Executive Summary

The Electrical Engineering Graduate Program Review Committee (GPRC) consisting of Professors Petros Ioannou from University of Southern California, Charles Tu from University of California San Diego and Sharon Hu from University of Notre Dame, visited the University of California Riverside on December 8, 9 of 2016. The GPRC had meetings with various University administrators (graduate council, Department chairs, Graduate Dean, College of Engineering Dean, Provost, etc.), faculty and graduate students and toured several laboratories.

The overall impression is that the Electrical and Computer Engineering (ECE) Department has strong faculty with PhDs from some of the best universities in the country who are involved in high quality research and attract high quality PhD students. The Department is affiliated with several research centers, most of them directed by faculty from the Department, which add quality to research and provide more visibility in the scientific community. The Department is still on the expansion mode in terms of faculty hiring as its size is small relative to other Departments in the State of California. The PhD students appear to be of high quality and most of them indicate that they are happy with their choice to come to UCR and ECE Department. The Department and College provide good research support by guaranteeing student support for the first two years of the PhD program and providing attractive start up packages (which include reduced teaching load and summer support) to new faculty giving them the chance to build their research program. The GPRC finds this support generous and very helpful for the Department to rise in research.

Some of the urgent problems that are stated by faculty and students includes the lack of adequate space which hinders further faculty hiring. Another issue is the limited number of courses to take which is due to two factors. First, the number of faculty is relatively small to offer a wider range of graduate courses with desired frequency. Second, in some classes especially in the area of Computer Engineering where some courses are offered by Computer Science, the courses cannot accommodate ECE students due to inadequate classroom space. It appears that the central problem to these issues is the office and classroom space problem. The GPRC was told that the College and University are aware of the problem and they are working on finding solutions.

Another problem that came up is that of cluster hiring and the way it was done. This appears to be the most serious problem of concern and the reason that the Department cannot maintain a 5-year strategic plan. The GPRC recommends that this problem be addressed by the higher administration.

Overall the graduate program of the ECE Department is very strong and growing. It has achieved a lot of visibility and recognition over the years despite its young age, and it has a lot of room to grow. The problems identified are solvable. The higher administration is aware of the problems and is working in finding solutions. Hopefully with the hiring of a permanent Dean there is a strong opportunity to address these problems faster and more effectively.
1. Introduction

The graduate program in Electrical Engineering was established in 1998 and since then has been growing in a rather rapid pace. The faculty grew from 7 in 1997 to 22 in 2008 (last Review) and to 29 in 2016. In parallel, the number of graduate students also grew. This growth puts a lot of pressure on facilities and space (faculty and student offices as well as laboratory space) which faculty and students saw shrinking over time. On the positive side, with this growth the Department became very visible in the scientific community which helped attract young faculty from top universities as well as graduate students. The problems faced by the Department are more or less not unique to UCR, and the review committee addresses them in the sections below.

2. Strengths of the Graduate Program

The Graduate program is the 2nd largest program in the University with good support from the College of Engineering. The graduate program is organized in three major areas:

- Signals, Systems and Machine Intelligence
- Computer Engineering
- Nano Materials, Devices, and Circuits

All three areas are very important in Engineering with considerable room for growth. The graduate program is affiliated with a number of research centers that include

- CRIS – Center for Research in Intelligent Systems, Director: Bir Bhanu
- CE-CERT – Center for Environmental Research & Technology: Director: Matt Barth
- UC-Light – Ubiquitous Communication by Light, Director: Albert Wang
- POEM – Phonon Optimized Engineering Materials, Director: Alex Balandin
- CNSE – Center for Nanoscience and Engineering, Interim Director: Alex Balandin

All of the directors are ECE faculty members. The centers provide strength and visibility to the graduate programs of the Department. Some of these centers gain a lot of visibility and, according to some students, was one of the reasons that they decided to come to UCR.

