduation	5-Year Graduation	6-Year Graduation
2010	98	–	–	–	–	–
2009	99	95	–	–	–	–
2008	97	94	93	–	–	–
2007	97	93	91	72	–	–
2006	97	95	92	72	88	–
2005	97	92	91	69	85	88
2004	96	91	90	66	82	87
2003	97	93	90	67	86	88
2002	97	93	91	58	84	87
2001	92	87	84	51	74	78
2000	93	87	85	53	77	80
1999	94	86	83	51	73	75
1998	94	85	83	44	69	73

Source: USC Office of the Provost.

Washington University in St. Louis, School of Engineering and Applied Science

Washington University's Engineering Students Services office interviews students to ascertain their reasons for leaving engineering. Based on their responses the school has pursued a number of retention strategies since 2007.

History

Washington University in St. Louis's Engineering Students Services office was reconfigured in 2007 to support undergraduate engineering student success. Staff members interact with undergraduates from the time they are prospective students until they graduate. The office focuses on admissions, advising, student records, interacting with student groups, connecting students with campus resources, coordinating actions with other internal and campus-wide departments, and providing academic support.
Each student who leaves engineering is given an exit interview and the information provided is collected and reviewed. Consistently, the reasons students give for leaving engineering cluster around three primary areas:

- Academic rigor,
- Inflexible curriculum (i.e., inability to pursue multiple interests), and
- Loss of interest/passion in the field of engineering (sometimes owing to a lack of connection to the engineering school itself).

This information has helped the office tailor specific support efforts.

Resulting Initiatives

1. Strategic Admissions: The school chooses student applicants who are the most academically prepared for the rigors of math, science and engineering coursework and who also appear to have a genuine long-term interest in pursuing engineering careers (based upon their completed coursework, extra-curricular activities, and research experiences).

2. Four-year Advising: In addition to having a faculty member assigned to each student as a "major" adviser, each freshman has a "four-year" adviser for the duration of his or her enrollment. Advisers are changed only if a student shifts majors, or when a faculty member goes on sabbatical or leaves the institution. Faculty members typically know a great deal about their own departments, but often do not know much about campus resources and general support services available to students. The four-year adviser serves as a general resource adviser and forms a long-term connection between the student and the school.

3. Academic Support:

- Tutoring. Students may receive up to four hours per week of free one-on-one tutoring for each course, including math, chemistry and physics courses. Upperclassmen in strong academic standing are hired to be the tutors.
- Calculus Help Room. Math graduate teaching assistants staff a help desk for calculus courses and differential equations, Monday – Friday, for walk-in assistance. Academic performance in calculus courses is strongly linked to retention and academic success in engineering courses.
- Problem-solving Teams. Static study groups are created for targeted engineering courses. Each study group is facilitated by an upper-class engineering student who has been academically successful in the course.
- Progress Counseling. Academically low-achieving students are counseled on a scheduled basis to monitor their progress and are given recommendations and strategies to increase their success.

4. Freshman Engineering Seminar: This is a weekly hands-on course that provides freshmen an opportunity to meet other students, learn about the school, and discover the resources located throughout the university. Participants focus on effective methods of collaboration and communication while completing design and build-oriented projects in small groups. The intent is also to give students an overview of all areas of engineering. The course is taught primarily by upperclassmen, which adds to their leadership skills and connection to the school.

5. A Pre-orientation Engineering Program offers incoming freshmen practical, hands-on experience solving engineering problems. Students learn the steps of the design process, such as assessing an engineering problem, proposing solutions, creating a budget, and building the project. Students get the opportunity to meet other freshmen and work with upperclassmen.

6. Experiences Abroad: Engineering students are encouraged to study abroad through department-sponsored programs, exchange programs, and the same summer and semester-long programs offered to other students on campus.

7. Mentoring of Student Groups: Engineering student groups are supported with advice, mentoring, and funding of student design competitions.

Data

Using freshmen who entered in fall 2006 as a baseline, Washington University in St. Louis has seen an increase in retention in the years since. A one-year drop occurred for freshmen who entered in fall 2010. Through exit interviews, the school has traced the decline to the way a specific freshmen introductory course was taught that year. Listed below are our most recently tracked retention rates.

Engineering Retention Rates of Students who Entered as Freshmen in Engineering

	1st Yr	2nd Yr	3rd Yr	4th Yr
FL2010	84%	–	–	–
FL2009	89%	81%	–	–
FL2008	89%	80%	77%	–
FL2007	89%	80%	77%	78%
FL2006	83%	74%	70%	69%

West Virginia University, College of Engineering and Mineral Resources

West Virginia University employs multiple retention strategies that run the gamut of best practices identified in the literature. These strategies have evolved over a decade of collaboration among faculty within the college of engineering and across the university. The process begins at the time of recruitment and continues with activities that support students' academic, professional, and social growth throughout their undergraduate careers.

