Strategic Plan 2020

Committee Members

Alexander Balandin, Chair
Reza Abbaschian
Kelley Barsanti
Matt Barth
Harvey Blanch
Mitch Boretz
Philip Brisk
Rajiv Gupta
Xiaoping Hu
Lorenzo Mangolini
Chinya Ravishankar, Ex Officio
Victor Rodgers
Amit Roy Chowdhury
Vassilis Tsotras
Michael Zachariah

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EXECUTIVE SUMMARY

In its first 30 years the Marlan and Rosemary Bourns College of Engineering (BCOE) at the University of California, Riverside (UCR) has made remarkable contributions both in engineering research and education, earning its spot as a top 20 public engineering college in the world (U.S. News, Global Rankings). BCOE is an integral part of the world-renowned University of California (UC) system, delivering the student-centered academics and purpose-driven, high-impact research the system is known for. We have achieved great milestones in our relatively short history – and the start of our next 30 years brings with it exciting possibilities.

BCOE has broken down many barriers since opening its doors. Founding Dean Susan Hackwood became the country's first woman to lead an engineering college at a major research institution. Record-breaking support from Ford Motor Company, The Bourns Foundation, and battery inventor and entrepreneur Winston Chung, whose gift remains as one of the largest individual gift in campus history, helped set the college on a steady and impressive upward trajectory.

The college has made pivotal scientific breakthroughs that continue to shape the field of engineering. BCOE's research portfolio has grown tremendously in such a short time and has achieved national prominence. In addition to serving as a key contributor to the National Science Foundation (NSF) Engineering Research Center (ERC) working to stop biological time and leading one of only nine Department of Defense Centers of Excellence addressing robust, secure, learning-based networked systems, BCOE is home to one of the country's leading air quality research centers focused on sustainability. Our junior faculty are highly productive in research, with BCOE having the most active NSF CAREER Awards among our peers.

BCOE's faculty and students benefit from well-equipped research labs and long-standing collaborations with industry and government partners. Our BK Precision labs offer students access to the latest electrical technologies. CE-CERT researchers partner with AVL at its light-duty testing facility to work toward zero emissions and zero traffic accidents. In 2021, the California Air Resources Board (CARB) will officially open its new headquarters in Riverside, offering new opportunities for cooperation, internships, and air quality research. Our partnership with the City of Riverside to build a clean technology park combined with our proximity to the Los Angeles, San Diego, and Silicon Valley industries serve as the foundation for Riverside to become the next major technology hub.

At the core of this success is what BCOE does best – multidisciplinary innovative research and education. The college recently welcomed its first cohort to the new inter-college data science undergraduate degree program. Additional technical tracks are under development for online M.S. degree program. High-achieving engineering students benefit from UCR's only B.S.+M.S. program, a fast-track to earning a graduate degree. In 2021, the college launched the UC system's first M.S. degree in robotics, combining coursework in computer science, electrical engineering, and mechanical engineering. These and other programs prepare our graduates to succeed in their careers and address the complex challenges that face our society.

BCOE is a leader in educating and advancing one of the most diverse student bodies in the country. In 2009 the college was named a recipient of the ABET Claire Felbinger Award for recruiting undergraduate and graduate students from diverse and disadvantaged backgrounds, retaining them, and advancing them to graduate studies and careers in engineering. BCOE is a Hispanic Serving Institution (HSI) and a member of the ASEE Diversity Recognition Program. With high percentages of first generation, low-income, and Pell grant recipient students, the college is a major contributor to UCR being ranked No. 1 for social mobility two years in a row.

BCOE has experienced incredible success over the past 30 years and is poised to continue its impressive trajectory – making a difference in the lives of our students, serving the community, and contributing to the public good through relevant research. The following strategic plan is a blueprint that lays the foundation for the next 5, 10, even 15 years. It is ambitious and addresses actions we can take now to build an even brighter future. Looking ahead, we focus on four strategic goals: (1) Sustaining and enhancing BCOE's reputation for excellence in research and education; (2) Meeting growing needs of engineering research and educational programs; (3) Producing graduates who become tomorrow's leaders; (4) Developing and expanding the operational infrastructure required to support the strategic growth of the College. The following are a core part of our vision for achieving success.

RESPOND TO THE WORLD'S COMPLEX NEEDS WITH A MULTIDISCIPLINARY APPROACH

- Build critical mass in focus areas
- Establish campus-driven interdisciplinary-based national centers
- Collaborate with national laboratories
- Increase collaborations with industry

PRODUCE BACHELOR GRADUATES WHO PREPARED TO IMPACT THE WORLD

- Enhance classroom learning with online materials for cross disciplinary interaction
- Develop and provide resources such as mentorship to faculty, building an infrastructure that introduces new teaching and learning approaches
- Integrate hands-on first-year engagements through new learning communities
- Expand laboratory use to provide students a rich experience in understanding and solving challenges
- Open access to engineering education to engage students in opportunities for multidisciplinary study
- Create a formal undergraduate research function to connect students with opportunities and track success
- Develop student mentorship programs to help them navigate the path from education to career

SERVE AS A LEADER IN GRADUATE EDUCATION

- Enhance BCOE's research profile with faculty hires in areas of critical investment
- Execute a comprehensive public relations and marketing campaign to share our accomplishments
- Conduct outreach, recruiting applicants from women and underrepresented communities
- Scale-up interdisciplinary M.S. programs through collaboration to meet the needs of early-career professionals
- Explore novel approaches for expanding M.S. programs
- Foster an M.S. community that develops a sense of belonging

ATTRACT AND SUPPORT A TOP-QUALITY, INCLUSIVE FACULTY

- Introduce new diverse recruitment efforts focused on women and individuals from underpresented communities
- Increase faculty development and recognition
- Promote success in at-scale instruction

SUPPORT A SKILLED, DYNAMIC STAFF

- Invest in staff to fill critical needs across the college
- Develop a culture embracing thought leadership and organizational efficiency
- Create an equitable staffing program that positions BCOE as a competitive employer and promotes retention
- Retire obsolete or duplicative systems to improve efficiency

ENHANCE USER FACILITIES AND RESEARCH INFRASTRUCTURE

- Restore engineering buildings III and VI as a top priority on the campus expansion list
- Invest in long-term resources to support college user facilities
- Advance development of Riverside as a regional research hub

ENGAGE THE COMMUNITY AT BOTH THE MICRO AND MACRO LEVELS

- Lead and support early intervention pipeline activities, especially within underpresented communities
- Develop Riverside into a living laboratory in sustainability and transportation
- Broaden industry engagement through alumni connections and entrepreneurialship

STRATEGIC PLANS

STRATEGIC GOALS AND RESEARCH AREAS OF STRENGTH

The four strategic goals for BCOE are shown in Figure 1.

Figure 1: Schematic of the strategic goals of BCOE.

The success of BCOE, similar to other engineering colleges of the UC system, is deeply rooted in its **research-intensive** nature. Graduate students join BCOE because they want to work on their dissertation research directed by faculty who are leaders in their respective fields. Financial assistance provided in the form of graduate student researcher (GSR) stipends is essential for maintaining and developing graduate programs. The funds for GSR appointments are derived from cutting-edge federal, state or industry funded research grants and contracts. Undergraduate students are attracted to BCOE, and other engineering colleges of the UC system, by the reputation of UC engineering degrees, which open doors to future employment and graduate schools. The undergraduate research experience and opportunity to interact with leading professors are major factors for attracting students. These factors highlight the need to maintain and develop the research enterprise of BCOE.

The analysis of the research strength of BCOE allows one to identify the current core research themes (listed in alphabetical order): Advanced Materials; Biomedical; Biotechnology; Computational Engineering; Computer Science Engineering; Data Science; Machine Intelligence; Energy, Environment, Sustainability; Mechanics and Manufacturing; Nanoengineering; Networking Communications; Robotics, Controls, and Smart Systems. Based on the BCOE areas of strength; existing research areas; emerging areas of strength on campus; recent trends in Federal funding; local, state and National needs lead us to the following strategically important cross-cutting research themes for BCOE faculty (alphabetical order): Advanced Materials and Nanotechnology; Energy, Environment and Sustainability; Engineering applied to Biological and Medical Systems; Information, Communication and Digital Technology; Robotic and Cyber-Physical Systems; Transportation and Infrastructure. These strategic areas are depicted in Figure 2.

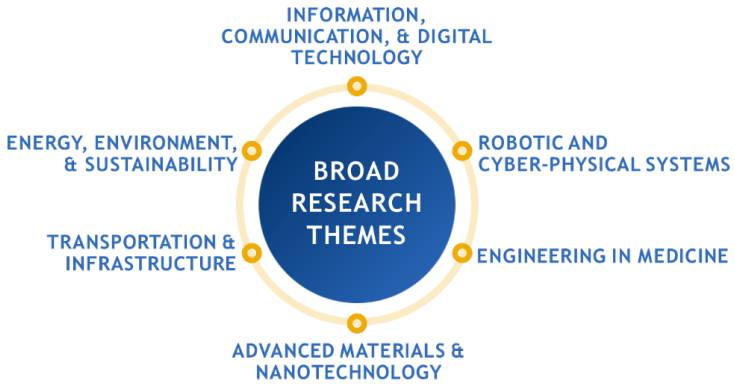


Figure 2: Schematic of strategically important cross-cutting research themes for BCOE.

To address the cross-cutting research themes, the BCOE departments and programs will continue to expand cooperation with existing and developing research centers. This includes future interactions with CARB. The BCOE

faculty envisions strong cooperation and partnering with the UCR School of Medicine (SOM) and the College of Natural and Agricultural Sciences (CNAS).

The summaries by department and program below provide detailed descriptions of each of the research and educational units within the College-level strategic research thrusts (see the diagram and listing above).

Department of Bioengineering offers state-of-the-art research and education in broad areas of biomedical and biological engineering, which lead to novel discoveries, innovative technologies, and products for improving human healthcare, biomedicine, and biotechnology. Areas of strength include bio-imaging; molecular engineering in pharmaceutical applications and high-throughput screening for drug discovery; biomaterials; computational modeling; medical device and sensors. Building on its strength and importance of collaboration with SOM, BIEN faculty envision strategic growth in the areas of biomedical imaging; biomaterials and regenerative medicine; computational bioengineering; molecular and cellular engineering; and neuroengineering.

Department of Chemical and Environmental Engineering is well positioned to be a global leader in the development of enabling tools and transformative technologies to improve our standard of living, and the health of humans and the environment. CEE is exceptionally strong in air and water quality systems engineering; industrial biotechnology; computation and molecular modeling; and energy conversion and storage. Department growth will be directed at interdisciplinary research for environmental protection and providing sustainable routes for energy, water, materials, and chemical and pharmaceutical products. CEE is moving into new areas of strategic importance, including new technologies for clean energy and water; phytochemicals production; engineering of extraterrestrial environments for sustainable human life; inverse product design and manufacturing.

Department of Computer Science and Engineering offers specializations in algorithms, theory and cryptography; computational biology and bioinformatics; computer architecture, high-performance computing, and embedded systems; parallel and distributed computing; cybersecurity; data management and information retrieval; artificial intelligence, machine learning, natural language processing, and data mining; graphics, animation, visualization, and scientific computing; programming languages, compilers, and software engineering; systems and networks; computer science education. The department is growing in the areas of bioinformatics and computational biology; artificial intelligence; software engineering; operating and distributed systems; computing for social sciences and economics; graphics with emphasis on visualization and animation.

Department of Electrical and Computer Engineering is engaged in cutting-edge research focused on development of electronic, energy and information technologies of the future. ECE is exceptionally strong in intelligent and autonomous systems; nanoscale materials and devices; communications and signal processing; power systems and smart grid; and computer engineering. Among the strategic goals of the department is increased cooperation with SOM using strengths in nanotechnologies, phononics, optics, image processing and computer engineering. To expand strategic research areas, ECE is growing in the areas of autonomous and cyber-physical systems; computer engineering and devices; signal processing and networking; biomedical signal and image processing; quantum information and communication science.

Department of Mechanical Engineering conducts research ranging from mechanical, thermal, and fluid science to novel areas like robotics and nanoscale engineering. ME has six interdisciplinary research areas of importance: bioapplications; mechanics, advanced materials, and manufacturing; controls, robotics, and automation; thermal systems and multiphase flows; nanoscale design and micro-device engineering; air quality and environmental fluids engineering. In the near term, the department plans to continue expansion in controls, robotics, and autonomy. In the longer-term, it will focus its growth in topical areas that synergistically leverage unique strengths on campus such as medical devices, disease modeling, translational bioscience; sustainability, environment, sensors and controls; and robotics and advanced controls.

The Computer Engineering Program encompasses technologies underlying the computing revolution: electronic devices, circuits, hardware systems, and the software that manages them. The CEN discipline focuses on designing computing systems to best support emerging workloads with respect to metrics and constraints that include performance, energy-efficiency, real-time guarantees, reliability, security, form factor, cost and functionality. The CEN strategic goals include strengthening core CEN areas; growing into post-Moore's Law systems, e.g., quantum architectures and novel memory technologies; developing the area of computational and hardware support for emerging applications such as deep learning, neuromorphic computing, robotics, and intelligent systems.

The Data Science Program was fueled by the demand for data scientists, which is expected to remain high for years to come. DS provides a comprehensive approach to how data can be collected, transformed, analyzed, and

used to solve problems across various disciplines. The DS program is educating future data scientists by building knowledge bottom-up, covering essential knowledge from Computer Science and Statistics, and integrating this knowledge with applications to other domains and to real-life challenges. Given its interdisciplinary character, DS will strategically strengthen existing areas and expand to new promising areas.

Materials Science and Engineering Program is an interdisciplinary initiative that cuts across departmental and collegiate lines. The MSE current core research areas include biomaterials; structural materials; computational materials; materials processing; electronic, optical, and magnetic materials; energy and green technology. The MSE program intends to join in the development of robotics via cooperation with the college's research center focused on robotics in the cross-departmental Controls, Robotics, and Autonomy (CORA) initiative. The MSE program will build on its strengths in the design of active materials and interface with center participants on the design of shape-change materials for robotic applications. The program will increase cooperation with the School of Medicine and build on a strong base in quantum materials, nanofabrication, optics and superconductivity via cooperation with ECE Department.

The Robotics Program is jointly managed by CSE, ECE, and ME. The program provides inter-disciplinary training in various aspects involved in the design, construction, and deployment of robots and autonomous systems. Students gain exposure to the foundational principles underlying mechanical and electronic aspects of robot design, control and navigation of robots, and artificial intelligence required for robots to perceive their surroundings and make decisions.

The BCOE strategic plan is focused on nine core areas of emphasis - multidisciplinary research programs, undergraduate education, undergraduate research, graduate education, faculty, staff, user facilities and research infrastructure, community engagement, diversity and inclusion. Strategies are identified within each area for which the four strategic goals above are incorporated.

MULTIDISCIPLINARY RESEARCH PROGRAMS

Excellence in scholarship and research is integral to the mission of BCOE. The development and strength of multidisciplinary research programs has been an important signature of UCR. The BCOE faculty is actively involved in research with faculty from CNAS, SOM, College of Humanities, Arts, and Social Sciences, and School of Public Policy to name a few. Such collaborations have been established both through research efforts led by the various research centers as well as educational efforts involving training graduate students (i.e., Plants3D NRT, BIEN BIG program).

BCOE will focus on leveraging its existing interdisciplinary research programs to further enhance its leadership and reputation as an engineering research institution. BCOE multidisciplinary research goals include:

1. Bridging the expertise of the College with faculty throughout UCR to further accelerate the establishment of preeminent state-of-the-art interdisciplinary research;
2. Attaining world-class status in key focus areas by building cross-disciplinary critical mass;
3. Strengthening the synergy among research, undergraduate, and graduate education to ensure BCOE alumni are positioned to take on technical leadership positions in multifaceted fields in the future. A specific metric for these goals is that college research expenditures increase from $250,000/faculty member per year to $400,000/year in the next 15 years.

STRATEGIES

ESTABLISH CAMPUS-DRIVEN INTERDISCIPLINARY-BASED NATIONAL CENTERS. Given the strengths in building interdisciplinary research, BCOE is poised to position itself to lead and participate in ambitious campus-wide national centers such as NSF Engineering Research Centers (ERC), NSF Expeditions in Computing (Expeditions), NIH Specialized Center (P50), and NSF Science and Technology Centers (STC). These federally supported large centers will increase BCOE's visibility and rankings.

COLLABORATE WITH NATIONAL LABORATORIES. BCOE faculty will increase interactions with researchers at National Laboratories. The National Laboratories possess unique instruments and facilities that can leverage our research investments and capabilities. The Labs address large-scale, complex research and development challenges with a multidisciplinary approach that places an emphasis on translating basic science to innovation. By strengthening its collaborations with National Labs, BCOE will enhance the activities of its major centers and facilitate the development of new centers and research groups.

INCREASE COLLABORATIONS WITH INDUSTRY. Many of the research projects addressed by BCOE are translational in nature and can benefit from close interactions with industry. The development of a College Industry Advisory Board can aid in forming stronger ties between research groups in BCOE and industry. These interactions can be leveraged in support of large research grants and in providing opportunities for students to undertake industry internships.

BUILD CRITICAL MASS IN FOCUS AREAS. Faculty are already established leaders in numerous areas. By leveraging identified strengths, the college will grow to meet its intended goals of the next 15 years.

UNDERGRADUATE EDUCATION

Engineering is central to enhancing our living standards, improving healthcare and developing sustainable technologies that benefit the environment. The pace of technological innovation in all engineering disciplines has driven the need for continuous updates in engineering education to produce engineers who combine technical skills with the leadership and creativity to address the challenging problems facing society. BCOE is one of the few B.S. programs that have made the necessary transformation to educate students in areas such as data growth and analysis, automation and autonomous systems, understanding of materials at the micro and nanoscale to provide improved functionality, and the increasing ability to sense and control behavior at cell and subcellular levels. In addressing these ongoing challenges, BCOE undergraduate programs will lead in providing new approaches to educateing the engineering professionals of tomorrow.

STRATEGIES

ENHANCE CLASSROOM LEARNING WITH ONLINE MATERIALS. The development of online resources for areas that are common across BCOE departments will provide a route for enhancing student learning and developing cross-disciplinary student interactions. For example, thermodynamics is common to chemical, environmental, mechanical and biomedical engineering. Statistics and data science are common to all engineering disciplines. BCOE will review and recognize the efforts of faculty in developing online materials in areas such as these, assessing them as significant teaching contributions.

BUILD UPON THE UCR ACADEMY OF DISTINGUISHED TEACHERS. BCOE will build upon the existing UCR Academy of Distinguished Teachers to reward excellence in teaching and create a central core of teachers who can serve as a resource for other instructors in BCOE. Academy members will serve as teaching mentors for new BCOE faculty, organize and take part in seminars, colloquia, and workshops on teaching excellence to further improve instruction and expand new active learning approaches.