2.1 Research Areas

The main research areas of the graduate program are:

a) Signals, Systems, and Machine Intelligence which include the following sub-areas

- Communications and Signal Processing (4 faculty),
- Control and Robotics (5 faculty)
- Intelligent Systems (4 faculty)
- Power and Energy Systems (2 faculty)

b) Computer Engineering and VLSI (7 faculty)
c) Nano-materials and Devices (7 faculty)
The research areas cover most of the important areas in Electrical Engineering. The Computer Engineering area is rather small in comparison because of the overlap with Computer Science. All areas have a lot of room for expansion relative to other Electrical Engineering Departments. Important areas such as robotics, power and energy as well as computer engineering and nano materials have a lot of growth potential in addition to the other areas.

2.2 Faculty Research

At the time of the last external review in 2008, the ECE Department had 12 full professors, 5 associate professors, and 5 assistant professors (22 FTE). The department has grown since then; now it has 17 full professors, 4 associate professors, and 9 assistant professors (28.6 FTE). About one third of the faculty members are fellows of the IEEE and other professional societies, and about one half have received NSF CAREER Awards or ONR Young Investigator Awards. Three faculty members have also been elected president of their IEEE professional societies. All of these indicate the successful recruitment of faculty members, especially at the junior level, and the high quality of the faculty.

Senior faculty are very helpful, generous and have an informal mentoring system in helping new young faculty. In general there is a good collaboration within the Department. The faculty are collegial and supportive of each other. There are collaborations within the department as well as with CSE and other departments and research centers.

Despite the recent growth, the Department is relatively small in comparison to other schools such as UC Irvine and UC Santa Barbara. Possible core areas of expansion are robotics, power and energy systems and nanomaterials. Bioengineering (cluster hiring) is another area that the Department may consider expanding due to existing strengths in electronics and nanodevices.

Overall, the faculty is doing very well with respect to research in terms of publications, research funding and PhD students.

2.3 Faculty Teaching

The teaching load is reasonable and within the norm of most universities with emphasis on research. The committee recommends maintaining this load together with other research supportive measures for the success of the graduate program.

2.4 Research Facilities

The research laboratories visited appeared to be spacious and used for multiple purposes including student offices in addition to equipment. Large spaces are used for multiple purposes due to lack of space. Students complained about noise due to equipment noise but also for having many people sharing the same large room. Perhaps remodeling and some reorganization of space could easily address this problem. The various labs visited appeared to have adequate equipment for research; the Nano-Device Laboratory has some unique equipment.
2.5 Research Centers

The Department is closely affiliated with the following research centers whose faculty are directing them. [Comment: this is repeating what’s a couple of pages ago.]

- CRIS – Center for Research in Intelligent Systems, Director: Bir Bhanu
- CE-CERT – Center for Environmental Res. & Tech., Director: Matt Barth
- UC-Light – Ubiquitous Communication by Light, Director: Albert Wang
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All of the directors are ECE faculty members. These centers are multidisciplinary and form a good vehicle to bring researchers together from different areas across the University. The centers provide strength and visibility to the graduate programs of the Department. Some of these centers gain a lot of visibility and, according to some students, was one of the reasons that they decided to come to UCR.

2.6 Graduate Students

The Department attracts relatively good quality graduate students. Several of them stated that the main reason they came to UCR and ECE is because of the advisor. This indicates the visibility and good reputation of faculty in the Department. The main problems the students expressed as having were office space and finding courses relevant to their field of study to take. With respect to space the committee noticed very large rooms where equipment and experiments were housed together with student offices. One student indicated that he shares a big room with another 16 students and it is often noisy and difficult to concentrate. Another student indicated that certain experiments are noisy and disturb other students in the same room.

With respect to finding courses to take the reason is that the number of faculty is relatively small to offer many more courses. The collaboration with CS helps a lot with respect to courses in the area of computer engineering; however, some of the courses are closed to ECE students as they are filled with CS students. The CS students have first priority since some of these courses are required for them.

With respect to space the College as well as the University are aware of the problem and are currently studying various solutions. As the Department grows in number of faculty, more courses will be offered, which will solve the problem of finding courses to take.