Overview

The Benjamin M. Statler College of Engineering and Mineral Resources at West Virginia University employs an integrated student support and enrichment paradigm within the first-year program to encourage students to: develop appropriate time management and study habits; learn about various engineering careers; and become engaged in engineering student organizations, mentorship relationships, undergraduate research experiences, and study abroad and internship opportunities. This multifaceted approach, which begins with recruitment and appropriate math placement, has evolved though a decade of faculty and administrative collaboration within the college and across the university, and has been successful in increasing engineering enrollment, retention, and graduation rates.

The heart of this program is appropriate course placement and academic support. Incoming students are placed into initial math courses based on math placement test results. Their path to degree completion is determined by their initial math placement. Academic support is provided through the Freshman Engineering Learning Center, which offers free tutoring in math, chemistry, physics, and freshman engineering coursework, group work rooms for students to work together on class projects, and access to advising assistance. All first-year students must spend at least two hours a week on homework or studying in the Engineering Learning Center or another campus learning center. The Statler College recruiting office is located within the Freshman Engineering Learning Center so prospective students and parents can see the supportive environment that is described and highlighted in all recruiting materials.

The Statler College encourages students to become engaged in their chosen profession and the life of the college. All first-year students participate in "Out of Class Experiences" (OCEs). These are designed to foster excitement about and prepare students to succeed in an engineering major and future career by teaching them study and time-management skills; presenting undergraduate research, career preparation, and study abroad opportunities; and facilitating their engagement in student organizations.

EngineerFEST, a student organization fair held early each fall semester, introduces and encourages early engagement with student chapters of professional engineering societies and other engineering student organizations that represent the college in national engineering competitions, outreach and recruiting activities, and global service projects. Early engagement helps students identify with and take pride in engineering, the college, and the university, and this tends to increase their persistence.

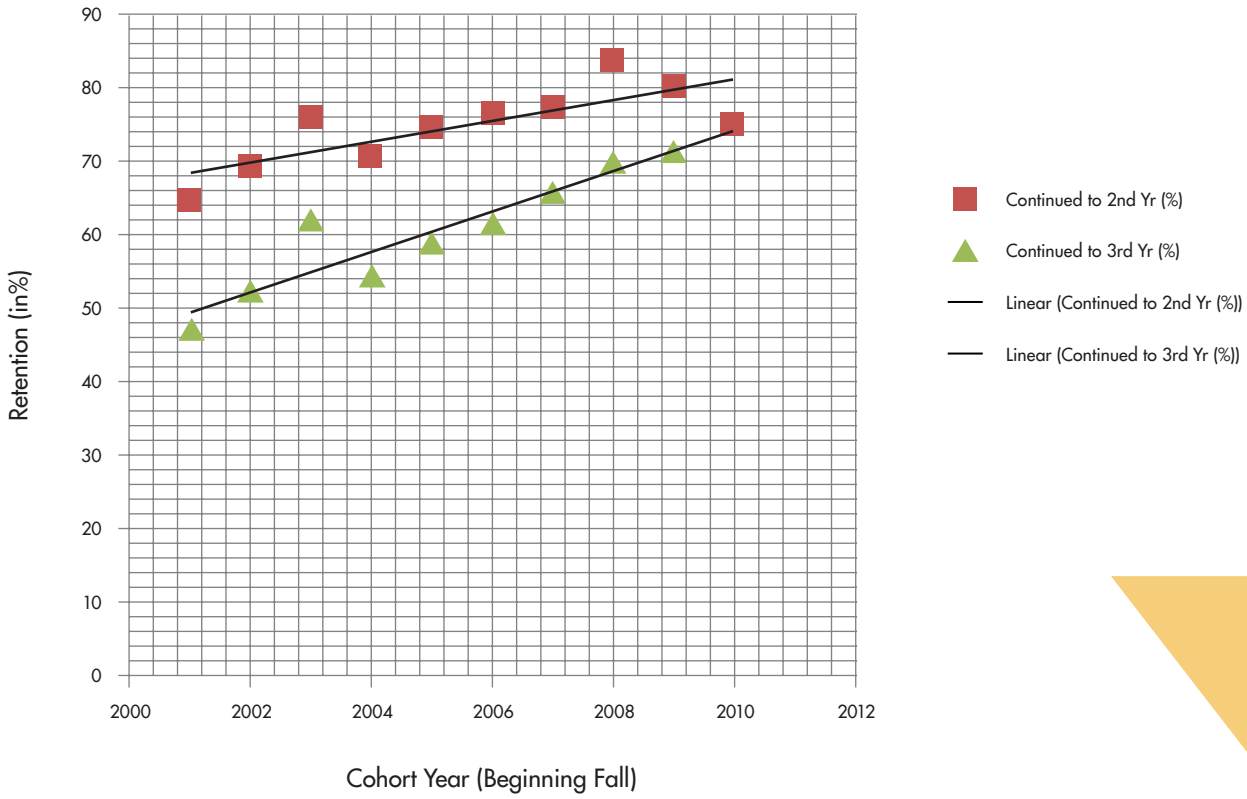
Social support is provided through formal and informal mentoring programs. In the more formal program, graduate students volunteer to mentor two or three freshmen by getting to know them through planned social events throughout the first year and serving as resources to help them "learn the ropes" of college life. Additional support is provided through an engineering-dominant residence hall in which students live with others who have common course loads, have engineering Resident Assistants (RAs) who understand the transition issues unique to engineering freshmen, and participate in co-curricular programming designed to support engineering students, including dinners with faculty and practicing engineers, study skills seminars, and engineering-related activities and field trips. Informal mentoring occurs as freshmen work alongside upper level students in the student organization activities, work with tutors and faculty in the Engineering Learning Center, and engage in interactions with their engineering RAs or Resident Faculty Leaders associated with their dorm.