ADDRESS PROBLEM SOLVING AND INNOVATION WITH LABORATORIES AND FACILITIES. Laboratories are an important component of undergraduate engineering education, differentiating leading universities. BCOE will continue to expand its undergraduate laboratories, providing students with a rich experience in understanding and solving engineering problems.

INSERT FLEXIBILITY INTO CURRICULUM. Studies by the National Academy of Engineering, the Carnegie Foundation, and ASEE have indicated that enhancing the flexibility of the engineering curriculum provides students with opportunities to engage in multidisciplinary studies (e.g., minors and certificate programs), undertake industry (and other) internships and prepares them for non-traditional engineering roles. BCOE will undertake a review of existing curricula with the goals of:

- Better defining the core curriculum in each of BCOE's departments;
- Enhancing technical electives and courses in the humanities;
- Facilitating minors within and outside of BCOE;
- Offering certificate programs that address emerging professional work opportunities;
- Expand offering five-year B.S.+M.S. programs that enable students to enter the workforce at a higher level.

UNDERGRADUATE RESEARCH

BCOE has always emphasized research opportunities to complement the undergraduate curriculum. However, to distinguish its undergraduate mission from many other engineering programs, BCOE will increase its focus on providing unique research experiences for undergraduate engineers. This is particularly important as, due to the quarter system, undergraduates are often limited in obtaining internships and joining other NSF-supported REU

programs nationally. This concern is particularly significant because most graduate programs give heavy weight to undergraduate research experience in their acceptance criteria. Undergraduate research opportunities are currently embedded in the BCOE culture but not institutionalized. Students must directly request opportunities from individual faculty members. While this has been successful, opportunities may be missed. Previous BCOE staffers helped students navigate options, develop large college-wide programs such as Research Experiences for Undergraduates (REU) programs, and serve as a clearinghouse for undergraduate research opportunities. BCOE may consider formalizing this position.

STRATEGIES

FORMALIZE UNDERGRADUATE RESEARCH OPPORTUNITIES. BCOE will institutionalize the undergraduate research function, allowing more students to gain access to opportunities and the college to more widely track those research activities.

GRADUATE EDUCATION

BCOE is deeply committed to graduate student education as this is a vital component of UCR's mission of teaching, research and service to the citizens of California. The knowledge and expertise gained by students who graduate with M.S. and Ph.D. degrees directly benefits the Inland Empire, the State, the Nation and the world. Graduate education is a cornerstone of UCR's standing as an R1 institution, and further growth of the BCOE graduate programs will be instrumental to UCR achieving AAU status. Success in graduate education is inevitably linked to success in research and is therefore determined by the following factors:

- Hire and retain the highest quality faculty (measured by publications, awards, fellowships, service, etc.);
- Attract and graduate highly motivated and creative graduate students;
- Attract and achieve a high level of extramural funding in support of the research and graduate education enterprise.

Plans for the hiring and retention of the highest quality faculty are addressed elsewhere in this document. Here we address current and future plans for graduate student recruitment, with particular focus toward areas of growth.

Each department within BCOE, together with the MSE and CEN programs, offers M.S. and Ph.D. degrees. M.S. degrees are also offered by the MSOL program. BCOE launched in 2021 an M.S. in Robotics across ECE, ME and CSE and an M.S. in Data Science is under development by CSE and ECE. Overall, graduate student enrollment has grown significantly in the 2010s, as summarized in Table 4 below. Out of the 936 graduate students enrolled as of Fall 2019, 585 were international students. Out of the remaining 351, 83 are self-reported as URM.

Table 4: Overall graduate enrollment has grown consistently.

	Ph.D. students	MS students	Total
2010	398	87	485
2019	540	396	936
% growth	35% (~4% annually)	350% (35% annually)	90% (~10% annually)

Particularly noteworthy is the ratio of Ph.D. students to the number of tenure-track faculty and how that compares with UC sister campuses, shown in Figure 7. Averaged over 2018-20, the ratio is 4.51 for BCOE. This is practically identical to UCI (4.54), and higher than UCSB (4.13) and UCD (3.27). The same ratio is 5.64 for UCLA, 5.38 for UCSD and 5.14 for UCB. This statistic is particularly promising when accounting for the fact that BCOE is still academically young, with 37.6% of its faculty being at the assistant professor level (compared to 23.7% at UCI, 21.9% at UCSD, 20.6% at UCSB, 18% at UCD, 15.8% at UCLA and 14.8% at UCB).

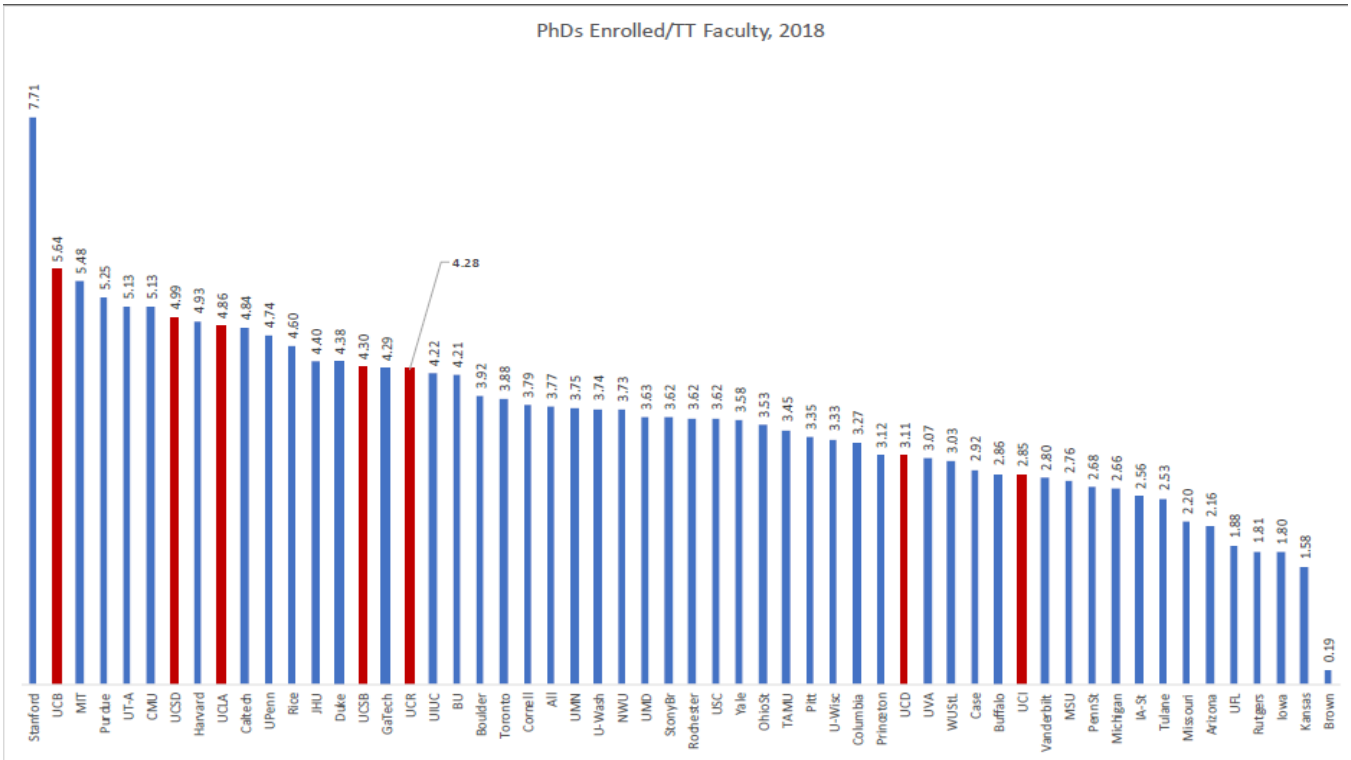


Figure 7: Number of Ph.D. students per tenure-track faculty.

The growth in the BCOE graduate program has been supported by an array of recruitment activities, including:

- Direct mailings of program recruitment information to top domestic GRE test takers;
- Workshops for high-achieving UCR engineering students (GPA>3);
- Open houses for domestic applicants, mainly organized at the departmental levels; in Fall 2019, for the first time, Graduate Division held a campus-wide open house with several attendees interested in BCOE;
- Faculty visitation to several Cal State, UC campuses and other undergraduate institutions, such as Harvey Mudd, University of Redlands, Walla Walla etc.;
- Promotion through research presentations at national and international research conferences (Faculty are provided with a few slides to promote UCR and BCOE);
- Exhibit booths (often separately from Graduate Division) at national conferences for underrepresented students in science and engineering (i.e., National Society of Black Engineers (NSBE), Society of Hispanic Professional Engineers (SHPE), Society for the Advancement of Chicano and Native American Scientists (SACNAS), and Society of Women Engineers (SWE));
- Sponsorship in the National Consortium for Graduate Degrees for Minorities in Engineering and Science (GEM).

The five-year B.S.+M.S., approved in 2009, allows high-achieving (GPA>3.4) UCR engineering undergraduates to apply up to 12 graduate course units toward both B.S. and M.S. degrees. In 2020, 42 students completed their M.S. degrees in BCOE under this option. Another contributor to M.S. enrollment has been the professional Online M.S. Engineering Program (MSOL), deployed in 2013, which enables fully employed engineers to advance their professional education. MSOL enrolled 115 students, as of Fall 2019.

Particularly noteworthy has been BCOE's success with the Graduate Assistance in Areas of National Need (GAANN) program from the U.S. Department of Education. In 2018, BCOE was awarded five GAANN grants, each at $895,000 over three years, to increase the number and diversity of domestic engineers and computer scientists.

Students who have completed their Ph.D. and M.S. at BCOE are highly successful after graduation. They routinely secure high-paying jobs in the high-tech industry immediately after completion of their degrees, at companies such

as Intel, Raytheon, Applied Materials, Google, Amazon, Facebook, Apple, Microsoft, Teradata, ESRI, LinkedIn, IBM, Oracle, and Yahoo! Many of these businesses require an M.S. or a Ph.D. for employment. The projected growth in STEM-related occupations largely outpaces growth in the overall job market, as reported by the U.S. Bureau of Labor Statistics. Unemployment rate for workers with doctoral and master's degrees in engineering is consistently and significantly lower than bachelor-degree holders, and median earnings are significantly higher. BCOE is poised to continue making a significant contribution toward the rising status of UCR as "Best in Social Mobility" among US institutions. A number of BCOE graduates choose to follow the academic path. Out of the graduate students who completed a Ph.D. in BCOE in 2011-19, 27 (5.5%) secured an Assistant Professor position after graduation, and 86 (almost 18%) secured a postdoc position after graduation. This is additional testament to the quality of the graduate education offered by BCOE.

STRATEGIES

BCOE aims at aggressively growing the overall number of graduate students. Based on the feedback from departments and programs, we expect the total number of graduate students to grow from ~900 in 2020 to ~1,500 in 2025. Roughly two-thirds of this increase will come from M.S. students (from ~400 in 2020 to ~800 in 2025). This aggressive growth won't be realized by implementing a single initiative, but rather by following a multi-pronged strategy which includes the following:

IMPROVE BCOE'S RESEARCH PROFILE. BCOE must continue to recruit high-quality junior faculty, renew efforts to retain the most successful faculty, and pursue larger funding opportunities (center-level grants), which will inevitably involve multiple faculty across different departments and centers. We must also recruit successful mid- to senior-level faculty to further enhance areas of strength. Special focus will be given toward the strategic hire of faculty with expertise in areas that are now identified as critical investment by the government (quantum computation and science, data processing and artificial intelligence, water-energy nexus). Faculty hiring will be driven by research needs so as to develop a holistic research profile for the entire College.

EXPAND THE PH.D. APPLICANT POOL AND BECOME MORE SELECTIVE, EVEN WHILE GROWING. We will achieve this by continuing many of the efforts already in place and listed before, and by a renewed public relations and marketing to increase the visibility of BCOE. As more undergraduates learn about BCOE, the expected result is a larger number of Ph.D. applicants, both resident and international.

INCREASE PARTICIPATION OF U.S. STUDENTS, PARTICULARLY UNDERREPRESENTED STUDENTS AND WOMEN. We will achieve this by targeted recruitment efforts (already ongoing) and by pursuing funding mechanisms tailored toward these groups (such as GAANN awards). As already stated above, further targeted messaging toward these groups is needed to highlight the strengths of the college. For instance, the high graduation rate for URM students at the undergraduate level is indicative of a nurturing culture which spills into the education and mentoring of URM graduate students. The quality and diversity of the BCOE undergraduate population is currently an underutilized source of graduate students. A renewed focus toward mentoring activities and research opportunities for our own undergraduates will be effective at recruiting the best students into our graduate programs.

SCALE-UP OF M.S. PROGRAMS. The nascent programs in Data Science and Robotics offer a model we can expand. The establishment of interdepartmental M.S. programs provides an education that is more closely aligned with needs of the workplace. Growth in these areas will be supported by (a) close collaboration between departments and programs, and (b) engagement with college stakeholders and industry recruiters, with the goal of ensuring that M.S. curricula respond to current and projected future needs of early-career professionals.

EXPLORE NOVEL APPROACHES FOR EXPANDING M.S. PROGRAMS. As of 2020, most of our M.S. students are concentrated in two departments, CSE and ECE. Diversification of the M.S. pool is needed. Efforts will be made to identify other areas where there is need for M.S. degrees, possibly in a multi-departmental setting. One area to consider is an M.S. program at the intersection of the materials sciences and computing, where there is growing interest in AI-powered scientific computing applications. Another domain to consider is quantum computing, which involves topics in devices, materials, computing and communications.

ADAPT M.S. PROGRAMS FOR A NIMBLE APPROACH. The process of developing M.S. programs is time-consuming and is a disincentive for many faculty to devote time to develop these programs. This also hinders flexibility in the M.S. program, which aims to provide students depth in a particular area where there is high interest

in industry. Since trends in industry can quickly shift, it is necessary to develop a nimble approach to adapt our M.S. programs. The college should consider specializations within existing approved programs that can be adapted quickly to the needs of the students.

FOSTER AN M.S. COMMUNITY. M.S. students spend a short time on campus, somewhere between 1-2 years. This does not result in their developing a sense of belonging to the campus, unlike B.S. and Ph.D. students who spend many years here. Also, M.S. students, unlike Ph.D. students, often do not work with a faculty advisor and develop a long-term relationship. It is imperative for the college to foster a sense of community and belonging among M.S. students, and devote efforts to be in touch with them for the long term.

FACULTY

The College has 128 faculty members as of 2020. Sustained hiring of new faculty in strategic areas will be required for attaining the profile of a top 25 engineering college. Our recruitment strategy will be to attract the most outstanding candidates who will not only enhance BCOE's research, graduate training and undergraduate teaching, but will also enhance the cross-disciplinary research portfolio and improve the diversity profile.

Increased emphasis on faculty development activities and recognizing faculty accomplishments will be central to raising the profile of BCOE while ensuring the success and retention of the current faculty. Of the 128 BCOE faculty in 2020, 39 or 30.5% are at the assistant professor rank. This is a very high percentage in comparison with other UC campuses: in 2018 the percentage of faculty at assistant professor rank ranged from 14.8% at UCB to 23.7% at UCI. Hiring of assistant professors has greatly enhanced both the research stature and gender diversity of the college. BCOE faculty have won 71 prestigious National Science Foundation CAREER and other young investigator awards from federal agencies as of 2020. Of the assistant professors, 11 or 28.2% are female. However, the overall percentage of female faculty in BCOE – just over 12% - lags behind other UC campuses and other AAU member universities. This is also true for underrepresented faculty across all ethnic and racial groups.

STRATEGIES

ESTABLISH DIVERSE RECRUITMENT EFFORTS. Recruiting and retaining female and underrepresented faculty remain high priorities for BCOE and will continue to be emphasized in discussions with department chairs and search committees. The college has established an integrated, college-wide recruitment process to attract diverse faculty in targeted research areas. This approach has met with success, and we will continue to use it to attract outstanding candidates.

IDENTIFY NEW CROSS-DISCIPLINARY RESEARCH AREAS AND DEGREE OFFERINGS. New faculty hires in BCOE will expand cross-disciplinary research. The faculty will be involved in identifying potential new cross-disciplinary research areas and degree offerings through their departmental meetings, retreats, meetings of their Board of Advisors and interactions with other colleges. For the purpose of college-wide planning, BCOE will also continue with retreats where the faculty can discuss these opportunities. Before the retreats, committees will have assessed the state of the college, comparison with peer institutions, and the strategic goals of UCR. Departmental long-range plans will also be reviewed with the aim of ensuring their alignment with the college-wide strategic goals.

INCREASE FACULTY DEVELOPMENT AND RECOGNITION. To ensure the success and retention of junior faculty, BCOE will focus on effective mentorship. Mechanisms for providing increased opportunities for participation in the development of large grant proposals as well as team teaching of new and innovative course offerings will be instituted. Recruiting and retaining female and URM faculty at senior ranks will also be given high priority. Strategies for retention across all faculty ranks will build the college climate and culture to support equity and inclusivity.

PROMOTE SUCCESS IN AT-SCALE INSTRUCTION. Class sizes have continued to grow. To recognize faculty, BCOE will build upon the existing UCR Academy of Distinguished Teachers. This Academy would honor and reward excellence in teaching at scale, enhance teaching effectiveness, create a central core of teachers who can serve as a resource and inspiration for other teachers in BCOE, and promote a sense of community among BCOE instructors. Contributors could advise the Associate Dean of Undergraduate Education on teaching excellence within BCOE and could provide institutional leadership and guidance for the distinctive undergraduate experience available in BCOE's research-intensive environment. Academy members could fulfill these broad roles in various ways, such as serving as teaching mentors for new BCOE faculty, or organizing and taking part in seminars, colloquia, and workshops on teaching excellence, among other possible activities.

STAFF

Administrative staff support BCOE operations in the Dean's Office, Departments, and Centers. Many staff roles require expertise in matters such as finance, institutional policy, government/sponsor policy, and safety. A UC systemwide structure, Career Tracks, defines staff duties and salary grades and is intended to provide consistency among campuses and among organizations within a single campus.

UCR is understaffed relative to the UC system and BCOE is understaffed relative to UCR, a persistent problem that, if left unaddressed, could grow into a crippling crisis for the college. Other UCR organizations lure staff to jobs with more attractive pay and conditions, leading to costly turnover, a lack of expertise/institutional memory, low morale, and the inability to see-through long-term organizational changes. Insufficient staff support can complicate routine matters and has the potential to also impact faculty, making them more susceptible to offers from competing institutions, and can dissuade faculty from pursuing ambitious funding opportunities because they fear having inadequate resources to support awards. Insufficient advising can put student success at risk, insufficient staffing in systems and safety can put the college's security at risk, and insufficient staffing in finance and administration can put extramural funding at risk. These and other risks can impair the college's ability to achieve its strategic goals.