2.7 Graduate school support

The Department guarantees financial support to PhD students for the first 2 years of their study. This is a significant contribution to the research program and enables faculty to research areas not currently funded.
3. Challenges and Opportunities within the Department

The University is poised to increase its faculty size by 300 in 5 years, about 100 of which is for the new School of Medicine and 200 for the general campus. It is expected that about 20%, or 40, will be in the Bourns College of Engineering (BCOE). ECE will probably get about 8 FTE. With possible retirements, EE can expect to hire 2 FTE per year for the next 5 years. Therefore, the ECE Department will have another opportunity to reach its stated vision, but it will also face several challenges.

3.1 Faculty Recruitment and Retention

3.1.1 Faculty Recruitment

The EE Department has successfully recruited 6+ new faculty members in the last 8 years. The junior faculty members have all been quite productive.

The ECE Department has 3 women faculty members, or about 10% of the department, which is about normal in ECE departments in the US. The department has an additional resource to increase faculty diversity. The BCOE has recently obtained a $200,000 grant from the State of California targeting women and underrepresented minority (URM) junior faculty members. In this program, the new hires in these categories will be given a postdoctoral fellowship for one year before rejoining the department. The tenure clock starts only after their postdoctoral period. This program is engineering college-wide, providing additional resource to recruit URM junior faculty members in all engineering departments, including ECE.

The challenge in faculty recruiting is competitions from other schools in Southern California, but given the growth and upward ranking trajectory, appropriate programmatic fit, competitive start-up package, and collegial atmosphere, the ECE Department has an opportunity to become stronger and better recognized.

The other challenge is cluster hiring, which does not allow good departmental planning, because it is meant to encourage interdisciplinary and interdepartmental collaborations. Faculty members from different departments propose a cluster to the dean via their departments, but the selection apparently is not transparent. The ECE Department won some and lost some. The three new hires in the Intelligent Systems cluster all joined ECE, but the new hires of the Nanotechnology cluster chose to join the Physics Department.

3.1.2 Faculty Retention

The challenge to the department is faculty retention, especially the junior faculty. Some of them are well funded and becoming more recognized, and they can be lured away unless they feel recognized and rewarded at UC Riverside, for example, teaching relief and more space from supervising a relatively large group of graduate students, acceleration in faculty ladder, teaching assistant support, special awards, etc.
One issue with all faculty members, as mentioned previously, is space. In particular, there should be a space model, which is transparent and just.

Another way to improve faculty retention is the culture or collegiality of the department. It is recommended to have a faculty retreat once a year to engage all faculty members on various departmental issues. Not only will the issues be discussed more thoughtfully and thoroughly but also the faculty members feel part of a big team.

3.2 Research Focus Areas

Although the department is relatively small, it has critical mass in a few areas. The Nano Materials and Devices area has a good mix of junior and senior faculty members and excellent experimental facilities. The challenge is that it is expensive to maintain these facilities. However, the opportunities are there, especially in biomaterials and devices.

The Signals, Systems, and Machine Intelligence area also has a critical mass, covering from theory to implementation. For the autonomous vehicle project, recruiting someone in the antenna area can expand the capability of the program.

The Power and Energy Systems, increasingly important topics in the era of several different energy sources for the grid, has only two faculty members. Clearly, this area needs to hire more people to achieve critical mass and to meet students’ as well as employers’ needs.

Computer Engineering and VLSI has gone through a difficult start-up phase. The challenge in this area is that the students cannot access most of the impacted Computer Science courses and there is no VLSI graduate course. Meeting this challenge requires additional faculty FTE.

3.3 Research Funding

The average research dollars per faculty is about $311,000, which does not include the awards brought in as Co-PI. It would be better if the latter were included, which would make the dollars per faculty higher and reflect the actual research expenditure.

3.4 Teaching

3.4.1 Teaching Load

The teaching load is currently 4 courses in 3 quarters. It can be reduced for course buyouts, supervision of six or more PhD students, and for certain service roles such as department chair, graduate advisor and undergraduate advisor. Assistant professors also get one course relief. Buying out the first course requires 10% of the salary, and buying out the second course, 15%.

Some faculty members feel that supervising six PhD students is a large jump, which is difficult and applicable to only a few faculty members. To make this process more equitable, it is recommended that
counting advising credits in terms of student quarters, similar to what’s done at UC Berkeley, be implemented. Arranging a series of colloquium talks can be considered a partial teaching credit, too.