This program prepares students for a successful engineering career or graduate studies and has been used as a model within WVU to improve overall university retention.

Supporting Data

Statler College first-to-second-year engineering retention rose from 64.9 percent (2001) to a high of 83.6 percent (2008) and averaged 79.3 percent throughout the past 5 years. Cohorts continuing to the third year have increased steadily from 47.1 percent (2001) to 71.4 percent (2009).

Graph of WVU Statler College Retention Data (AY 2003-2012)



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- at the local, regional, and national levels, by forging and reinforcing connections between academic engineering and business, industry, and government.

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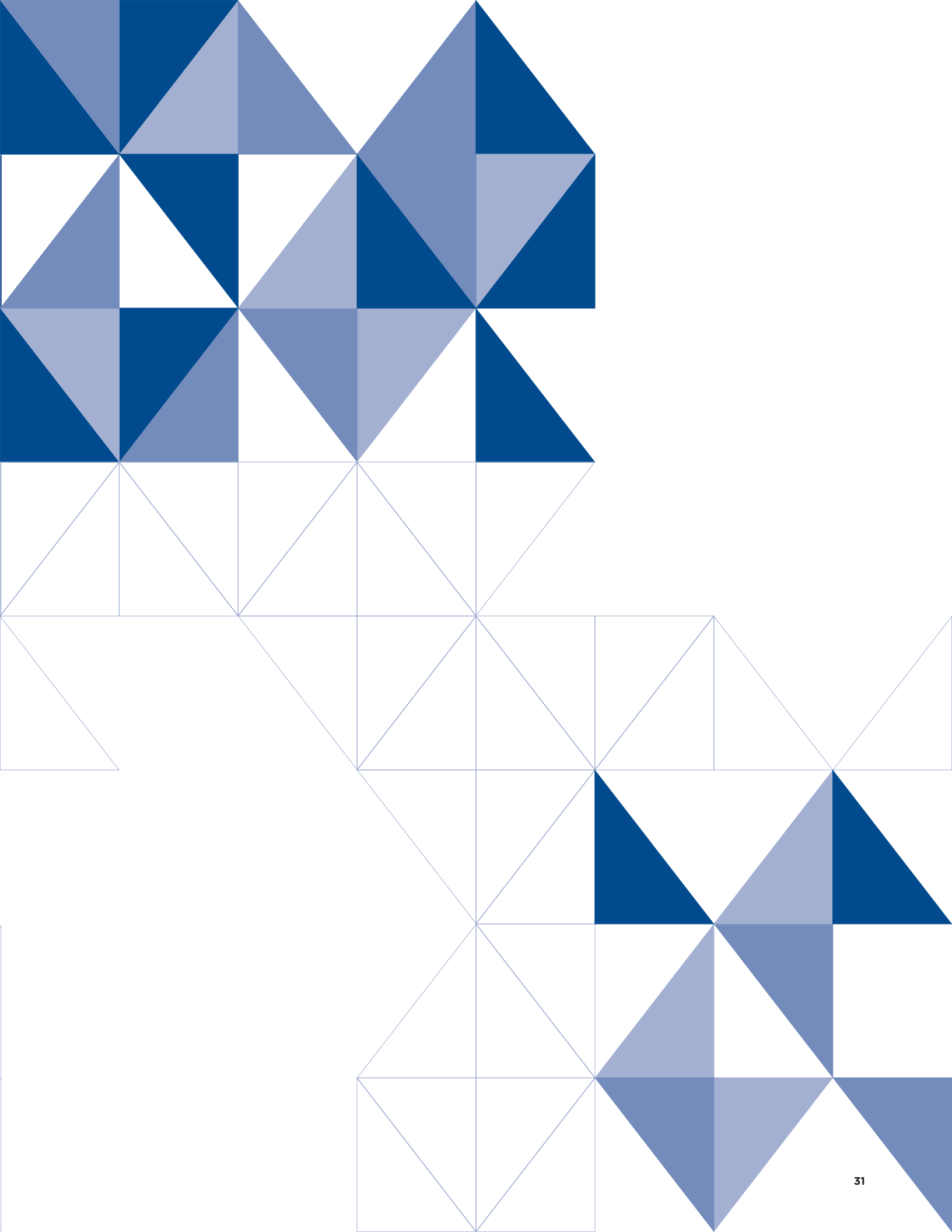

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