On the positive side, staff growth approximately kept pace with faculty and student growth in the 2010s, although we note that the staff headcount declined in four of those ten years. Nevertheless, the college still must catch up with UCR and other institutions on staffing.

Table 5: BCOE staffing is low relative to the rest of UCR and the rest of the UC system.

	Staff count	1 yr % change	10 yr % change	Faculty count	1 yr % change	10 yr % change	Student count	1 yr % change	9 yr % change
2019	142	6%	51%	123	2%	39%	3812	12%	46%
2018	134	14%		120	5%		3389	-1%	
2017	118	19%		114	7%		3434	2%	
2016	99	-2%		106	12%		3377	10%	
2015	101	-1%		93	3%		3077	5%	
2014	102	2%		90	6%		2944	0%	
2013	100	12%		85	4%		2930	7%	
2012	89	-3%		82	5%		2747	5%	
2011	92	-2%		78	4%		2614		
2010	94			75					

STRATEGIES

BCOE must make up for decades of underinvestment in staff if we are to achieve the goals articulated for research, education, and institutional prominence.

INVEST IN STAFF SUPPORT. Intentional funding for the staffing necessary to support the college's growing needs, including resources for salaries, physical space, and professional development.

POSITION STAFF DESCRIPTIONS COMPETITIVELY. Evaluate and adjust job descriptions and job classifications to make staff positions competitive across campus and with industry.

FORMALIZE LONG-TERM ADVANCEMENT. Create departmental, interdepartmental, and college-wide structures that provide opportunities for advancement and make it possible to groom staff for more senior roles.

INCREASE EFFICIENCY. BCOE will work with the campus to retire obsolete and/or unwieldy systems that consume significant time, necessitate duplicative work (e.g., via "shadow" systems), and require non-reproducible knowledge.

USER FACILITIES AND RESEARCH INFRASTRUCTURE

Few University users' facilities can operate entirely on users' fees. Campus support is required for a vibrant infrastructure complex that supports the University mission in education, research, and service to California and the Nation.

STRATEGIES

INVEST IN THE NANOFAB USER FACILITY. The NanoFab is crucial for conducting research for a large number of BCOE and CNAS faculty and is essential for training opportunities for Ph.D., M.S. and B.S. students. Without NanoFab, faculty would not be able to conduct the research needed to fulfill current and future Federal grants. Ph.D. students in materials and device areas at BCOE, and in solid-state physics and materials science areas at CNAS, would not receive required training to be competitive for jobs with industry leaders. A closure of nanofabrication cleanroom facility would do irreparable damage to the image and the ranking of UCR as well as the campus' ability to compete for Federal funds. For a number of years, NanoFab has not received support from the Vice Chancellor for Research and Economic Development (RED) or central campus. Its operation is maintained with the users' fees and support from BCOE and CNAS. Analysis of the operation of nanofabrication facilities at other UC campus' and other universities tells that such facilities cannot operate without campus support. It is important that RED and the Provost office resume funding support for this crucial facility. The NanoFab needs to complete the move from Bourns to the MSE cleanroom. An investment at the scale of $10M is needed for full equipment upgrade and support of the campus activities. This investment will pay off in savings on retention packages to individual faculty members, which often duplicate the NanoFab equipment, increase the revenue from both internal and external users, and have a positive effect on faculty competitiveness in Federal funding. The NanoFab can become instrumental in increasing BCOE and Medical School cooperation providing equipment needed for research in nano-medicine, drug delivery, etc.

CE-CERT EXPANSION. The establishment of the CARB Southern California headquarters in Riverside represents a singular opportunity for BCOE, and in particular for CE-CERT. It would be highly advantageous to establish a larger building near CARB (e.g., along the University Avenue), expanding CE-CERT's program under BCOE, and incorporating other campus elements into a larger Sustainability Institute. Major investments would be needed for this expansion, and this development could become the hub of a new Clean Technology Park. As of 2020, CE-CERT has its own staff and operations, and therefore the majority of its return on indirect costs goes to the Center. This is causing challenges for BCOE as funding is not available for other necessary expenses.

WINSTON CHUNG GLOBAL ENERGY CENTER TECH TRANSITION ASSISTANCE. WCGEC has two thrust areas: battery technology and systems level energy technology. There have been multiple requests to establish a battery pilot production line to assist with tech transition, which could provide both industry sponsored R&D and start-up opportunities.

MULTIDISCIPLINARY CROSS-OVER AT CENTER FOR ADVANCED NEUROIMAGING. There are considerable opportunities between Engineering and Medicine, with a large share in Bioengineering. This is a growth opportunity as bioengineering attracts top students.

ENHANCED COMPUTING FACILITIES. Computing is presently the most sought-after area of study within BCOE. This is supported by three-degree programs in Computer Science, Data Science, and Computer Engineering as well as areas of study in computer vision and machine learning in ECE. Ample computing resources are required to maintain this area of growth.

COMMUNITY ENGAGEMENT

BCOE serves the community through a variety of research, education, and outreach engagements. These activities provide "real-world" applications for our research, opportunities to educate the public about what we do, and access to young people who may consider careers in engineering. Major connective points with the community fall into three broad categories: developing the STEM pipeline, building the region, and capitalizing on the arrival of the CARB lab in Riverside.

Bourns Science and Engineering Day is one of our more prominent and most institutionalized community engagement activities. This annual event attracts hundreds of young people, many affiliated with the regional Girl Scout Council, to UCR for hands-on opportunities to learn about science and engineering. For several years, the

college has worked with the student chapter of the Society of Women Engineers to plan and conduct the event. This points to our second important institutionalized engagement program: a robust array of more than 20 professional engineering and computing societies with student chapters and faculty advisors.

The annual Science and Technology Education Partnership (STEP) Conference, held in October in partnership with Bourns, Inc., invites middle and high school students from Riverside and San Bernardino counties into our laboratories to learn about STEM topics. The conference is coupled with an open house event where the public can visit laboratories and see our research. The focus of these events is to spark interest in underserved student groups in pursuing education and careers in STEM.

The Council for the Advancement of Black Engineers (CABE) is a non-profit organization working with the National Society of Black Engineers (NSBE) at UCR to support and advocate for African-American engineering students. In 2020, the college began working with CABE to establish a scholarship fund. CABE volunteers work with the college and directly with students to provide mentoring, help with career planning, raise awareness of opportunities for advanced degrees in engineering, and navigate around barriers to the success of engineering students from underrepresented groups.

MESA is a UC-systemwide initiative aimed at sparking early interest in STEM. The UC Office of the President and corporate donors support MESA efforts at UCR. Since its establishment in 1999, the mission of the MESA Schools Program (MSP) at UCR is to assist and support students at middle schools and high schools (and some elementary schools) who excel in math and science and become competitively eligible for the most rigorous colleges and universities. The MSP partners with teachers, administrators, school district officials and industry representatives to provide this effective academic enrichment model. Students are selected to participate in the MSP through a process that involves teachers at participating schools and locally-based MESA personnel. Separately, MESA has been a supporter of FIRST Lego League, an international competition that introduces children in elementary school and middle school to robotics. MESA has arranged for the annual regional competition to take place at BCOE for the past several years, and our faculty and students volunteer as judges and scorekeepers.

BCOE's Advancement office actively develops funding for scholarships for our students supported by industry, alumni, and non-profit organizations.

Smart Riverside, a City of Riverside program, is aimed at building a technology-capable workforce in the region and using technology to locally improve quality of life. The college has cooperated with the City of Riverside formally and informally in numerous ways. As an example, CE-CERT has worked closely with the City on developing an "Innovation Corridor", where we are applying transportation technology on University Avenue between the UCR campus and downtown Riverside, and using this roadway as a testbed for research in connected and automated vehicles. There are now several research projects that are utilizing this Innovation Corridor, hosted both at CE-CERT and the City. The college also collaborates with the International Relations Council of Riverside, which coordinates the city's global relationships with nine sister cities.

STRATEGIES

BCOE faculty, students, and staff touch the community in countless ways through personal relationships, ad-hoc connections, and formal partnerships. As the college continues to grow, we will have additional opportunities to build these connections, and will seek to institutionalize relationships. A strategic framework for making the most of our many relationships should incorporate these constituencies and priorities:

SUPPORT PRIMARY AND SECONDARY EDUCATION PIPELINE ACTIVITIES. Maintain active working relationships with the Riverside County Office of Education, the San Bernardino County Superintendent of Schools, and individual school districts and schools through the MESA program, student organizations, and undergraduate education team members. Provide opportunities for teachers to spend summers working in BCOE laboratories. Work with UCR's Graduate School of Education on instruction under Common Core for in-service and pre-service teachers so they connect fundamental academic concepts in math and science to real-world contexts such as environmental quality and technology adoption. Provide judges and coaches for area science fairs and similar competitions. Continue to expand on its annual STEP conference, highlighting a larger number of laboratories.

PARTNER ON ENVIRONMENTAL PROTECTION AND SUSTAINABILITY INITIATIVES. Collaborate closely with the CARB laboratory on research, methods development, and curriculum. Working with the UCR SOM and CNAS, develop technologies and tools to understand and manage health risks from pollution, and to identify

and pursue opportunities for clean, sustainable development. This will include development of sensors and models to understand personal exposure to pollutants indoors and outdoors.

The 2020s will bring UCR, and particularly BCOE, a remarkable opportunity for engagement with the opening of the California Air Resources Board (CARB) Southern California Headquarters in Riverside. This facility, scheduled to open in 2021, will bring hundreds of scientists/engineers and tens of millions of dollars' worth of infrastructure to Riverside. We have the opportunity to partner with CARB scientists/engineers as adjunct faculty members in our departments, and provide internships for our students. BCOE will collaborate on methods development and other research, and many related technology companies likely will open office and labs nearby.

Make Riverside a living laboratory and active partner in advancing technology, such as autonomous vehicles and traffic management strategies. This will include further development of the Innovation Corridor between downtown Riverside and UCR, where we can experiment with technologies that reduce congestion and pollution.

COLLABORATE FOR FIRE CONTROL. Collaborate with the U.S. Forest Service Fire Laboratory in Riverside on engineering research pertaining to forest management, fire control, and the environmental implications of fire.

ENGAGE IN INFORMAL SCIENCE EDUCATION. Because Riverside and San Bernardino counties have below-average percentages of adults who have completed college, it is important for the college to introduce its educational mission and research to the population we serve. Opportunities for this abound including the City of Riverside's Long Night of Arts and Innovation; the City of Riverside First Sunday's program, in which museum admission on the first Sunday of each month is free; after-school programs and community lectures in local libraries; Boy Scouts, Girl Scouts, and similar organizations; and FIRST Lego League, a robotics competition for elementary and middle-school students.

SUPPORT PROFESSIONAL ENGAGEMENT. Continue to support our students' active participation in the college's 20-plus professional societies.

BROADEN INDUSTRY ENGAGEMENT. Partner with companies to develop, assess, and implement new technologies. Offer adjunct faculty appointments to qualified engineers from industry. License our inventions to developers, and encourage our own faculty and students to consider start-up ventures aimed at commercializing their inventions. Bring alumni back to talk to current students about careers. Increase the number and diversity of companies that recruit our growing numbers of graduates. BCOE will continue to grow its interaction with industry, building on the fact that CARB will open its new facilities. Several technology-oriented companies are already making plans to move to Riverside to be near CARB.

DIVERSITY AND INCLUSION

BCOE will further establish itself as a leader in gender and ethnic inclusion and social mobility among research-oriented engineering colleges in the nation. BCOE equity and inclusion objectives for the strategic plan are to: 1) increase the percentage of female and African-American students to match the demographic distribution of the state, 2) increase the number of female and URM groups in tenure-track faculty positions to match the demographic distribution of the students and the nation, and 3) maintain and strengthen our culture of acceptance and understanding in BCOE.

Since its founding, BCOE has sought to recruit and retain female and URM students and faculty. Progress toward ethnic and gender inclusion can be evaluated by tracking the ethnicities and social identities of students and faculty over time and comparing these statistics against other institutions and the general population. As of 2020, demographics in the United States are 51% female, 18% Hispanic and 13% African-American. In California, Hispanics and Blacks make up 39% and 6.5% of population, respectively.

BCOE is one of America's most diverse engineering colleges, and one of the most successful at graduating students from URM populations. Within BCOE in 2019, 39% of undergraduate domestic students are URM (31% Hispanic/Latinx, 6% two or more races). At the graduate level, 34% of domestic students are URM (20% Hispanic/Latinx, 11% two or more races). The exceptional strength of BCOE in recruiting and retaining URMs at the undergraduate level is demonstrated by the comparisons with AAU member universities (Figure 8).

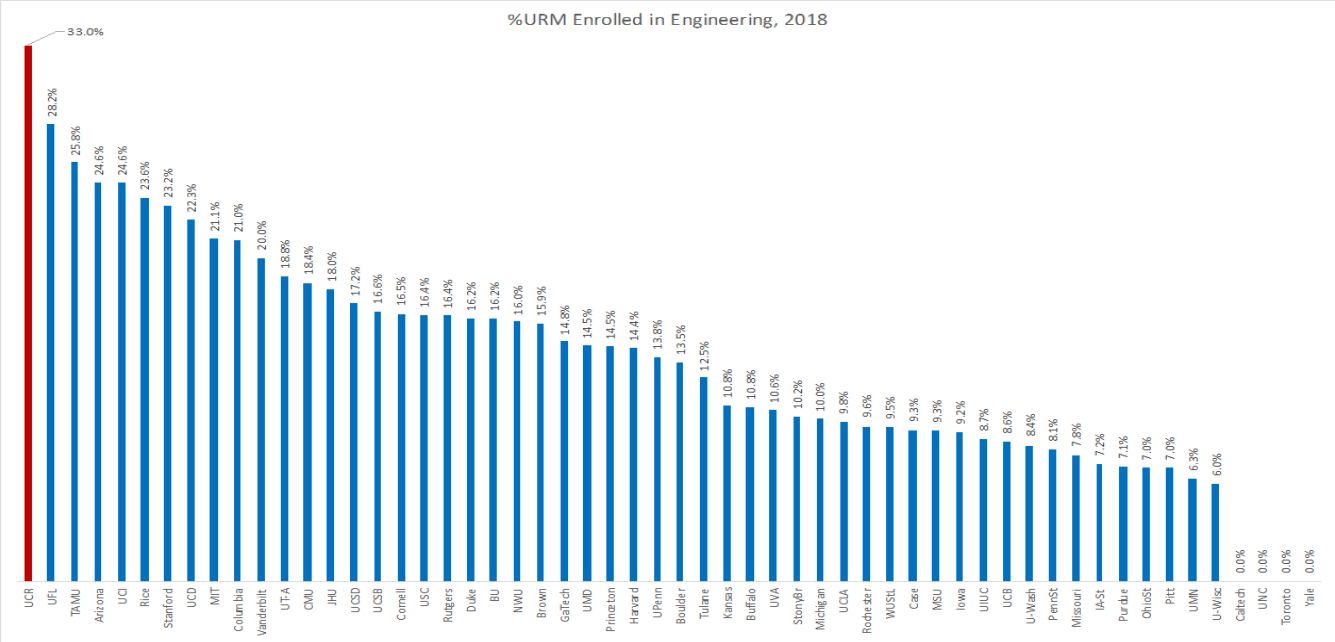


Figure 8: Percentages of URM Students in Engineering at the UG level at UCR and AAU member universities (does not include two or more races).

While the overall inclusion of URMs is a strength, upon taking a closer look at the identities of URM groups, Black/African-American students are significantly underrepresented relative to their demographic distribution in the country and state, making up only 2% of the BCOE undergraduate student body. The percentage of Black/African-American undergraduate students has been decreasing since 2007, at greater rates than the decrease in the same population in California. Further, relative to the graduation rates of all BCOE students, the ratio of graduation rates for Black/African-American students has generally declined since 2005.

The gender balance in the BCOE student population remains problematic. Female students make up only 22% of the undergraduate and 24% graduate student population as of 2019. Comparisons with AAU member universities illustrate that there is a need to better recruit and retain female students.

BCOE is poised to act in these critical areas of inclusion in the next decade such that the students better represent the demographics of the US population. The following strategies will allow continued success in the recruitment and retention of Hispanic/Latinx students, and increase the recruitment and retention of Black/African-American and female students.

Availability of diverse faculty to serve as mentors and role models is one key factor in expanding the presence of women and URM groups, particularly Black/African-Americans, in engineering disciplines and the STEM workforce. Across UC campuses as of 2020, 59% of faculty are male, and 41% female; at UCR, these percentages shift slightly to 64% male and 36% female. Of the domestic faculty, 54% are white, 5% Hispanic/Latinx, and 3% Black/African/African-American; at UCR, 46% are white, 6% Hispanic/Latinx, and 4% Black/African/African-American. Faculty composition within BCOE largely mirrors that in computer science and engineering departments across the UC system: 86% are male and 14% are female; 13% international, 2.6% Chicano/Latinx, 2.5% Black/African-American, and 1% two or more races. Black/African/African-American, Hispanic, and female faculty within these disciplines are clearly severely underrepresented relative to AAU member universities, the UC student population, and the US population more broadly. Diversifying the faculty to more closely align with the diversity of students is an ongoing priority with BCOE.

STRATEGIES

EXPAND SUMMER PROGRAMS. Build on current successful summer engineering programs and camps (e.g., CS 4 All Code Camp) by expanding topical areas and recruiting more women and URMs.

INCREASE VISIBILITY OF URM SUCCESS. Increase the visibility of female and URM student success across all BCOE channels including social media, websites, and in print.

DEVELOP FACULTY AND STUDENT MENTORSHIP PROGRAMS. Build mentorship programs for female undergraduate students, modeled on successful programs in the sciences. Develop mentoring programs for female and URM faculty. One possibility is to model these programs after successful programs for undergraduate students in STEM. Mentors do not need to be of the same gender or ethnic identities, but would serve as allies and advocates to help faculty navigate the promotion and tenure process at the same pace as their colleagues; nominate the faculty for awards; advise on strategic service opportunities; and in general, actively support the equitable treatment of women and URM faculty in the college.

ENHANCE NSBE OUTREACH. Grow support for, participation in, and activities of NSBE; including training BCOE students to work with local middle and high school students to facilitate a path to enrollment, and connect NSBE students with NSBE mentors.

EXPLORE HBCU PARTNERSHIPS. Establish relationships and pipelines with HBCUs, such that students would spend 3 years at an HBCU and then 2 years at UCR earning B.S. and M.S. degrees.