Teaching relief from service should apply to junior faculty as well, even though they already receive one-course relief. The key is to have a just and transparent process in place.

3.4.2 Pedagogy

As new faculty members had no teaching experience, except maybe as a TA, it would be good to have a teaching workshop for the faculty and graduate students who would be a TA. The topics would cover the best teaching techniques as well as the teaching technologies used at UC Riverside, in particular, the iLearn system. The workshop will ease the anxiety and stress of first-time instructors.

3.5 Student Recruitment

The quality of the students seems quite good. Many of the students the Committee met joined the department to work with a particular advisor; they learned of the professor’s name while doing research on term papers. Most of the students are articulate and confident in obtaining employment after graduation because their seniors had no problems finding a job.

Moreover, UC Riverside has a Graduate Preparation Program with about 10 Chinese universities, in which Chinese undergraduates study at UC Riverside through the Extension. Many of them are in ECE and some of them stay on to become graduate students. This program is an opportunity for the department as it also provides a good return to the department, which gets $15,000 out of the $25,000 tuition fee per student. Currently there are 25 students in this program.

The first challenge in student recruitment is in (1) recruiting domestic US students. It is recommended to hold an open house in February or March, inviting (and paying for) domestic students who have been admitted to the graduate program. Many schools have such open house, and the yield is reportedly higher. If the number of domestic applicants or admits is too small, invite 4 or 5 prospective students at a time for a visit before their acceptance decisions.

With the new funding model for MS students, which gives more to the department from non-resident tuition (NRT), the MS student population is expected to increase. This is an opportunity for the department as a pipeline for more PhD students and expanding the research programs.

Another pipeline to the graduate programs is the Department’s own undergraduates. The 5-year BS/MS program should be encouraged. It can be a source of domestic students as well as underrepresented minority students, which is good for student diversity.

(2) Marketing the program will become important, such as sending flyers or posters and having the faculty members talk about the program when they give a seminar outside.
In particular, the advertisement should emphasize the excellent and competitive package for PhD students, who get financial support in their first two years of study. The Graduate Division funds the first year, and the department the second year.

3.6 Finding an Advisor

It is best for the students to have an advisor before their arrival. For those who do not, the department can tentatively match them with junior faculty members and/or implement rotational assignments.

To help new graduate students find an advisor, it is also recommended that a seminar course be created where faculty members, especially those who are looking for students, give a 20-minute introduction to their projects. Their graduate students can give a talk, too, about their research.

One challenge is that students can get stuck with the advisor, and no system is in place for student to resolve the problems between the student and the advisor. The Graduate Division is planning to restructure graduate student evaluation, which will have an individual development plan for each student (stating goals in the beginning and reflections at the end of the year) and mentoring as well. Although the advisor has the primary responsibility, but in some cases a third party, such as the department chair, can be involved. It is also important for the process to be clearly described in a document easily accessible to the students.

3.7 MS and PhD Exams

The MS program has two options for the degree: Thesis Plan or Comprehensive Exam Plan. The students can switch to the Thesis Plan after failing the first attempt of the Comprehensive Exam Plan.

For the PhD degree, the students must pass the Preliminary Exam, which is similar to the Comprehensive Exam for MS students, and then the Oral Qualifying Exam before advancing to candidacy. The final requirement is a PhD thesis and oral defense of the thesis.

These requirements are similar to those at other schools, but the challenge to the students is that the format was changed quite a few times in the last several years. It is quite confusing to students as students in different years have to follow different rules. The department should avoid frequent program changes. Hopefully the last changes for 2015-16 will stay for several years.

3.8 Graduate Courses

As the program grows, more careful planning of graduate level courses is needed. Concerns were raised about the core course requirement. A more streamlined core course model can be developed so that each area has its own clearly defined core courses that are distributed evenly among different quarters.

Students in the CE area seem to have more difficulty satisfying their course requirements, especially with respect to courses offered by the CSE Department. The main reason is the fast increase in CS enrollment resulting in limited seats for ECE students. Some priority system should be worked out so that CE
students get equal access to the required courses offered by CSE. One possibility is to Cross-list CSE and ECE courses in the Computer Engineering area.