EXPAND DIVERSE FACULTY HIRING INITIATIVES. Build on the successful Provost's Diversity in Engineering Fellowship (PDEF) program, including expanding the number of recipients, ensuring there are no inequities in salary and rank for recipients, and building the college culture to value diversity as an integral part of excellence. Th PDEF program was originated in BCOE in 2017, and was modeled after a predecessor initiative originated in 2004, targeted at increasing gender diversity. The PDEF program led to the hiring of three female faculty in 2017; two of whom are also underrepresented minorities.

ESTABLISH BIAS TRAINING. Develop an institutionalized program for faculty bias and bystander intervention training. This training should be developed with support at the University level, but should largely be driven by BCOE faculty.

ENHANCE RETENTION RESOURCES. Secure funds to be used to supplement retention packages for female and URM faculty. Create endowed chair positions specifically to recruit and/or retain female and URM faculty.


BOURNS HALL

DEPARTMENTS

BIOENGINEERING (BIEN)

AT-A-GLANCE

Department Overview:	Students, Faculty & Staff:

- Established in 2006
- Degrees offered: B.S., M.S., M.S. Online, Ph.D.
- Newest and fastest-growing department in BCOE
- Part of the UC systemwide Bioengineering Institute of California (BIC)
- Success developing interdepartmental and interdisciplinary collaborations across colleges at UCR and the UC system, as well as with universities and companies across the nation and the globe
- Research Areas:
  ○ Biomaterials and regenerative medicine
  ○ Biomedical imaging
  ○ Computational bioengineering
  ○ Molecular and cellular bioengineering
  ○ Neuroengineering
	- Approximately 350 undergraduate students
	- Approximately 50 graduate students + faculty serve as prime advisors to 10 non-BIEN Ph.D. students
	- 16 core faculty members plus 1 lecturer
	- 8 cooperating faculty members from BCOE, SOM, and CNAS
	- 40+ faculty members from across campus for the Bioengineering Interdepartmental Graduate (BIG) program
	- Supported by 4 full-time staff members
	- Core faculty participate in the MSE program and various graduate programs in CNAS
	- Faculty are directors of multidisciplinary campus research centers and play pivotal roles in nine additional campus centers
	- Many faculty are Fellows in professional societies (i.e., IEEE, BMES, AIMBE, SPIE, ISMRM, AAAS)

FUTURE OUTLOOK

By 2025, BIEN expects to reach a steady state of around 25 FTE faculty and more than 100 graduate students, including a substantial increase in the number of M.S. students. Priority areas for expanding the faculty include:

- Biomedical imaging: 2 hires
- Biomaterials and regenerative medicine: 1-2 hires
- Computational bioengineering: 1-2 hires
- Molecular and cellular engineering: 2 hires
- Neuroengineering: 1 hire
- Two lecturers with security of employment for the first 5 years in line with anticipated student growth

BIEN will build on current strengths and expand based on emerging trends in bioengineering to grow into a prominent research and education unit and increase its national rankings and international visibility. BIEN will:

- Infuse artificial intelligence into biomedical imaging systems and incorporate big data in multiple aspects, creating opportunities for collaborations with SOM, CNAS and the College of Humanities, Arts, and Social Sciences (CHASS).
- Expand in areas of computational biomaterials, modeling of biomaterials, smart materials, devices and sensors for tissue engineering and stem cell therapy; and further collaborations with UCR SOM and other medical schools in the region.
- Expand in big data, AI and systems biology approaches for basic science and personalized medicine; biological networks, including multi-omics data, protein-protein interaction and pharmacology networks for disease prognosis and personalized medicine.
- Develop molecular and cellular tools for basic science, high-throughput screening, drug discovery and development, biotechnology, personalized medicine, and immunotherapies, by leveraging the faculty expertise in this area, in collaboration with SOM and CNAS. BIEN will also expand synthetic biology, with pre-knowledge in network, pathway fabrication, transcriptional and translational regulations. BIEN plans to develop technical advancements to rapidly deploy critical health-related technologies in response to critical global health threats.

- Leverage faculty expertise in bio-imaging with potential expansions of molecular, cellular and pharmacological engineering approaches for neuronal work modeling and perturbations in various psychological settings and neuro-degenerative diseases.
- Further enhance external collaborations with other medical schools/institutions, (i.e., other UC campuses, City of Hope, Loma Linda University Medical School, USC Keck Medical School, etc.)
- Promote entrepreneurship, industry collaboration, and rapid translation of research from bench to bed.

CHEMICAL AND ENVIRONMENTAL ENGINEERING (CEE)

AT-A-GLANCE

Department Overview:	**Students, Faculty & Staff:**
- Established in 2006 - Degrees Offered: B.S. (Chemical Engineering or Environmental Engineering), M.S., M.S. Online, Ph.D. - One of only 5 departments in the nation with teaching and research activities at the interface of chemical and environmental engineering - Research Areas: o Advanced materials and nanotechnology o Air quality systems engineering o Computation and molecular modeling o Energy conversion and storage o Industrial biotechnology o Water quality systems engineering	- Approximately 430 undergraduate students - Approximately 80 graduate students + faculty serve as prime advisors to 20 non-CEE Ph.D. students - 21 core faculty members plus 1 lecturer - Supported by 6.5 full-time staff members - Core faculty participate in the MSE program - Faculty are directors of research centers (i.e., CIB, the Water Resource Center, UC-Korea Institute of Material Science) and contribute to the multidisciplinary CE-CERT and WCGEC - Highly recognized faculty members including a National Academy of Engineering member and Fellows of AAAS, IIB, APS, and AIMBE

FUTURE OUTLOOK

The department expects to reach a steady state of about 30 FTE faculty by 2025, translating to a graduate student size of about 150. Additional growth is expected in the CEE M.S. program through anticipated growth in the new Biotechnology track for M.S. students, and growth in the air quality M.S. track with the opening of the California Air Resources Board (CARB) laboratory in Riverside along with new training efforts with the South Coast Air Quality Management District. Combined, these programs are expected to engage about 40-50 additional M.S. students in the CEE program.

CEE has grown rapidly into a recognized leader in research and education. To sustain and further augment these achievements, department growth will be directed at interdisciplinary research for environmental protection and providing sustainable routes for energy, water, materials, and chemical and pharmaceutical products. New research areas of strategic importance to the department include:

- New technologies for clean energy and water supplies and security, including materials synthesis and development of innovative technologies for energy production and storage, desalination, water reuse, groundwater system, remediation, etc.
- Phytochemicals production in plants and microbes (industrial biotechnology). Agricultural biotechnology in CEE is poised to be the US leader in this area, as plant sciences at UCR is a nationally-recognized strength and CEE has benefited from a cluster hire in translational plant sciences. Additional hires at the plant science/biotechnology/engineering interface will be required to address industry needs for trained personnel.
- Extraterrestrial environmental engineering for sustainable human life.
- Inverse product design and manufacturing.
- Data analysis and machine learning applied to CEE research disciplines.
- Air quality, climate, and remote sensing, emissions and renewable energy, especially aimed at further integration with CARB and complementing CE-CERT. Emerging CEE air quality and health disparities research will offer key insights to local and state stakeholders regarding the effects of climate change on public health.

- Materials and nanotechnology; Multiple hires with areas including crystal growth / materials processing; materials characterization; polymer materials, materials under extreme conditions. These faculty members would interface with the MSE program.

Among the strategic goals is to grow the CIB, increase research collaboration with SOM and CNAS, maximize educational and research opportunities related to CARB moving to Riverside, continue to develop robust research areas within the department aimed to further enhance our national and international recognition, enhance our materials-related research, and further collaborations with CE-CERT, WCGEC, and other interdisciplinary research centers. The 2020 US News and World Report Rankings have CHE #50 and ENVE #58. Our ambition is to be top 30 by 2030.

COMPUTER SCIENCE AND ENGINEERING (CSE)

AT-A-GLANCE

Department Overview:	Students, Faculty & Staff:

- Established in 1990
- Degrees offered: B.S. (CS, CS with Business Applications, shared responsibility for Computer Engineering (ECE), Data Science (Statistics), and Robotics (ECE, ME)), M.S., M.S. Online, Ph.D.
- Approximately 90% of UCR students take a CS course
- Ranks 31st nationally (csrankings)
- Research Areas:
  o Algorithms, theory and cryptography
  o Computational biology and bioinformatics
  o Computer architecture, high-performance computing, and embedded systems
  o Parallel and distributed computing
  o Cybersecurity
  o Data management and information retrieval
  o Artificial intelligence, machine learning, natural language processing, and data mining
  o Graphics, animation, visualization, and scientific computing
  o Programming languages, compilers, and software engineering
  o Systems and networks
  o Computer science education
	- Approximately 1,097 undergraduate students
	- Approximately 286 graduate students
	- 35.5 core faculty members plus 2 teaching faculty
	- 16 adjuncts and cooperating faculty from 6 departments and institutions
	- 13 full- and part-time lecturers
	- Supported by 7.5 full-time staff members
	- Significant growth in faculty (54%), undergraduate enrollment (88%), M.S. enrollment (163%), and extramural research funding (73%) in the second half of the 2010s
	- Core faculty participate in the MSE program
	- Faculty are directors of research centers (i.e., CRESP) and contribute to various multidisciplinary centers (i.e., Discover, CRIS, Center for Geospatial Sciences)
	- Most of the senior faculty members are Fellows of one or more professional associations including IEEE, ACM and AAAS

FUTURE OUTLOOK

The 2021-25 proposed growth of CSE is a net increase of 13 tenure-track faculty, including teaching faculty. This will be accompanied with proportional increases in student enrollments, maintaining the current student-to-faculty ratios in the B.S. and Ph.D. degree programs, while increasing the M.S. student-to-faculty ratio by 30%. By 2025, the department aims to reach 1,650 undergraduates, 300 M.S. and 250 Ph.D. students. With the above faculty and student increases the department expects a 75% increase in extramural funding per faculty (from 228K to 400K per faculty per year).

As of 2020, the department has strong research productivity and national visibility in various research areas according to csrankings.org. However, there are areas that would benefit from strategic hiring efforts:

- Bioinformatics and computational biology (+2). This area (rank #12 nationally according to csranking.org) is crucial to the development of collaborative research with the SOM and CNAS life sciences.
- Artificial intelligence, machine learning, natural language processing, and robotics (+3). This area is not only essential to the development and growth of the DS and Robotics Programs within BCOE but also will support continued research collaborations with SOM and CNAS.

- Software engineering (+1). A core CS area essential to the teaching and research mission of the department.
- Operating and distributed systems (+2). A core CS area essential to the teaching and research mission of the department, are essential to Computer Engineering and complement and support research in Cybersecurity and DS.
- Computing for social sciences and/or economics (+1). An emerging area that strengthens the DS Program and would foster collaborations with the Social Sciences and the SPP.
- Graphics with emphasis on visualization and animation (+2). Animation is extremely popular among undergraduate and graduate students. It could support collaborative research with the arts and with computer science education. Visualization helps to display and animate physical and virtual phenomena and as such has a great impact, and potential collaborations, with all areas of STEM, as well as with Data Science.
- Teaching faculty (+2). Supports the teaching and service mission of the Department allowing the growth of its undergraduate programs and M.S. enrollments.

CSE will expand into emerging areas of computer science and further explore the potential for research collaborations within and outside BCOE, an effort that previously resulted in securing multi-million research funding grants. Centers such as the Data Science Center, CRIS, CRESP and Center for Geospatial Science (CSG) are a catalyst in maintaining and strengthening these research relationships.

CSE offers five service courses with over 5,600 enrolled students per academic year. The department will strengthen this aspect of its teaching activity with courses targeted to various academic disciplines within UCR, such as social sciences, physical sciences, engineering, and the arts, by offering a set of targeted introductory and second-level courses and by setting up a dedicated Departmental committee tasked with developing and coordinating, with various academic entities on campus, the offerings of *Computing as Breadth (or X + Computing)*. The increase in faculty size will allow us to offer a more diverse set of upper-division courses. Doing so can open opportunities establish areas of specializations within the major(s) at the B.S. and M.S. levels, such as areas of concentration in Cybersecurity, AI/ML, Systems and Networks.

ELECTRICAL AND COMPUTER ENGINEERING (ECE)

AT-A-GLANCE

Department Overview:	**Students, Faculty & Staff:**

- Established in 1989
- Degrees offered: B.S., M.S., M.S. Online (Electrical Systems), Ph.D.; shared responsibility for Computer Engineering (CSE) and Robotics (CSE, ME)
- Explosive growth in artificial intelligence industry
- Research Areas:
  o Communications, signal processing and networking
  o Computer engineering
  o Controls and robotics
  o Intelligent systems
  o Nanotechnology, advanced materials and devices
  o Power systems and smart grid
	- Approximately 500 undergraduate students
	- Approximately 200 graduate students + faculty serve as prime advisors to 20 non-ECE Ph.D. students
	- 31.5 core faculty members
	- Approximately 20 adjunct faculty, cooperating faculty, and lecturers
	- Supported by 7.5 full-time staff members
	- Core faculty participate in the MSE program
	- Faculty are directors of research centers (i.e., CE-ERT, CRIS, POEM, UC-Light, E3)
	- Most of the senior faculty members are Fellows of one or more professional associations including IEEE, MRS, APS, SPIE, OSA, and AAAS

FUTURE OUTLOOK

ECE expects to reach a steady state of about 40 FTE faculty by 2035, which would translate to around 300 Ph.D. and M.S. graduate students. Among the ECE educational goals are a substantial increase in the number of M.S. students.

ECE has made great strides in the first two decades of the 21st century with impressive achievements in a short period of time. To reach the next level and expand in the strategic research areas, ECE identified positions needed over the next five years for the department to realize its potential. They include:

- Autonomous and cyber-physical systems (2 new positions and 1 replacement; intersection of robotics and computing, smart grid, applications of cyber-physical systems from transportation to medicine);
- Computer engineering and devices (2 new positions; intersection of devices and computer architecture, and computer engineering for intelligent systems design);
- Signal processing and networking (1 new position; microwave, RF, mm-waves devices and systems);
- Biomedical signal and image processing (1 new position; image processing with biomedical applications);
- Quantum information and communication science (1 new position; core areas of quantum computing, quantum sensors and quantum communications).

ECE plans to grow into new promising research directions by building on the areas of strength, to increase its standing in various rankings and international visibility. ECE will:

- Develop collaborations, facilitated through CRIS, with the environmental sciences and medical and biological sciences to target large-scale inter-disciplinary projects that achieve major societal goals.
- Expand into quantum computing technologies using its strength in quantum materials, nanofabrication, optics and superconductivity, and leveraging the facilities of the POEM Center and the UCR NanoFab.
- Strengthen its research in renewable energy generation, conversion and storage by leveraging the faculty expertise in this area, collaboration with CE-CERT, E3 and WCGEC, and its Southern California geographical location, which provides many opportunities for renewable energy research, e.g., photovoltaics.
- Continue to build on the existing expertise and potentially expand in power systems devices and power electronics, which will involve close collaboration with WCGEC, E3 and CE-CERT.
- Bridge the strength of computer engineering with the nanomaterials area by transitioning novel materials and devices into computing, memory and information storage systems.
- Increase collaboration with the robotics and intelligent systems areas for solving the computing problems underlying these systems.
- Increase cooperation with the UCR SOM focused on strengths in nanotechnologies, phononics, optics, image processing and computer engineering.

MECHANICAL ENGINEERING (ME)

AT-A-GLANCE

Department Overview:	**Students, Faculty & Staff:**

- Established in 2000
- Degrees offered: B.S., M.S., M.S. Online, Ph.D.; shared responsibility for Robotics (CSE, ECE)
- One of the top 10 most in-demand undergraduate programs at UCR
- Broad collaborations within BCOE and with CNAS, SOM and other campus programs
- Research Areas:
  o Bioapplications
  o Mechanics, advanced materials, and manufacturing
  o Controls, robotics, and automation
  o Thermal systems and multiphase flows
  o Nanoscale design and micro-device engineering
  o Air quality and environmental fluids engineering
	- Approximately 485 undergraduate students
	- Approximately 73 graduate students + faculty serve as prime advisors to 24 non-ME Ph.D. students
	- 27 core faculty members
	- Supported by 7 full-time staff members
	- Core faculty participate in the MSE program
	- Doubled the number of faculty from 2010 to 2020
	- Faculty are directors or collaborators of research centers (i.e., CE-CERT, CRIS, WCGEC)
	- 25 young investigator awards, with 12 of the current 27 ME faculty having received at least one
	- Most of the senior faculty members are Fellows of one or more professional associations including ASME, AAAS, AIAA, ASLMS, SPIE, TMS, AIME, and a member of the National Academy of Engineering of Mexico

FUTURE OUTLOOK

ME will grow to 40 faculty by 2035. This calls for roughly a net growth of one high-quality faculty member per year for 15 years and translates into about 200 Ph.D. students mentored by ME faculty. Among the ME educational goals at the graduate level, is to substantially increase the number of M.S. students to at least 100 over 15 years. The number of undergraduates is expected to grow to roughly 800 over the next 15 years with an aim of maintaining a 20:1 undergraduate-to-faculty ratio and 5:1 graduate student-to-faculty ratio.

In the near-term (i.e., 2020-25), ME anticipates the bulk of faculty hires will continue to be in controls, robotics, and autonomy (CORA), to ensure ME reaches a critical mass in this area and better position the department to build teams that can tackle increasingly complex research problems.

In the longer-term (i.e., 10 – 15 years), ME will focus on organic growth in frontier research foci that are highly visible and will help distinguish the department. ME will target growth in topical, rather than traditional disciplinary areas that synergistically leverage unique historic and emerging strengths in the Department, College, and Campus; e.g., health (medical devices, disease modeling, translational bioscience), energy (sustainability, environment and energy sciences), systems (dynamic systems, sensors and controls), and autonomy (robotics and advanced controls) to name a few.

ME will direct its efforts at strengthening the two currently smallest research areas (thermal systems and multiphase flows and air quality and environmental fluids engineering) as we find new faculty who can help leverage current strengths while focusing on the emerging topics mentioned above.

The current faculty distribution shows a current shortfall of Associate Professors. While this shortfall might diminish with the impending promotions of Assistant Professors, ME also needs to consider recruitment and pre-emptive retention strategies across the ranks, with key emphasis on the Associate Professor level. A key opportunity for faculty growth and visibility will also stem from the recruitment of “target(s) of excellence (TOEs)” and National Academy-level faculty to bring a level of prestige commensurate to our comparator programs. Doing so will require resources such as endowments, space, and perhaps parallel faculty lines to grow a “cluster” around the TOEs.

ME faculty growth will be consistent with our ongoing commitment to achieving diversity and inclusivity. With a current composition that includes 15% female and URM faculty, we have already achieved parity with our sister UC ME departments and other peer institutions. However, with the projected growth, we will have a unique opportunity to achieve a leadership role in this regard.

PROGRAMS

COMPUTER ENGINEERING (CEN)

AT-A-GLANCE

Department Overview:	Students, Faculty & Staff:

- Established in 2010
- Degree offered: B.S. and M.S.; affiliated with CSE and ECE
- Ranked No. 3 in the U.S. and No. 4 in the world for computer engineering (csrankings.org)
- Research Areas:
  o Compilers and Software Systems
  o Computer Architecture
  o Digital Design and Design Automation
  o Embedded and Real-Time Systems
  o High-Performance Computing
  o VLSI Circuits and Systems
	- Approximately 235 undergraduate students
	- Approximately 45 graduate students
	- 15 affiliated faculty members
	- Faculty participate in the Materials Science and Engineering (MSE) program
	- Senior faculty members are Fellows of professional associations including IEEE, ACM, AAAS

FUTURE OUTLOOK

Interest and demand in computing remains high. CEN will increase enrollment to 300 undergraduates and 75 M.S. students by 2025. The program is exploring the addition of a Ph.D. degree to emphasize the research strengths and avoid confusion with different offerings of our Ph.D. in both the ECE and CSE departments. We anticipate initiating a Ph.D. program by 2022 and enrolling ~20 students by 2027.

The computer engineering field is challenged in two critical ways, and CEN's continued excellence will rely on the program growing its expertise to meet these critical challenges.

First, with the end of Moore's Law, future performance will arise from two directions – within CMOS or novel devices and technologies that replace (or augment) silicon-based electronics. As a result, future systems that federate a large number of accelerators are needed to manage these future architectures and research is needed to bring novel materials to computer architectures, new algorithms, compilers and run-time systems.

Second, computing systems are rapidly evolving from small to large scales, creating challenges due to real-time constraints, power and form-factor limitations, and demanding workloads. CEN's strategic growth plan builds both on its core strengths in computer engineering and extends to meet the trends outlined above to meet the computing engineering challenges of tomorrow. To achieve that ambition, we anticipate the following hires are needed:

- Strengthen core CEN areas: Fill gaps in areas such as design techniques and automation for emerging applications, operating systems and VLSI systems; Expand to address emerging computing systems.
- Post-Moore's Law systems: Hire faculty with expertise in quantum architectures and novel memory technologies to bring novel devices and materials to computing systems and memories, and create a bridge to the materials and devices research group.
- Computational and hardware support for emerging applications: Hire faculty with expertise in computational and hardware support for deep learning, neuromorphic computing, robotics, and intelligent systems, complementing the BCOE investments and critical mass in those areas.
- Improving diversity: Aspirational goal of at least 50% of future hires being women or from URM communities.
- Improve advising and student experience: Hire a LSOE to improve the experience of the undergraduate and M.S. students in the program, and lead in both pedagogical excellence and service to the program.

DATA SCIENCE (DS)

AT-A-GLANCE

Department Overview:	Students, Faculty & Staff:
- Established in 2019 - Degree offered: B.S. and M.S.; affiliated with Statistics	- Approximately 12 undergraduate students - 15 affiliated faculty members

FUTURE OUTLOOK

The DS program targeted an inaugural class of 20-30 students starting in Fall 2020. At steady state the DS major aims for admitting 50 new students per year.

DS will further improve diversity within BCOE by blending data science with gender-balanced application areas related to Data Science, such as astronomy, biology, and economics. The CSE and Statistics Departments were awarded a major gift from the Technology Pathways Initiative (TPI) for the development of the new DS Major. TPI supports programs that increase female participation in computing. Furthermore, there is an on-going effort to create a (state-supported) Data Science Master's program to be offered between the CSE and ECE departments.

Given its interdisciplinary character, the DS Program looks to strategically strengthen existing areas and expand to new areas through new faculty hires. In addition to supporting the DS degrees, such faculty can also strengthen the Data Science Center, which focuses on collaborative DS research related problems across BCOE, CNAS, SOM, SPP and CHASS. The proposed new hires (4) in AI/ML/NLP/Visualization are included in the CSE and ECE plans above.

MASTER OF SCIENCE IN ENGINEERING ON-LINE (MSOL)

AT-A-GLANCE

Department Overview:	Students, Faculty & Staff:

- Established in 2014
- Degrees offered: Online M.S., via video
- 7 specializations
  ○ Bioengineering
  ○ Data science
  ○ Chemical engineering
  ○ Electrical engineering (Power Systems)
  ○ Environmental engineering
  ○ Materials at the nanoscale
  ○ Mechanical engineering
	- Approximately 115 students
	- 26 affiliated faculty members and 1 lecturer
	- Supported by 2 staff members

FUTURE OUTLOOK

The MSOL Program enables fully employed engineers, including computer scientists, to advance their professional education, enhance value to their employers, and apply their enhanced skills to build upon the body of knowledge within their chosen field. MSOL is unique in that it combines engineering and professional development classes. The design project (in lieu of comprehensive-examination) is handled as a course in which the instructor is in contact with the students, and with portions of the projects being sent to the instructor throughout the duration of the course.

The MSOL strategic plans include the following:

- Increasing the MSOL enrollment to around 300 to 400 students by 2030;
- Adding courses for each specialization;
- Increasing the number of offerings within each specialization.
- Adding new degree programs

MATERIALS SCIENCE AND ENGINEERING (MSE)

AT-A-GLANCE

Department Overview:	Students, Faculty & Staff:

- Established in 2007
- Degrees offered: B.S., M.S., M.S. Online, Ph.D.
- Research areas:
  o Biomaterials
  o Structural materials
  o Computational materials
  o Materials processing
  o Electronic, optical, and magnetic materials
  o Energy and green technology
	- 11 undergraduate students
	- 63 graduate students
	- 63 faculty affiliations from BCOE and CNAS, including 6 adjunct faculty and lecturers
	- Supported by 3 staff members
	- Faculty are involved in various research collaborations (i.e., NanoFab Facility, Central Facility for Advanced Microscopy and Microanalysis, POEM, WCGEC, High Performance Computing Center)

FUTURE OUTLOOK

To keep pace with the growth of UCR's student population, the MSE program expects to hire one materials faculty per year in BCOE. Hiring of materials faculty in BCOE and CNAS departments will naturally bring growth to the number of graduate students, with a projection of 17 M.S. students and 82 Ph.D. student by 2025. As with the BCOE departments, a goal of the MSE program is to aggressively seek out M.S. students, which in part will be enabled via the implementation of a B.S.+M.S. program. Contrary to the general campus trend, in the near term the MSE program anticipates a decrease in the overall number of undergraduate students admitted as admission criteria are increased. It is projected that a smaller number of well prepared MSE undergraduate students will increase the quality of education, as well as the perception and visibility of the program.

The MSE program will:

- Join in the development of robotics, and participate in the Center for Robotic and Intelligent Systems (CRIS). The MSE program will build on its strengths in the design of active materials and interface with center participants on the design of shape-change materials for robotic applications.
- Further increase cooperation and interactions with SOM, especially in the areas of biomedical implants and bio-materials characterization.
- Build on a strong base in quantum materials, nanofabrication, optics and superconductivity in line with the goals of the ECE Department.

By 2025, the MSE program will seek a number of hires in key areas to address faculty attrition, maintain the necessary research and pedagogical breadth, and fully position itself as a top-ranked MSE program:

- Structural materials: 1 new hire and 1 replacement; metal additive manufacturing/solidification and advanced ceramics processing
- Crystal growth: 1 new position; epitaxial thin films or single-crystal growth
- Materials characterization: 1 new position and 1 replacement; nanomechanical characterization of materials, advanced electron microscopy techniques
- Polymeric materials: 1 new position; soft matter synthesis and properties for soft robotics
- Bioinspired materials: 1 replacement

ROBOTICS

AT-A-GLANCE

Department Overview:	Students, Faculty & Staff:
- Launched in fall 2021 - Degrees offered: M.S. - Provides a holistic understanding of robotics - Four focus areas: - Mechanical design and fabrication - Embedded platforms and system design - Control and navigation - Artificial intelligence and perception	- Fall 2021 enrollment numbers pending - 20 affiliated faculty members

FUTURE OUTLOOK

Robotics is an area of fast-growing interest driven by recent advancements in artificial intelligence research and technology development. Heavy investment in robotics is expected with the Department of Defense planning to invest more than $2 billion over the next five years in artificial intelligence research, which encompasses many aspects of robotics. Application areas are varied including manufacturing, logistics, health care, public safety, and the military. For this reason, the Robotics program is expected to be at least as much in demand as the EE and CEN programs. The program is expected to start at around 20 students in the first two years and grow by 15-25 students per year thereafter. Within 5 years, the program is expected to enroll about 80 students. This growth would be achieved without impacting enrollment in the CS, ME, CEN, or EE programs, thus driving up overall enrollment in BCOE. To achieve this growth, the Robotics program will require office space and one FTE for administrative support.

CENTER FOR ENVIRONMENTAL RESEARCH AND TECHNOLOGY (CE-CERT)

AT-A-GLANCE

CE-CERT is an internationally recognized multidisciplinary research unit focused on sustainable environmental technologies. The center's mission is to be a recognized leader in research and education, a creative source of new technology, and a strong contributor to solving societal environmental issues. CE-CERT serves with a high-quality collaborative, interdisciplinary research agenda that is of key importance in addressing air quality, transportation and energy challenges. In addition, the center provides a responsive research agenda and honest broker role between industry and government are critical elements of our success.

Center Overview:	**Facts & Stats:**
- Founded in 1992 - UCR's largest research center - Serves key role to help meet California's clean air and climate goals; Contributes to University of California's carbon neutrality goal	- $29 million research portfolio - 27 interdisciplinary faculty members and 30 full-time technical and administrative staff members - Approximately 55 engineering graduate students and 50 undergraduate students

FUTURE OUTLOOK

CE-CERT's four key interdisciplinary research themes and focus areas of growth are as follows:

- *Air Pollution, Climate Change and Health Effects:* Improving our understanding of the sources and impacts of particles, toxins, ozone, and greenhouse gases (GHG). CE-CERT will continue to build bridges with CNAS air quality faculty and will pursue an Academic Senate faculty hire in combustion/emissions who could help lead this particular research area.
- *Mobility Solutions:* Developing improved transportation technologies and systems that are not only beneficial for the environment, but also improve mobility, safety and economics. CE-CERT will pursue, with UCR and BCOE, graduate programs in transportation and will consider growing its mobility solutions research by engaging additional existing faculty from campus.
- *Microgrid and Energy Infrastructure:* Developing integrated energy solutions for transportation, the electric grid, energy storage applications, and electric motors. Working in partnership with WCGEC, CE-CERT will develop a plan that seeks senior leadership in this area.
- *Renewable Energy Solutions:* Developing and demonstrating renewable energy solutions, in particular renewable ethanol through aqueous processing, renewable natural gas (RNG), and waste-to-energy conversion. CE-CERT will pursue an academic senate faculty hire in this area as well as new postdocs and a technical staff member.

CE-CERT's long-term strategic goals include:

- Continue to pursue a large-scale, broad-based, integrated research agenda in emissions measurement, analysis, and control; atmospheric measurements and modeling; advanced vehicle technologies and transportation systems; and renewable energy and fuel production and integration;
- At both the undergraduate and graduate levels, contribute to UCR's overall excellence in education, including instruction, student mentoring, and conducting outreach activities;
- Make significant contributions through research and technology development to the quality of life, economy, and sustainability in California, the nation, and the world;
- Remain flexible and responsive as an honest broker to the research, education and outreach needs of the local community, state and national governmental entities, industrial partners, and academia.

Specific planned activities in 2020-25 include, but are not limited to:

- Follow and track emerging funding opportunities (e.g., greenhouse gas reduction funds, Strategic Growth Council, community air protection program, etc.) and present our research, fact sheets, and policy briefs to appropriate venues.

- Organize the submission of large center-level proposals, such as an NSF Engineering Research Center, USDOT University Transportation Centers, and a Transformational Climate Communities program; pursue other relevant opportunities , coordinating with central campus and city, county, and regional governments.
- Work with CARB to identify synergies and opportunities to connect on research, education, and outreach.
- Increase the connections of engineering research with other colleges on campus. Emphasize multidisciplinary proposals that can raise the impact and visibility of our research through these large efforts.
- Expand outreach efforts by interacting more with K-12 students and teachers, hosting major international conferences, and working closely with the city and county to develop a comprehensive training program, building on our Air Quality and Climate Training Endowment.
- Update laboratories and equipment to conduct additional cutting-edge research and perform improved testing services. Testing services can act as an important stabilizing component of funding to pay for needed research equipment, but require an initial investment against our endowment. Several such expanded and new laboratories are being considered in the air pollution and renewable fuels areas over the next three years.
- Expand facilities as CE-CERT continues to grow. Current buildings are mostly full, and our mortgage will be paid off in 2021. CE-CERT will expand at the current Columbia Avenue site as well as become a major part of UCR's Clean Technology Park adjacent to the main campus.
- Working with campus leadership, continue to push for a UCR Sustainability Institute that will consolidate sustainability-focused research across campus, including the activities of the Office of Sustainability.
- Expand overall faculty by working with additional faculty from UCR academic departments and centers, as well as hiring additional research faculty.

CENTER FOR INDUSTRIAL BIOTECHNOLOGY (CIB)

AT-A-GLANCE

CIB is directed at research and education for (i) the production of chemicals, biofuels, and healthcare products and (ii) food security through sustainable agriculture and crop production. Key research areas include developing new synthetic biology approaches to understand and enhance stress tolerance in microbes and plants to improve production yields and crop resilience to weather extremes (climate change); the design of high-throughput engineering; and characterization technologies for the discovery of new biologics and the development of new biomanufacturing capabilities. The demand for trained students and new biotechnologies for industry will expand with the growth of the manufacturing base; the CIB is well-positioned to meet these demands.

Center Overview:	**Facts & Stats:**
- Features a CEE M.S. degree with a specialization in Industrial Biotechnology; 20-30 students per year - Industrial biotechnology is upwards of 2.5% of GDP in 2020; Estimated to grow at over 10% annually	- Brings together BCOE and CNAS from chemical engineering, bioengineering, plant sciences, genomics, and chemistry

FUTURE OUTLOOK

A major thrust of the Center is to create an NSF-funded Engineering Research Center in plant synthetic biology.

CENTER FOR PHONON OPTIMIZED ENGINEERED MATERIALS (POEM)

AT-A-GLANCE

POEM conducts interdisciplinary cutting-edge experimental and computational research on the foundations and applications of phonon engineering in materials and devices. Its mission is to use the full scope of phonon engineering approaches for optimizing advanced materials for applications in electronics, photonics, thermoelectric and photovoltaic energy conversion, battery technologies, and biomedical applications. Among the accomplishments of POEM researchers are the discovery of the exceptional heat conduction properties of graphene, pioneering development of graphene-enhanced composites for thermal management applications, and

development of the phonon engineering approaches for increasing efficiency of heat removal and the thermoelectric energy conversion.

FUTURE OUTLOOK

The strategic goal of POEM is to become a leader in phononics research worldwide, develop unique one-of-a-kind experimental facilities at UCR, and serve as an enabling framework for future multi-PI projects and extramurally funded research centers.

CENTER FOR ROBOTICS AND INTELLIGENT SYSTEMS (CRIS)

AT-A-GLANCE

CRIS is an interdepartmental research center in the foundations and applications of intelligent and autonomous systems, including robotics, computer vision, controls, machine learning, and real-time systems. It brings together researchers from academia and industry to develop cross-disciplinary solutions to key societal problems and train the next generation of researchers and practitioners. Application areas of interest include security, biomedical systems, environmental monitoring, agricultural automation, transportation, logistics and manufacturing, and advanced materials, among others.

FUTURE OUTLOOK

CRIS will continue its focus on providing a single platform to bring together research in robotics and intelligent systems from across campus. A state-of-the-art shared facility with motion capture systems, robots and manipulators, and computational servers is being developed as of 2020. Affiliated faculty have built a strong collaboration with researchers in agriculture and environmental/ecosystem monitoring, which is expected to be a major focus area for the Center. CRIS also plans to work closely with other campus centers, e.g., CE-CERT and the Data Science Center, and build synergies to increase UCR's visibility in robotics and intelligent systems.

ENERGY, ECONOMICS, AND ENVIRONMENT (E3) RESEARCH CENTER

AT-A-GLANCE

The E3 Research Center seeks to determine how society can best integrate the energy system, the economic system and the built environment to provide for growing demand of energy in an economical and sustainable manner. The research center has over 37 affiliated faculty members from 9 departments and centers. E3 Research Center's research activities fall into three main categories: (i) water, energy, climate, and food nexus, (ii) machine learning theory and its applications in energy, economic and environment systems, and (iii) cyber-physical systems and smart and connected communities.

FUTURE OUTLOOK

The E3 Research Center will build on these areas of strength and further leverage California's geographical location, which provides abundant opportunities for research in the area of greenhouse gas emission reduction, renewable energy, wildfire prevention, and machine learning.

UCR CENTER FOR ADVANCED NEUROIMAGING (CAN)

AT-A-GLANCE

CAN was established in 2016 to spearhead human neuroimaging at UCR. It serves as a campus-wide core to imaging researchers at UCR and local institutions, a catalyst for new projects involving human imaging, and a hub for advancing magnetic resonance imaging (MRI) and its applications. The mission of the Center is threefold: advancing methodology and applications of MRI, providing technical support to research projects utilizing MRI, and providing dissemination/training/education to the UCR community. In terms of research, we have developed and refined a number of neuroimaging methodologies, including neuromelanin imaging, iron imaging and high-resolution diffusion tensor imaging.

Center Overview:	Facts & Stats:
- Budget of $500k - Provided assistance to approximately 10 projects across campus and funded a dozen pilot projects aimed at collecting preliminary data for grant submissions	- Lab features a state-of-the-art 3 Tesla Siemens MRI system - 2 core faculty members; Support from 3 staff members - Supports approximately 10 major research projects by faculty in psychology, engineering and the school of medicine

FUTURE OUTLOOK

The core strengths of the center include:

- *High-resolution imaging:* Improving the ability to probe small structures in the brain.
- *Perfusion imaging with arterial spin-labeling:* Refinement and application of noninvasive perfusion imaging.
- *Novel MRI Approaches for detecting and monitoring neurodegeneration:* Development of multipronged approaches for assessment neurodegeneration associated with Parkinson's Disease and aging.
- *Machine learning-based data analysis:* Developing machine learning based analysis approaches for extracting information in big data in a way that is robust and capitalizes on the data heterogeneity and applying them to neuropsychiatric disorders:

CAN's long-term strategic goals include:

- Further expand the core faculty critical mass to put UCR on the map in the nation in terms of imaging;
- Develop an establishment of small animal imaging capabilities;
- Integrate MRI with other imaging modalities that are available or becoming available on campus, particularly in vivo optical imaging and high-speed ultrasound;
- Enhance synergistic interactions with SOM clinical researchers in neuroscience and cardiovascular medicine.