Better distribution of course offering is also important. Currently the classes are not well distributed; most of the classes are in the Fall Quarter.

The departmental Colloquium is inspirational even though the topic is not in a student’s field. However, the biography of the speakers is interesting. Therefore, it is recommended the Colloquium invite more industry speakers.

3.9 Online MS program

The Online MS program on Power Systems was started two years ago, and a few ECE faculty members are teaching the courses as an extra load, not part of the regular teaching load. It is in the Bourns College of Engineering, not in the departments; hence, not part of the external review of the graduate program. Nevertheless, it indirectly impacts the department in that it places some burden on the faculty who teach for it and would have less time for research. It is another rationale for more FTE in this area.

The MS students in the online program are counted in the metrics for the college ranking, but not the departmental ranking, in the US News and World Report.

3.10 Miscellaneous Challenges

If there are more students, especially MS students as expected, and more faculty members, the following issues raised by the students during the interviews may not be a long-term problem.

- There is no VLSI graduate course.
- Courses should be offered every year so that the students can satisfy the course requirement more easily; at present some courses are offered every other year.
- It is difficult to get into impacted CS courses. Therefore, combine several CS topics (such as C++, Python, etc.) into one course specifically for EE students.
- More simulation courses would be helpful in fulfilling course requirements.

Overall, GPRC feels that the Department can work on getting grad students more involved with the management process, e.g., conducting periodic surveys on their satisfaction with the program, creating a platform for senior students to share their own research with new students, etc.
4. Challenges and Opportunities at the College and University Level

The GPRC finds that the College and University have provided good support to the Department in the past years, especially in terms of graduate student support and teaching load, which allowed the Department to grow quite impressively. However, there are still quite some challenges at the College and University level. Given the increased state funding, the College and University have some great opportunities to help raise ECE graduate program to the next level.

4.1 Faculty Hiring

BCOE is expected to get 40ish new hires in the next 5 years while approximately ¼ of them are allotted to ECE. To maximize the benefit of this great opportunity, the Department, College and University need to have a common vision and an implementable process.

GPRC has sensed a strong dissatisfaction among faculty and chairs of all Departments regarding the approach taken for cluster hiring which seem to have bypassed Departments and Colleges. It appears that this approach from the higher administration was not appropriate as it created more problems than it aimed to solved.

It seems a better faculty recruitment process is a combination of cluster hiring to strengthen a particular interdisciplinary research area, and targeted hiring to fill certain programmatic needs in research and teaching. Furthermore, the decision making process can be improved by allowing more interactions between faculty, Department chair, COE dean, etc.

4.2 Faculty Incentives

GPRC did not find clear guidelines in terms of grant overhead return. It seems that the overhead is mostly used for startup packages. To help current faculty morale and faculty retention, the University can consider returning a portion of the overhead to the College, Department and individual faculty. The universities where the GPRC members work at have such policies in place.

As a related issue, the incentive model for online courses seems discourage Department support since only individual faculty members who are teaching the courses receive compensation. As more such courses are being offered, the Department will have difficulty balancing the teaching needs of on-campus courses and online courses. GPRC recommends to re-examine the model so that a portion of the earning is returned to the Department level.

The Department can use these returns to hire part-time teaching staff, provide favorable buyout programs, domestic student recruiting, etc.

4.3 Student Placement and industry Contacts

The University has a career office and organises job fairs mainly for undergraduate students. The office provides help with CV preparation and possible contacts to all students; however, for graduate students it
is their direct contacts with potential employers that gain them possible employment opportunities. With
the growing number of graduate students, a number of universities have dedicated graduate career
services. GPRC recommends UCR’s graduate school to look into the possibility of establishing such
services.

The document provided to the GPRC did not have a breakdown of graduate placement data according to
positions. Based on our rough estimate, more than 50% of the graduates go to industry. Career services
addressing the needs of students who aim to go to either industry or academia would be helpful.

The GradSuccess program at the Graduate School is a good effort. However, we found that not many
ECE graduate students are aware of it. More targeted advertisements is needed. This effort can be
coordinated through the Graduate Advisor in the Department.