Specific planned activities in 2020-25 include, but are not limited to:

- Expanding core critical mass;
- Raising funds to acquire a small animal MRI system;
- Securing multi-investigator grants utilizing imaging;
- Developing core technologies to prepare for a P41 NIH resource center application;
- Establishing a UCR consortium for imaging;
- Establishing cardiovascular imaging programs;
- Developing an M.S. degree program focused on imaging.

For CAN to reach its strategic aims, we have identified potential positions that are needed in the following areas:

- In collaboration with ECE and/or CS, hiring new faculty focused on data analysis;
- With UCR matching and help from biomedical sciences and other potential users, acquire an animal MRI system;
- Administrative support for a UCR imaging consortium;
- Hiring an instructor to take responsibility of our educational goals.

UBIQUITOUS COMMUNICATION BY LIGHT (UC-LIGHT)

AT-A-GLANCE

UC-Light is a University of California (UC) system-wide research center established in 2010 and funded by the Multicampus Research Program and Initiatives (MRPI) program. UC-Light Center consists of 13 faculty members from UC Riverside, UC Berkeley, UC Santa Barbara, UC Davis and UC Merced, as well as Lawrence Berkeley National Laboratory. The mission of UC-Light is to enable wireless communications by embedding signals into the light emitted by next-generation LEDs in systems for illumination, traffic control, advertising, and other purposes.

UC-Light conducts cross-campus interdisciplinary research to develop next-generation LED-based visible light communications (VLC) and positioning/navigation (VLP) technologies and systems, with three research thrusts pertinent to LED lighting – efficient lighting, communication, and navigation.

FUTURE OUTLOOK

LEDs will replace conventional bulbs as energy-efficient and sustainable lighting sources. Simultaneously, LEDs can be modulated to transmit optical wireless signals at beyond giga-bit-per-second (Gbps) speed. Interfacing with wired networks (Ethernet, power-line or fiber), LED-based VLC technology will enable next-generation ubiquitous wireless networking to eventually realize the dream of *communicate as you see*. VLC will allow wireless communications in RF-prohibited environments, facilitating smart hospitals and smart-and-connected health. Further, LED-based VLP technology will lead to revolutionary indoor and outdoor navigation, enabling smart city, smart traffics control and smart environment.

UCR CENTER FOR RESEARCH AND EDUCATION IN CYBER SECURITY AND PRIVACY (CRESP)

AT-A-GLANCE

CRESP is an interdisciplinary center conducting cutting-edge research in cybersecurity and data privacy. As cyber systems are becoming increasingly complex, security and privacy problems are more and more pervasive. They can appear in all parts and layers of our cyber systems, from servers to mobile and IoT devices, from hardware to operating system and applications.

FUTURE OUTLOOK

Due to the complexity of the problems, no single method, technique, approach and discipline can address them entirely. It means that experts from different fields (e.g., computer science, computer engineering, data science, mathematics, public policy, psychology, etc.) must work together to gain better understanding of individual problems and come up with comprehensive solutions.

There is often a gap between theory and practice. Vulnerabilities are often found in the system implementation and users, but not in design. A system with a perfect formal proof can still be broken, due to unrealistic assumptions and abstractions of the real world. It requires our academic researchers to work more closely with industrial and operational experts. Therefore, our strategic plan is to develop innovative and disruptive technologies for addressing long-standing and emerging security and privacy problems, as well as train our next-generation workforce, by bringing together academic researchers (from multiple departments and colleges) and establishing close industrial partnership.

WINSTON CHUNG GLOBAL ENERGY CENTER (WCGEC)

AT-A-GLANCE

WCGEC is a multidisciplinary research center focusing on the broad area of energy and sustainability. In addition to the center, SIGI demonstrates “smart integration” of battery technologies, renewable energy, and advanced dispatch controls through applied research and field implementations at UCR.

Center Overview:	**Facts & Stats:**
- Established in 2011 by a $10 million donation by Winston Chung, a Chinese battery technology scientist, inventor, and entrepreneur - $5 million in additional funding helped establish the Sustainable Integrated Grid Initiative (SIGI) - $1.2 million gift used to develop next-generation battery technologies	- Led by a center director and an associate director - Two professional researchers and one research engineer - 24 faculty affiliations across BCOE and CNAS - Supported by one administrative officer - Approximately $7 million in extramural awards

FUTURE OUTLOOK

WCGEC’s key interdisciplinary research themes and focus areas of growth are as follows:

- *Area 1: Energy Devices and Materials:* Developing and enhancing energy materials and energy devices, with applications to scalable batteries, fuel cells, solar cells, solar thermal, super capacitors.
- *Area 2: Energy and Power Systems:* Developing and testing new methodologies and new applications in power systems and smart grid.

WCGEC's long-term strategic goals include:

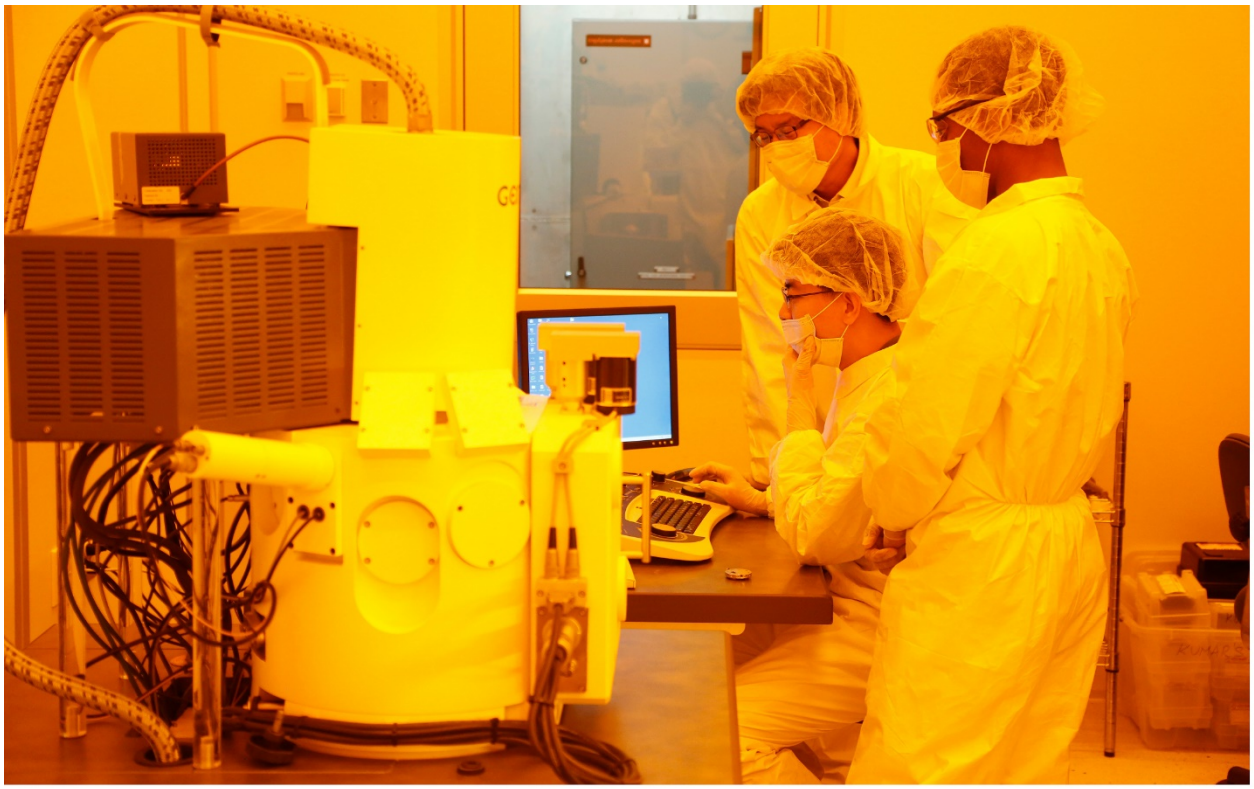
- Continue to grow in fundamental and applied research in both areas; and bridge the gap between industry and academia to address energy generation, storage, distribution, and utilization needs and challenges;
- Become a nationally recognized Center in the broad area of energy; with a research profile comparable with that of a National Science Foundation (NSF) Engineering Research Center (ERC);
- Expand the research agenda to include other areas of renewable power research, including green hydrogen technologies;
- At both the undergraduate and graduate levels, contribute to UCR's overall excellence in education, including instruction, student mentoring, and conducting outreach activities;
- Grow gradually and expand focus areas to cover all the key areas in the field of energy; in order to create the critical mass for UCR to be recognized as a leader in energy research.

Specific growth activities in 2020-25 include, but are not limited to:

- Enhance the research portfolio in energy storage technologies and applications;
- Expand collaborations with the BCOE departments to fund and supervise graduate students;
- Follow and track emerging funding opportunities (e.g., smart grid funds, cyber-physical and interconnected systems opportunities, renewable energy related funds, energy storage opportunities, research, demonstration and deployment (RandDandD) funding opportunities, etc.) and present our research, fact sheets, and policy briefs to appropriate venues;
- Submit proposals to large center-scale federal and state programs, in particular, the NSF Engineering Research Center (ERC) program;
- Expand involvement with the MSOL program to develop an online master's degree in energy, covering a multi-disciplinary curriculum across both energy systems and energy materials and devices. WCGEC is also well-positioned to offer topic-specific certificate or short courses on energy, designed for professional audience, in topics such as energy storage, renewable energy, power grid cybersecurity, etc. This can be done in partnership with University Extension.

In order for WCGEC to expand in our strategic research areas, we have identified potential positions that are needed in our different research areas and groups:

- One senior Academic Senate faculty member to *uniquely fill the gap* between systems and materials, through partnership with ME, ECE, CEE, and/ or MSE;
- One junior or senior ladder-ranked faculty in the area of *energy storage modeling and operation*, through partnership with ECE, CS, or ME;
- One research-track or ladder-ranked faculty in the area *storage-plus,* i.e., the hybrid systems including energy storage and renewables, EVs, distribution energy resources, or expertise on energy storage applications in building energy management and utilization;
- One research-track or ladder-ranked faculty in the area of *large-scale storage*, to develop and deploy GWh and power-plant-scale storage;
- One research-track or ladder-ranked faculty with expertise on energy storage materials *beyond lithium* and *beyond batteries*.



USER FACILITIES

The user facilities are an essential part of any research-intensive university. BCOE faculty supervise, maintain and develop a number of core user facilities important for the entire campus. Some of the facilities and their development plans are outlined below.

UCR BIOENGINEERING BIOSAFETY LEVEL II FACILITY

The biosafety level II facility in the Department of Bioengineering consists of BCOE's Microbial Facility and Mammalian Cell Culture Facility (665 square feet). BCOE faculty have access to these facilities for their research. Mammalian Cell Culture Facility maintains the following research infrastructure: culture rooms for growing and experimenting with mammalian cells; biosafety cabinets and CO_2 incubators; -20ºC freezers and 4ºC refrigerators; autoclaves.

UCR NANOFABRICATION FACILITY (NANOFAB)

The NanoFab originated as the Center for Nanoscale Science and Engineering but has refined its mission to support research and training as a core facility. NanoFab's mission is to provide the following services:

- Enable world-class research and student training in all areas of nanotechnology;
- Foster interdisciplinary research and cooperation among scientists and engineers;
- Provide a state-of-the-art environment for students, postdocs and professors;
- Ensure the highest academic standards, integrity, equality and diversity;
- Maintain the highest level of safety for the users;
- Serve as the facilitator for developing proposals for externally funded research centers and multi-PI projects;
- Facilitate cooperation with the high-tech industry in the Inland Empire and California.

In addition to providing nanofabrication capabilities, NanoFab aims to facilitate the pursuit of research and education in interdisciplinary fields, and foster cooperation among BCOE, CNAS, SOM, and industry. NanoFab is an essential ingredient for UCR's strategic plan to become more competitive in obtaining federal, state, and private funding. NanoFab advances the UCR objectives of increasing research and educational visibility, improving academic rankings, and growing federal research funding, particularly in multi-PI and center-type proposals. A functional nanofabrication cleanroom facility is a must have for any research-intensive university. The cleanroom training is required for many graduating Ph.D. and M.S. students' employment. It is a major positive factor for B.S. students as well. Providing such is an educational part of the NanoFab mission. The strategic goal of NanoFab is to relocate the operation of the research cleanroom to the MSE building without service interruption, upgrade all essential equipment to provide better services to the campus community, and expand the external users' base.

The NanoFab operates two cleanrooms designed and built to enhance the research capabilities of a diverse set of researchers engaged in multidisciplinary nanotechnology research. The Bourns Hall B Wing nanofabrication research facility is a 2,000-square–foot controlled and monitored space that is fully operational and certified at Class 100 in the Photolithography Bay and Class 1,000 in the Thin Film Etch Bay. The facility is open 24 hours a day and has a staff of three full-time engineers available to users at no charge during normal business hours. The Materials Science and Engineering (MSE) cleanroom is a class 100/1,000 space that occupies 8,000 square feet. Two fully functional MSE cleanroom bays offer a number of etching and metal deposition tools. The NanoFab personnel also operate users' facilities, outside of the cleanroom spaces, which are used for material characterization and device testing.

The NanoFab offers electron beam lithography (EBL) and focused ion beam (FIB) instruments that provide state-of-the-art nanofabrication capabilities. In addition, users have access to the range of fabrication and metrology instruments. The Fabrication Processes equipment and capabilities include: surface preparation; thermal gate oxidation; low-pressure and plasma enhanced chemical vapor deposition (CVD); photolithography and associated wet chemical processing; electron-beam pattern generation; reactive ion etching (RIE); plasma etching; atomic layer deposition (ALD); thermal and electron-beam evaporation (EBE) of various metals and materials; metal and dielectric sputtering; and rapid thermal annealing. The Metrology Capabilities include: oxide metrology for oxide and nitride measurements; atomic force microscopy (AFM); energy dispersive spectroscopy (EDS); electron backscatter diffraction (EBSD); scanning transmission electron microscopy (STEM); thin-film profiling for photo resist and metal layer thickness; C/V stress measurement to ensure gate oxide process integrity; I/V probes for electrical parametric control; digital camera display optical microscopy; optical profilometry for surface inspection

and 3D surface analysis; ellipsometry; and thermal measurement equipment. NanoFab recently acquired a Quantum Design advanced physical property measurement system (PPMS) with the capability of measuring electric AC and DC resistance, Hall effect, I-V, differential resistance (dV/dI), directional thermal conductivity, heat capacity, Seebeck coefficient, and thermoelectric figure of merit with ultra-high sensitivity over a wide range of temperature between 4 K – 400 K under a variable magnetic field with maximum limit of 9 T.

BCOE MACHINE SHOP

The 4,300-square-foot ME Machine Shop houses advanced instrumentation and tooling for the design and development of experimental apparatus and scientific equipment. Advanced manufacturing tools include manual and CNC lathes and mills (e.g., Haas 3-axis CNC mill), CNC plasma cutter, wire EDM, Stratasys 3D printer, Miller TIG welder, Mitsui surface grinder, Mitutoyo optical comparator, and bandsaw. Consistent with the mission of the University, it also provides hands-on training opportunities in modern machining and fabrication. The Shop's capabilities allow students and researchers to develop their projects all the way from initial concepts to working prototypes. The Machine Shop personnel provide support to senior students toward the design of their capstone projects, and it supports student professional organizations, such as the Society of Automotive Engineers (SAE), American Society of Mechanical Engineers (ASME), and Institute of Electrical and Electronics Engineers (IEEE). Finally, the Machine Shop is also a resource for facilitation of corporate partnerships by providing sales and services for internal and external users and a central resource for the "Maker" community.

MSE USER FACILITY

UCR Materials Science and Engineering (MSE) Fee-For-Service (FFS) facility provides access to materials processing and characterization instrumentation in four separate laboratory spaces totaling 2,800 square feet. The facility provides basic and common capabilities to whole research groups such as optical microscopy, spectroscopy, mechanical processing and testing and more advanced capabilities for individual users that include scanning electron microscopy, crystallography, and thermal analysis. The facility is also available for undergraduate and graduate training in multiple BCOE courses.

CENTRAL FACILITY FOR ADVANCED MICROSCOPY AND MICROANALYSIS

The Central Facility for Advanced Microscopy and Microanalysis (CFAMM) is the primary UCR electron microscopy (EM) center. It provides expertise in electron and ion beam techniques to characterize organic and inorganic materials, biological tissue, ceramics and minerals at the atomic scale. The major resources in CFAMM are:

- 2 scanning electron microscopes (SEM): ThermoFisher NNS450 and Tescan Mira3;
- 1 scanning/transmission electron microscope (S/TEM) ThermoFisher S/TEM Titan Themis;
- 1 transmission electron microscope (TEM) ThermoFisher TEM Tecnai12, replaced in the summer of 2020 with state-of-the-art Talos120C TEM;
- 1 dual beam focused ion beam/electron beam FIB/SEM system ThermoFisher FIB/SEM Quanta3D.

Critical for the successful facility operation and consequently for the campus research is the need to keep the CFAMM instrumentation at the cutting edge of the EM technology and support adequate level of qualified research and technical staff.

CENTER FOR ENVIRONMENTAL RESEARCH AND TECHNOLOGY (CE-CERT) FACILITIES

CE-CERT facilities are divided among four categories:

INTELLIGENT TRANSPORTATION SYSTEMS (ITS)

ITS is focused on environmental and energy issues with computing, control, communication, and sensing technology and will continue to transform today's vehicles and transportation systems to improve safety, efficiency, economics, and environmental/energy issues. The ITS laboratories include:

- Eco-driving simulator: The eco-driving simulator models light- and heavy-duty trucks driving on various road conditions, therefore, the drivers are able to experience hands-on driving scenarios observing the output of a vehicle's speed and fuel consumption.
- Portable Positioning and Mapping System: The PPMS mobile platform utilizes an array of integrated GPS and aiding sensor technologies to achieve three-dimensional mapping details down to much smaller

distance calibrations (cm) than with traditional methods. This information is used to provide highly-detailed mapping data to researchers, developers and other stakeholders.
- Modeling Laboratories: A comprehensive modeling methodology to evaluate and quantify energy and emissions impacts of transportation programs.

EMISSIONS FROM NEXT GENERATION ENGINES AND FUELS

The Emissions from Next Generation Engines and Fuels laboratories include:

- Heavy Duty Chassis Laboratory: This high performance 48-inch Electric Chassis Dynamometer has Dual Direct Connected, 300 HP AC Motors individually attached to each roll set. The dynamometer is capable of simulating exacting road load and inertia forces to a vehicle operating over a range of driving conditions.
- Mobile Emissions Laboratory (MEL): Used for certification-type emissions measurements. The lab is housed inside a truck trailer, so it can be connected to a heavy-duty truck cab and collect measurements while going down the road, transported to any facility to measure and certify large stationary engines, or used in conjunction with UCR's or others heavy duty engine or chassis dynamometer.
- Heavy-Duty Engine Laboratory: Designed for a variety of applications including verification of diesel aftertreatment devices, certification of alternative diesel fuels, and fundamental research in diesel emissions and advanced diesel technologies. The facility is recognized by CARB for conducting engine dynamometer testing, and has been the cornerstone of CARB's recent study of biodiesel as part of the Low Carbon Fuel Standard (LCSF).
- Light-Duty Vehicle Laboratory: A state-of-the-art laboratory for measuring exhaust emissions under conditions that are representative of real-world driving conditions.
- Portable Emissions Measurement Systems: Laboratory has a fully 1065 approved gaseous and PM PEMS system for on-road and off-road applications. The PEMS utilizes the AVL M.O.V.E. system for gaseous emission measurements and the AVL 494 system for PM measurements.

NATIONAL ATMOSPHERIC CHAMBER FACILITY

CE-CERT hosts the world's largest and most accurate chamber for conducting air pollution measurements and understanding how smog and cancer-causing particles form in the atmosphere. The laboratory enables the following research activities:

- Study the role of secondary organic aerosol (SOA) formation from various sources such as natural gas, gasoline, and diesel combustion;
- Develop mechanisms for predictions of SOA on particulate matter (PM) formation in the atmosphere and the role in atmospheric warming, cloud condensation and nucleation;
- Study the impact of SOA, brown and black carbon on the formation of aerosol droplets and cloud formation.

CE-CERT is expanding its atmospheric chamber laboratory by creating a national research user facility available for use by U.S. industry, universities, other national laboratories, state and local governments, and the scientific community in general to directly address many of the issues relating to PM, ozone, and atmospheric transformations, modeling, and monitoring. The overall objectives of this effort are to improve protection of human health and welfare; conduct experimentation to improve the foundation for regulatory decision-making, including evaluation and validation; increase awareness of the impacts of air quality on the natural world, including visibility, degradation of property and effects of ecosystems; reduce the uncertainty of the science; and facilitate collaboration with industry, academia, and the regulatory community.

RENEWABLE ENERGY AND SMART GRID RESEARCH FACILITIES

The following laboratories focused on renewable energy and smart grid research include:

- Sustainable Integrated Grid Initiative: A unique integrated renewable energy system, which couple energy generation, storage, smart grid protocols, and electric transportation, allowing researchers to develop improved energy systems for the future.
- Motor Efficiency Lab: The first independent electric motor testing center in California capable of providing unbiased evaluation of motor efficiency at various operating conditions.

PHONON OPTIMIZED ENGINEERED MATERIALS (POEM) CENTER FACILITIES

The POEM Center facility consists of a wet-lab space with the material synthesis, thermal, optical and electrical characterization equipment; low-frequency noise laboratory and micro-Raman-Brillouin laboratory. In addition, the center includes several thermal conductivity measurement setups: Netzsch Nano Flash LFA 447 thermal diffusivity measurement system operating in the temperature range from 80K to 800K; transient planar source “Hot-Disk” TPS-2500 system with the automatic hot-cold bath for temperature control; transient “Hot-Wire” system; Netzsch DSC 214 system operating in the temperature range between 77 K to 873 K for material characterization and heat capacity measurements; MMR Technologies Seebeck-effect measurement system; as well as the equipment for the original Raman optothermal method developed for measuring the thermal conductivity of graphene and 2D materials. Other equipment includes in-house built low-frequency noise measurement system and Lake Shore TTPX probe station for low-temperature measurements (includes PS Turbo pump sys w/DP and six ZN50 probe body mounts). The in-house built low-frequency noise measurement system allows one to study noise in electronic materials and devices in a wide range of temperatures from 4 K to above 600 K. It is located in a separate specially designed laboratory protected from electromagnetic and acoustic vibrations. The optical characterization equipment setups include Renishaw InVia micro-Raman spectrometer operating under visible (488 nm; 633 nm) and ultraviolet (325 nm) laser excitation, Horiba Raman spectrometer with 633 nm excitation and fiber optic input/output. POEM Center is equipped with a home-built micro-Brillouin-Mandelstam spectrometer (μ-BMS), which can probe phonons and magnons with low energies in the range of ~1-900 GHz while an advanced filter for Raman spectrometry allows one to observe phonons and magnons with minimum energies of ~250 GHz. The instrumentation available at POEM enables one to investigate phonons, magnons and other elemental excitations in the entire range from a few GHz to several hundred THz.

WINSTON CHUNG GLOBAL ENERGY CENTER (WCGEC) FACILITIES

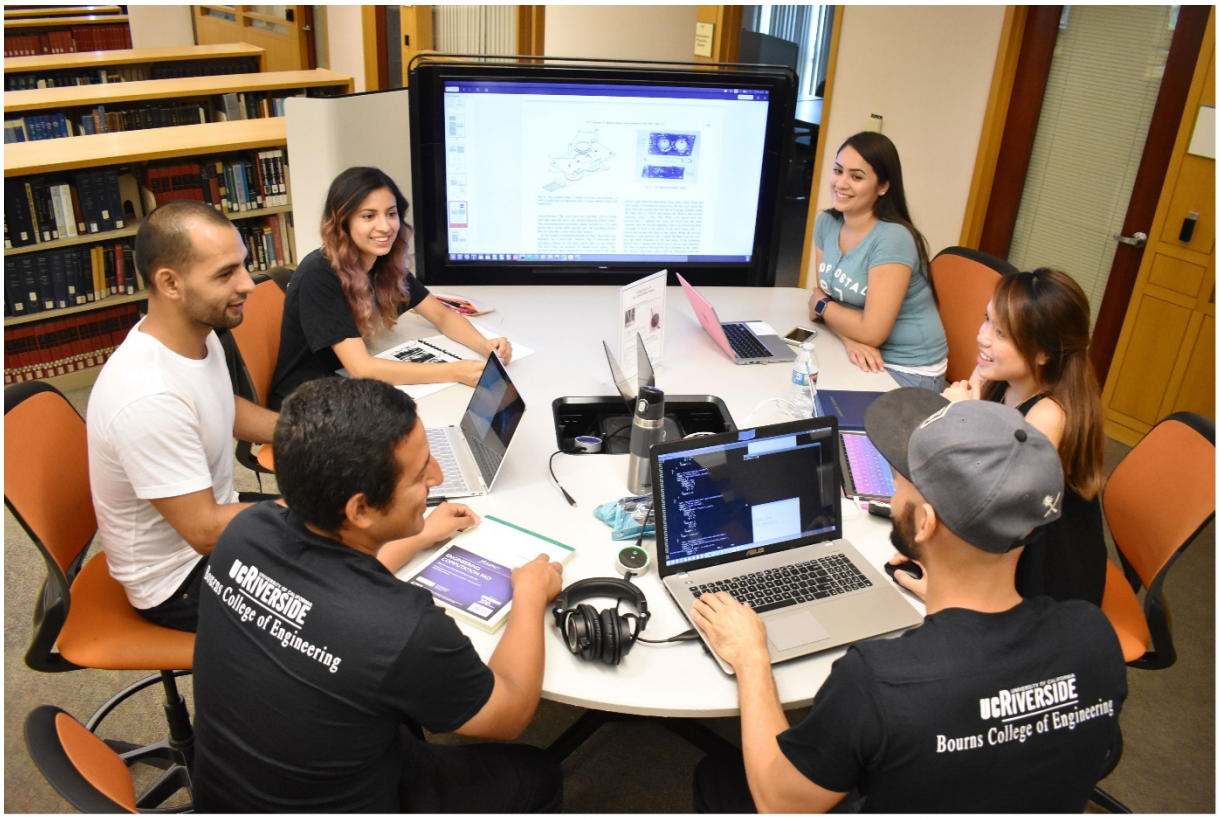
The WCGEC facilities include the following on-campus and off-campus facilities:

BATTERY TESTING FACILITES

The on-campus battery materials and testing shared research laboratories offer internal and external users tools for various material fabrication, characterization, testing, and device integration. For battery research, the facility houses controlled atmosphere glove box workstations equipped with a coin cell press. Two separate battery cyclers (Arbin 40-channel; Neware 48-channel) are also available for performance testing. Material and/or device characterization can be achieved with a multi-modal AFM, Raman Microscope, Custom Hall and Seebeck measurement systems, temperature-controlled probe station, and BioLogic Potentiostat. Other instrumentation includes a wire bonder, custom-electrode screen printer, environmental chamber, filtered light box, and polishing station with low-speed precision sectioning saw.

SUSTAINABLE INTEGRATED GRID INITITIVE (SIGI)

SIGI is comprised of several key features that demonstrate the integration of intermittent renewable energy, energy storage, and the use of electric and hybrid electric vehicles. The on-campus facility consists of two 500 kilowatt-hour batteries, each with its own inverter, battery management system (BMS), and control hardware. Princeton Power Systems bi-directional installed at the Bourns Technology Center, consists of 500 kW of photovoltaic power generation, integrated with energy storage, advanced smart grid monitoring and control systems, and vehicle-to-grid interface capabilities. Both systems allow for monitoring and controlling energy optimization strategies for daily power demand.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ADVANCEMENT

Securing resources necessary for the continued growth of the college and the excellence of its educational offerings and research activities is a strategic priority. Philanthropic support is also a crucially important component of the future facilities and infrastructure required for the modern research-intensive educational institution. As of 2021, BCOE's endowment is approximately $60 million, one of the largest of any academic unit on campus. BCOE has a history of success in raising external philanthropic funds, and has spearheaded major contributions to UCR, including the Ford, Bourns family, and Chung endowments. Over the course of UCR's Living the Promise campaign, BCOE produced more than $55 million in support and is well positioned to be a key partner in the University's upcoming student initiative (see Figure 1).

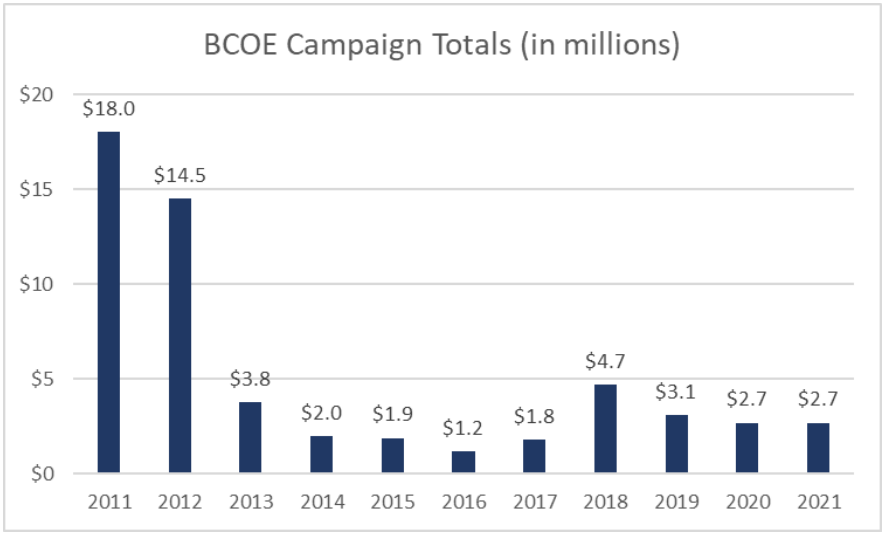

Figure 1: BCOE campaign totals in millions of dollars.

As a relatively young college, increasing the pipeline of donors is important to cultivate the major gift donors of the future. In recent years, a focus on increasing the total number of unique donors to the college resulted in a significant increase from an average of 254 donors per year from 2014 to 2018 to 725 donors in 2021. (See Figure 2).

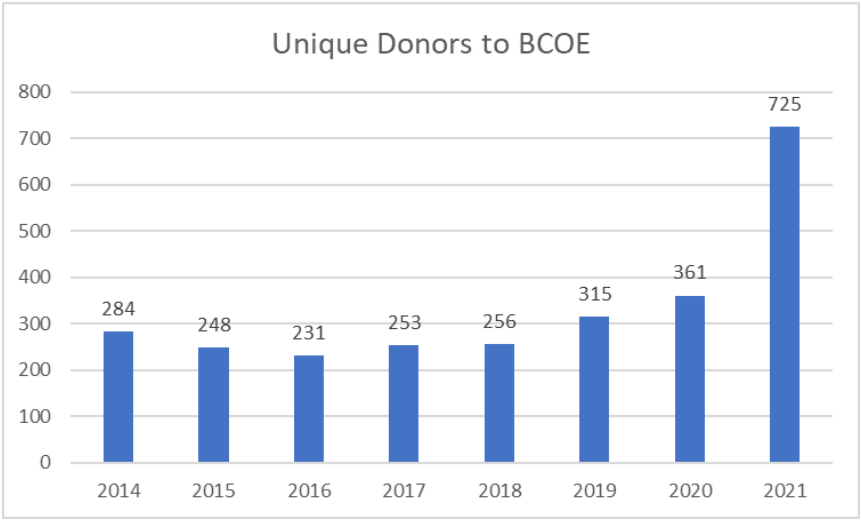

Figure 2: BCOE total number of unique donors each fiscal year.

The strategic focus for BCOE going forward requires a two-pronged approach. Continued growth in the pipeline of donors will better position the college for fundraising opportunities in the future. At the same time, it is vital that the college break away from its current plateau of raising $3 million per year and raise $5 million+ each year going forward. The upcoming student initiative provides ample opportunities for the college to

build upon the successful Dean Innovation Fund Match Challenge. Crowdfunding efforts have been well received by BCOE alumni, students, parents, staff, faculty and friends. Those along with greater outreach to targeted groups will help to drive the number of annual donors. Larger gifts will be secured through working with individuals on current and planned gifts. Greater coordination university-wide on corporate and foundation gifts will also benefit BCOE. The college is also actively promoting opportunities to recognize retiring staff and faculty through gift opportunities. A new retired staff and faculty group has begun to meet quarterly. BCOE parent volunteers are being recruited for a new parent advisory committee that will assist with the college fundraising efforts. An annual donor recognition event will help to reinforce and grow the philanthropic community at BCOE.

Increasing philanthropic support for BCOE will help to provide resources that will enable the College to accomplish its teaching and research goals. Establishing a culture of philanthropy and loyal donors will take thoughtful, and well-coordinated efforts.

BCOE ADVANCEMENT PRIORITIES

In 2020-25, the strategic goals for advancement are to:

- Increase total unique BCOE donors to 1,500+ annually
- Raise $5+M annually for BCOE
- Establish endowed funds to support all active BCOE student professional organizations
- Increase from 14 to 21 endowed chairs
- Conduct a feasibility study for next engineering building
- Successfully complete student success goals and position BCOE for next comprehensive campaign.


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GLOSSARY

AAAS ..... American Association for the Advancement of Science

AAU..... Association of American Universities

ACM ..... Association for Computing Machinery

AIMBE..... American Institute for Medical and Biological Engineering

APS..... American Physical Society

ASEE ..... American Society for Engineering Education

ASME..... American Society of Mechanical Engineers

BCOE..... Bourns College of Engineering

BIC ..... Bioengineering Institute of California

BIEN ..... Department of Bioengineering

BIG..... Bioengineering Interdepartmental Graduate Program

BMES..... Biomedical Engineering Society

CAN ..... Center for Advanced Neuroimaging

CARB..... California Air Resources Board

CE-CERT ..... College of Engineering-Center for Environmental Research and Technology

CE ..... Computer Engineering Program

CEE..... Department of Chemical and Environmental Engineering

CEN ..... Computer Engineering

CEPCEB ..... UCR's Center for Plant Cell Biology

CFAMM..... Central Facility for Advanced Microscopy and Microanalysis

CGS ..... Center for Geospatial Sciences

CHASS ..... College of Humanities, Arts, and Social Sciences

CIB ..... Center for Industrial Biotechnology

CNAS..... College of Natural and Agricultural Sciences

CRESP ..... Center for Research and Education in Cyber Security and Privacy

CRIS ..... Center for Robotics and Intelligent Systems

CS..... Computer Science

CSAMBA..... Center for the Synthesis of Advanced Materials for Biomedical Applications

CSE ..... Department of Computer Science and Engineering

DiSCoveR ..... Data Science Center

DS ..... Data Science

E3 ..... The Energy-Economics-Environment Research Center

ECE ..... Department of Electrical and Computer Engineering

ERC ..... National Science Foundation (NSF) Engineering Research Center

GSR ..... graduate student researcher

HPCC ..... High-Performance Computing Center

IEEE ..... Institute of Electrical and Electronics Engineers

MRS ..... Materials Research Society

ME ..... Department of Mechanical Engineering

MEL ..... Mobile Emissions Laboratory

MRI ..... magnetic resonance imaging

MRPI ..... University of California Multicampus Research Program and Initiatives

MSE ..... Materials Science and Engineering

MSOL ..... On-line Master of Science in Engineering

NanoFab ..... UCR Nanofabrication Facility

OSA ..... The Optical Society

PDEF ..... Provost's Diversity in Engineering Fellowship

POEM Center ..... Phonon Optimized Engineered Materials

PPP ..... public-private-partnerships

RCM ..... Responsibility Centered Management

REU ..... National Science Foundation (NSF) Research Experiences for Undergraduates

SAE ..... Society of Automotive Engineers

SEM ..... scanning electron microscope

SOA ..... secondary organic aerosol

SOM ..... School of Medicine

SPIE ..... International Society for Optics and Photonics

SPP ..... School of Public Policy

STC ..... National Science Foundation (NSF) Science and Technology Center

TEM ..... transmission electron microscope

TPI ..... Technology Pathways Initiative

UC-Light ..... The Center for Ubiquitous Communication by Light

URM ..... underrepresented minority

VERL ..... Vehicle Emissions Research Laboratory

WCGEC ..... Winston Chung Global Energy Center

APPENDIX:

BCOE AT A GLANCE: 2020

Tenure Track Faculty	**128**
NAE Members	1
Fellowships of Professional Societies	76
CAREER/Young Investigator Awards	71 (NSF, DOE, NIH, AFOSR, ARO, DARPA, ONR)
Undergraduate Enrollment	2,864
Undergraduate Diversity	URM: 33%, 1st Gen: 44%, Pell Recipient: 41%. Won ABET's *2009 Claire Felbinger Diversity Award*
Graduate Enrollment	936 (37.5% domestic, 62.5% international)
Graduate Student Diversity	URM: 23.6% of domestic graduate students
Total Research Expenditures	$46.2M (32.6M external, 13.6M internal + subcontracted out)
Total Endowment	$48M
Endowed Professorships	12 (two more under approval)
Departments and Programs	5 departments • Bioengineering • Chemical and Environmental Engineering • Computer Science and Engineering • Electrical and Computer Engineering • Mechanical Engineering 4 interdepartmental and intercollege programs • Materials Science and Engineering (intercollege) • Computer Engineering • Data Science (intercollege) • Robotics
Research Centers	11 research centers • Center for Environmental Research and Technology • Center for Industrial Biotechnology • Center for Robotics and Intelligent Systems • Center for Networked Configurable, Command, Control and Communication for Rapid Situational Awareness (NC4) • Center for Phonon Optimized Engineered Materials • Data Science Center • Winston Chung Global Energy Center • UC LIGHT • Energy, Economics, and Environment (E3) Research Center • Center for Advanced Neuro-engineering • Center for Research and Education in Cybersecurity
Self-Supporting Programs	Master of Science in Engineering Online
Staffing	109 FTE (64 perm, 45 temp)
US News Ranking	47th among public institutions, 80th overall
2010 NRC Rankings	All departments in top quartile

PEER COMPARISONS

COMPARISON WITH OTHER UC CAMPUSES AND OTHER ENGINEERING COLLEGES

While relatively young in the UC system, BCOE's achievements in research and graduate education are impressive. BCOE is a young and rapidly growing college, with over 37% of its ladder-rank faculty untenured as of 2018; its faculty cohort is among the youngest in an AAU comparison group and in the UC system (see Figure 2).