A few of the graduate students that we talked to expressed interests in establishing startups. Given the
opportunities in the State of CA and the new generation of graduates, including some training modules
and/or seminars on entrepreneurship in the GradSuccess program would be good.

4.4 Research Center Development

The ECE faculty has played active roles in a number of research centers on campus. This should be
continually encouraged. We did not find details on how these centers are managed nor the amount of
support from the College and/or University.

4.5 Space Needs

There is a uniform complaint among faculty and students that the space resources are shrinking at a fast
rate as the Department and University in general grow. There seems no effective near term solution to
resolve this problem. Besides impacting graduate student and faculty offices, an even more serious
problem is the classroom space which has affected course availability for graduate students. We believe
that space limitation may be a major threat to the growth of the Department whose size is relatively small
compared to departments in other universities, and hence hinders its strive to increase visibility and
recognition.

Our tour of the office spaces and walk around the campus seem to suggest that there are spaces available
but may not be well utilized. Perhaps some short term solutions of remodeling existing facilities and use
of prefabricated offices in plenty of empty spaces that exist in the campus may be feasible short term low
cost solutions which are similar to what those other universities follow. It appears that the Dean’s office
and the University is aware of the problem. We recommend that the College and University work together
with the Department to develop both short-term and long-term solutions. Furthermore, the College level
can consider develop an incentive model to match the space needs with the faculty productivity. What is
also important is to have a transparent space allocation policy to eliminate unnecessary misunderstanding.
4.6 Graduate Division Support

The Graduate Division plays an important role in terms of recruiting, admission and general professional development. The Department seems happy with most of the services. However, there are a few areas that improvements are desired.

The student admission process seems to take rather long time. The offer letters often takes weeks to go out after the acceptance decision has been made by the Department. The problem seems to be turnover of the personnel or the leadership team at the Graduate Division. Hopefully this will no longer be an issue. To help the Department recruit the best students possible, the admission process should be made more efficient, especially for domestic students (e.g., setting the goal of two-week turnaround time). International students can take more time and can encourage the Department to make decisions as early as possible.

The process of switching an MS applicant to the PhD program, and vice versa, should be streamlined; currently the applicant has to start a new application process with another application fee. This may be implemented by simply allowing an applicant to select both MS and PhD options.

Given the intense competition for strong applicants, the Graduate Division can consider working with the Department to come up with incentives (e.g., sign-up bonus) to encourage admitted students to accept the offers earlier.

Some students who attended conferences complained that the reimbursement process can take one to two months. This can be too long for a graduate student when the amount is several hundred dollars or more. A more efficient reimbursement process would be helpful. Perhaps also allow students to take cash advance.

We also heard complaints that housing cost has increased faster than the increase in graduate student stipends. This may be due to the housing cost was quite low initially. To help students better understand the financial advantages that they actually enjoy at UCR, it may be publish some comparison data once in while.

4.7 Additional Opportunities

To increase the visibility and recognition of the Department, faculty is encouraged to organize events (e.g., workshops and mini conferences) on the UCR campus. The College and University can provide logistic support to such activities to reduce the overhead that individual faculty members have to pay. Many universities have such support models in place.

5. Conclusions and Recommendations

To summarize, the GPRC was impressed with the progress and achievements that the Department made in less than 20 years. The Department definitely has the potential to realize its vision of being in the top
50 PhD granting programs in the U.S. The faculty is relatively young and very energetic. Many of them have well funded research programs and are well recognized in their own fields.

Besides the detailed recommendations listed in the earlier sections of this report, we would like to emphasize the following. (1) Develop a strategic plan approved by the College and University with measurable metrics. (2) Work out both short-term and long-term solutions to address the space needs. (3) Establish a well thought out hiring process that responds to the strategic plan. (4) Put in more resources in advertising the faculty achievements and the graduate program. All of these will contribute toward increasing the visibility and recognition of the Department and reaching the goal of becoming one of the top 50 PhD programs in the U.S.

As members of the EE GPRC, we valued the opportunity to review the EE graduate program, especially to talk with the inspiring faculty members and graduate students. We hope our report will benefit the continued effort of strengthening the program and will be happy to provide further support if needed.

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