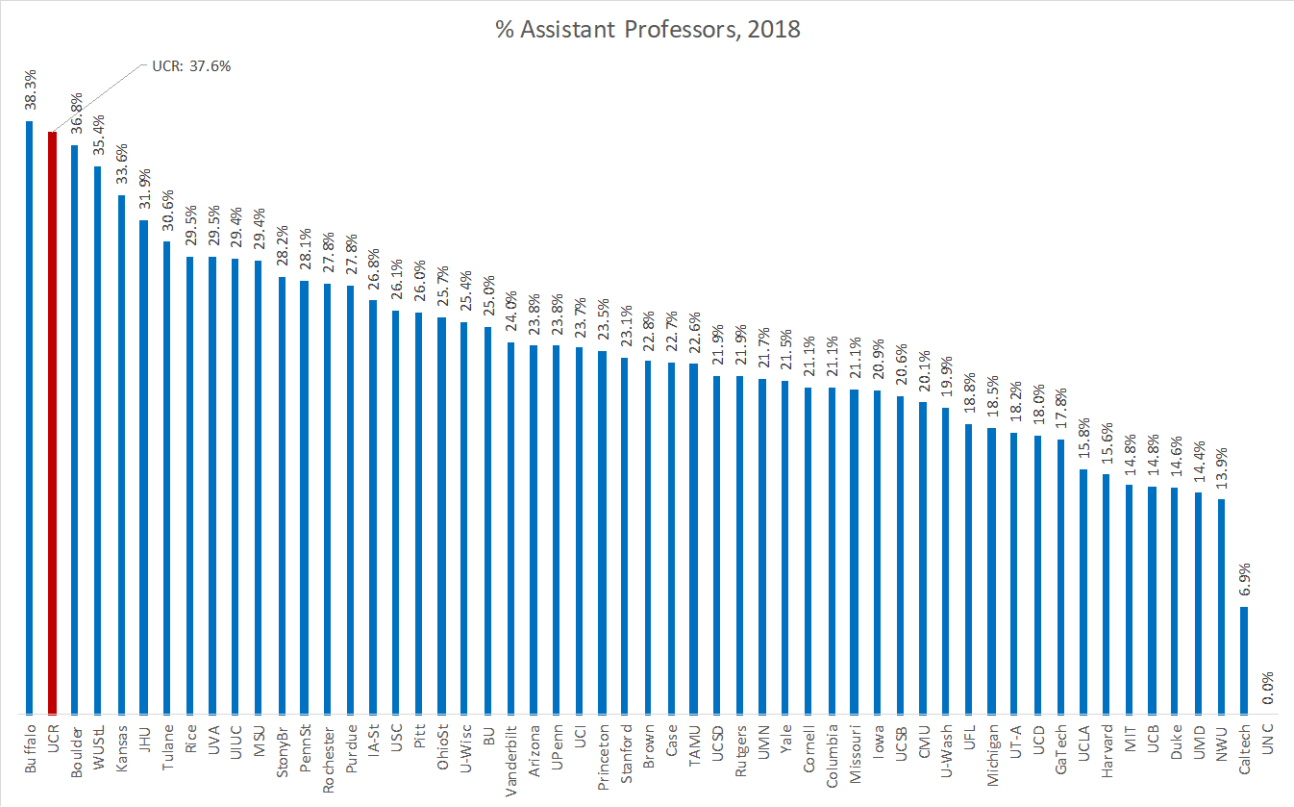

Figure 2: Fraction of untenured ladder-rank faculty.

Given this large fraction of junior faculty, a 5-year trailing average of some of the usual metrics may be a better measure of BCOE's faculty productivity. For instance, a 3-year average of Ph.D.s granted per faculty places BCOE in 6th place among its UC peers, but the same metric places BCOE 4th, behind only UCB, UCLA, and UCSD if we use faculty numbers from 5 years prior to award of Ph.D. Similarly, a 3-year average of Ph.D. enrollment has BCOE in 5th place among UC peers, essentially tied with UCI, and significantly ahead of UCSB and UCD. In fact, BCOE would place in the top 25% of AAU under these metrics. BCOE's research expenditures per faculty are expected to increase as its large fraction of assistant professors progress with their careers. BCOE's research expenditures should increase significantly by 2025, given its strong record of nurturing junior faculty. BCOE's approach to reporting research expenditures strictly follow American Society for Engineering Education (ASEE) guidelines while there seem to be significant discrepancies in the way institutions across the nation compute and report their numbers to ASEE and US News and World Report. There is a need to address this issue in the future to ensure that the numbers reflect the actual quality of BCOE's faculty research.

Despite its extraordinary research and educational achievements, BCOE remains underrecognized among other UC schools in peer ranking. Attention is needed to firm up metrics that impact ranking scores, including recruiter impression of BCOE graduates, and to effectively present BCOE's impressive profile to department chairs and deans nationwide. This outreach will become a major emphasis as it impacts recruitment across the board (undergraduate, graduate, faculty, and staff).

US NEWS RANKINGS COMPARISONS AMONG UC CAMPUSES

Table 1 compares the UC schools in terms of the parameters that comprise the US News ranking. The score for each parameter represents its relative position among the top 103 schools ranked. The single biggest factor influencing BCOE's US News ranking is the low peer and recruiter assessment scores, which account for 40% of the US News ranking. This is an issue that needs to be quickly addressed through an outreach campaign that specifically targets peers and recruiters. BCOE's graduate admissions process appears less selective in recent years because of the need to grow our M.S. program, driven by the need for external revenue. The lower numbers for total research expenditures are a function of the smaller size of our college, as well as likely discrepancies between the manner in which these numbers are reported by different institutions. BCOE does relatively well in other metrics used by US News. A very similar trend is evident in the US News rankings of programs, which are based entirely on perception. Table 2 compares the US News rankings for each of our programs with the rankings for our UC peers. The numbers in parentheses show the USN rank, the peer ranking raw score, and for UCR, the percentile ranking in each field.

BCOE has an enormous opportunity to raise its rankings, since peer perception seriously lags the reality of the productivity of our programs and faculty. For instance, Computer Science is ranked 61 in the US News rankings table below. (This ranking is from 2018. CS is ranked with the Sciences, for which no rankings have been published since 2018). However, we can contrast this with a more objective assessment of research productivity through csrankings.org, which provides rankings updated in "real-time" based on tracking publications in the leading venues in CS. This website ranks our CS activity 37 in the nation as of 2020. If we look only at the "core" area of systems (which includes architecture, networks, security, databases, design automation, embedded systems, high-performance computing, mobile computing, operating systems, performance analysis, programming languages, and software engineering), our CS activity's rank rises to 16 in the nation, ahead of such schools as UCLA, UT-Austin, U-Penn, Princeton, UCI, UCSB, UCSC, Harvard, Yale, UCD, and UCI). There is little doubt that there is ample opportunity to bring peer perception more in line with the reality of the quality of our programs. In another example, in 2018, UCR received an exceptionally high ranking – 28th in the world – in the "Materials Science and Engineering" category by the respected Shanghai Subject Ranking. For comparison, California Institute of Technology was ranked 23rd, the University of Tokyo ranked at 27th, and the University of Wisconsin – Madison ranked at 29th. The Shanghai Subject Ranking is mostly compiled based on the number of citations received by the papers published by researchers of a given university, in a given research area. Strategically, a stronger emphasis on the data-driven rankings can benefit the BCOE perception by the peers.

Table 1: US News and World Report rankings for the UC colleges of engineering. Each score is the relative rank of the college among its national peers.

USN Rank	Inst.	Relative Rank for Metric Among Top 103 USNWR Colleges									
		Ranking by peers (25% wt.)	Recruiter rankings (15% wt.)	Acceptance rate (3.25% wt.)	GRE-Q (6.75% wt.)	Ph.D. students per TTF (7.5% wt.)	NAE Members (7.5% wt.)	Total research exp. (15% wt.)	Res. exp. per TTF (10% wt.)	Ph.Ds. granted (6.25% wt.)	Graduate enrollment (0% wt.)
3	UCB	3	4	11	9	5	5	7	11	9	22
9	UCSD	13	22	30	9	3	7	12	9	13	14
16	UCLA	13	22	24	9	2	3	36	31	22	27
27	UCSB	29	34	11	31	33	14	33	15	56	76
33	UCD	29	34	34	45	31	29	37	38	37	53
36	UCI	33	57	22	31	33	36	34	42	29	39
80	**UCR**	**81**	**101**	**62**	**31**	**31**	**74**	**84**	**77**	**48**	**73**
83	UCSC	88	97	38	45	56	70	80	63	83	86

Table 2: US News and World Report rankings of individual engineering programs in UC colleges of engineering. The numbers in parentheses are the rank, the raw score, and for UCR, the percentile rank nationally.

Bioengineering	Chemical Engr.	Computer Engr.	Computer Science	Electrical Engr.	Env. Engr.	Mech. Engr.	Materials Engr.
UCB (4, 4.4)	UCB (2, 4.7)	UCB (2, 4.8)	UCB (1, 5)	UCB (1, 4.9)	UCB (1, 4.5)	UCB (3, 4.6)	UCB (2, 4.7)
UCSD (4, 4.4)	UCSB (8, 4.2)	UCSD (14, 3.9)	UCLA (13, 4.1)	UCLA (13, 4.2)	UCD (9, 3.7)	UCLA (14, 3.8)	UCSB (4, 4.5)
UCD (24, 3.6)	UCLA (23, 3.3)	UCD (36, 3.3)	UCSD (16, 4)	UCSD (14, 4.0)	UCI (35, 3.0)	UCSD (17, 3.7)	UCLA (23, 3.3)
UCI (30, 3.4)	UCD (31, 3.1)	UCI (36, 3.3)	UCI (30, 3.4)	UCSB (22, 3.8)	**UCR (59, 2.4, top 61%)**	UCSB (28, 3.4)	UCD (31, 3.1)
UCLA (30, 3.4)	UCI (47, 2.7)	**UCR (52, 2.8, top 34%)**	UCD (37, 3.3)	UCD (39, 3.3)	UCM (84, 1.9)	UCD (34, 3.3)	UCI (36, 2.9)
UCR (80, 2.4, top 61%)	**UCR (53, 2.6, top 43%)**	UCSC (52, 2.8)	UCSB (37, 3.3)	UCI (50, 3.1)		UCI (40, 3.1)	**UCR (62, 2.4, top 56%)**
UCSC (93, 2.2)	UCSD (53, 2.6)		UCSC (35, 2.8)	**UCR (68, 2.8, top 37%)**		**UCR (81, 2.4, top 46%)**	
			UCR (61, 2.7, top 32%)	UCSC (82, 2.6)			

COMPARISONS WITH AAU COLLEGES OF ENGINEERING

BCOE does quite well when compared both with AAU averages as well as the metrics for the top 20 colleges of engineering in the 2021 US News rankings. The number of faculty is significantly smaller than the comparison groups, but BCOE matches them in all metrics except M.S. enrollments per faculty member. BCOE's efforts to increase the M.S. enrollments have been effective. The ratio of M.S. students per faculty member stood at 3.1 in fall 2019.

Table 3: BCOE compared with averages for AAU and the top 20 colleges in the 2021 USNWR rankings. The ratios correspond to data from 2018.

	AAU	US News Top 20 (in 2021)	BCOE
TT Faculty	193	270	125
B.S. per TTF	18.36	17.03	19.5
M.S. per TTF	3.68	4.62	1.67
Ph.D. per TTF	4.23	4.81	4.28

SOCIAL MOBILITY COMPARISONS

BCOE does exceptionally well both in diversity as well as mobility at the undergraduate level. Figure 4 shows the level of UG diversity as well as the average starting salaries for B.S. graduates for UCR and the next seven public institutions with the highest UG diversity. Using starting salaries as a proxy for social mobility, UCR clearly does exceptionally well. Salaries for UCR graduates match the salaries for this comparison group, but this benefit extends to the larger fraction of URMs in its UG population.

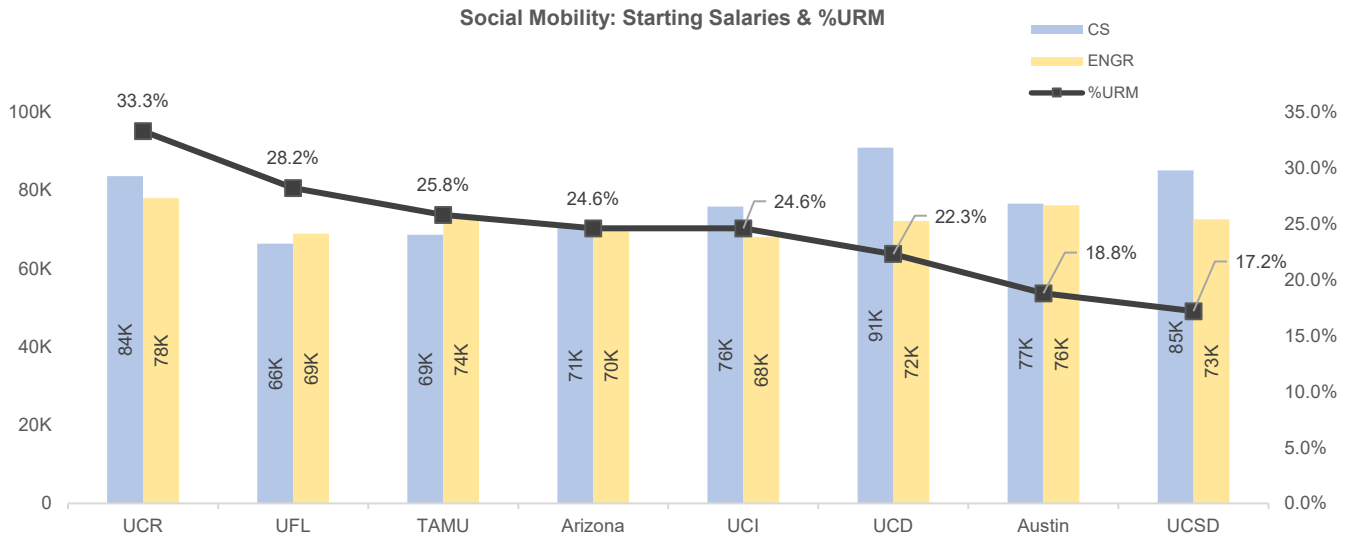

Figure 3: Starting salaries and percentages of underrepresented minorities in public institutions as an index of contribution to social mobility.

SWOT ANALYSIS

Strengths

- Part of the prominent University of California (UC) system
- Proximity to new California Air Resources Board (CARB) headquarters
- Centrally located in Southern California
- Regionally affordable location compared to other UC schools
- Highly successful early-career faculty, among top schools for active NSF CAREER awardees
- Home to reputable, federally-funded research centers (ERC, DoD COE, CE-CERT)
- No. 1 for the second consecutive year for social mobility among graduating students
- Educating and graduating high rates of first generation, low-income, and underrepresented students
- Recognized as a Hispanic-Serving Institution (HSI)
- Recognized as an ASEE Diversity Recognition Program Member (BCOE)
- Healthy graduate student population compared to undergraduate student populate
- Support from local and regional representatives
- High demand for engineers across multiple disciplines and industries
- Sizable footprint for infrastructure growth

Weaknesses

- Considered mid-level among other UC campuses
- Not located in a well-known industry hub such as Los Angeles or Silicon Valley
- Young by comparison to peer institutions
- Alumni base is not yet matured
- Highly competitive region for engineering education institutions
- Low staffing levels compared to other UC campuses
- Barriers to achieving a high research profile, such as attracting primarily early-career faculty
- Lower annual research expenditures than peers engineering colleges
- Few National Academy of Engineering members
- Low faculty retention rates due to highly successful early-career faculty who are recruited to other campuses
- Low retention rates for staff as they are poached by other UCR units and institutions
- Lack of regional, national and international awareness of UCR's presence and impact
- Limited effective pipeline programs with local and regional school districts
- Lack of diverse faculty members across ranks that matches the diverse student population
- Low peer and recruiter assessment scores for U.S. News & World Report rankings

Opportunities

- Increase revenue generation through non-resident tuition student enrollment
- Expand online offerings to increase enrollment
- Create in-person and/or online technical tracks for M.S. degrees
- Offer certification degrees
- Develop an industry hub (OASIS)
- Increase industry partnerships through the development of consortiums and co-ops
- Engage parent audiences to generate individual and industry support
- Increase student diversity by establishing pipeline programs with HBCUs
- Increase of federal and state investment in research funding related to engineering
- Strategic investment in hiring new faculty to promote growth in high impact areas
- Enhance operational efficiency through strategic staff hiring
- Support and promote existing user facilities to generate revenue
- Refine budget model to incentivize growth

Threats

- Increased interest in alternative education models (virtual learning, trade schools, certification programs)
- Budget cuts/restrictions from state/federal funds
- Complications of international issuance of visas
- Divestment in STEM research and education
- Mistrust of higher education institutions (Varsity Blues Scandal)
- Increased tuition costs
- Perceptions of increased international student populations
- Competitive market internationally for U.S. education
- Perceptions (negative or lack thereof) of UC Riverside campus
- Budget model that disincentivizes growth
- Unstable economic market impacting enrollment and student outcomes
- Negative coverage of higher education, UC Riverside, engineering, etc.
- Perception of safety (campus/community/ national) related to racism, police brutality, etc.