

**Report of the Academic Program Review Team  
for the Department of Computer Science  
at the University of New Mexico**

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**Introduction**

The Review Team was very impressed with the quality of the UNM Computer Science Department, especially given its small size. The quality of the faculty and students is well above the ranking of the department. We observe, however, that there are a number of actions that the University and School of Engineering could take to better support the department and better realize its potential in ranking, funding, and student output. In particular, the Computer Science Department could be better understood and evaluated within the University, undergraduate interested in CS could be better advised, and space for CS needs to be significantly improved. These issues are critical to future retention and recruitment, and to maintain the positive trajectory of the department.

**Department Quality**

The Computer Science Department has stellar faculty comparable to a top 40 or, in some cases, a top 10 department. The faculty have an excellent per capita funding rate of \$192K per faculty member. This is comparable to top 40 departments. The faculty have received numerous awards. For example, Melanie Moses was a Microsoft Faculty Fellowship Finalist in 2008, for which only 11 faculty members were selected nationwide. Almost all of these finalists come from the top 10 schools, most from the top 5 schools. Deepak Kaupr received the Herbrand award, the highest honor in his research specialty. Stephanie Forrest is one of the top-cited CS researchers in the world, with an H-index that places her in the top 200. Additionally, the faculty includes several NSF CAREER award winners and an Intel Fellowship winner. Perhaps even more impressive is the quality of some of the doctoral graduates from the department. One CS alumnus was also a Microsoft Faculty Fellowship Finalist. Another CS Alumnus was hired as a faculty member at the University of Colorado at Boulder, a top 40 department.

While the department has grown significantly in its research emphasis, it has also maintained its strong emphasis on undergraduate education. The Review Team interviewed several undergraduate students and they were all very positive about the program. In-department advising was viewed as excellent. The Review Team interviewed the department's two lecturers and found them to be very energetic and well-integrated into the department. The lecturers appeared very motivated to improve the program and to be involved in department initiatives to improve recruitment and retention of students.

## **CS is Different**

Although the CS department is of high quality, we observe that this relatively new discipline could be better understood in the University and the School of Engineering. Overall, we observe that CS seems to have been at the bottom of the list for resources (eg new space), but seems to be of similar quality and productivity as other departments in the SOE. We hypothesize that priorities appear to be somewhat historical and that new metrics are needed to more accurately evaluate CS value to the University and the SOE.

## **Leadership**

Informed leadership is a critical means of promoting a better understanding of CS and to better leverage the CS department's strengths. University and SOE metrics should be revisited. We understand that there is an ongoing search for a new Dean for the SOE. It is our hope that the new Dean will recognize CS strengths and invest resources to help the department reach its full potential.

We observe that CS could benefit from more targeted development efforts. Development for CS follows a different demographic and a different model than many other engineering disciplines. A short-term (eg 2 years) tasking of a development person to CS needs could yield significant benefits. It also seems to us that CS faculty have had more difficulty receiving internal UNM awards than external awards (note the many external awards above).

CS and ECE faculty have some good research collaborations and these appear to be growing. Often Computer Engineering faculty in ECE departments are a minority and have more common interests with CS than EE (or optics or sensor networks or whatever happens to be a local specialization in ECE). Also, Computer Engineering is the natural conduit for CS strengths in biology to be applied to Bioengineering. There may be natural ways to exploit common interests across departments that benefits both departments.

We note that both the Computer Engineering program and Computer Science Department appear to have a high degree of redundancy at the freshman and sophomore level. We have been told that previously these classes were only taught in Computer Science. The replication of these classes seems unnecessary and perhaps wasteful given the size of the two programs. On the other hand, crosslisted classes at the senior and graduate level that exploit the unique strengths of Computer Science and Computer Engineering could benefit both parties.

## **The CS Pipeline**

We suggest that CS could benefit significantly from increased enrollment. Increased enrollment gives the potential of increased TA and faculty FTE. CS is doing extremely well for a department of 17 faculty, but a look at top 40 (and lower) ranked departments reveals that almost all competitive departments are larger in terms of undergraduate enrollments.

We observe that there may be breakdown in the pipeline from freshman admission to the declaration of the CS major. Once a student declares CS, retention is excellent -- 80% as

compared to national averages around 30%. Only 42 out of 550 students, however, declare CS from the SOE pool of engineering students. From our interviews with students, it would appear that better informed advising at the SOE and University College could substantially improve this conversion rate. Specifically, the students commented that:

- SOE and U College advising not useful for CS ("clueless")
- told "CS has no advisor" (not true)
- told "Can't talk to CS advisor until you are a major" (not true)

Note that such deficiencies of advising would almost certainly result in an ABET deficiency. Given that students universally lauded CS internal advising, we recommend that SOE and University College advisors refer students interested in CS directly to CS advisors as soon as possible. The CS advisor, however, currently handles both graduate and undergraduate advising. We recommend an additional FTE to separate these duties as they are in most departments of this stature.

We also note that a primary strength of UNM is its diverse student population. Recruitment of diverse populations into CS could be a strong differentiating factor for UNM in national STEM initiatives. We recommend developing this strength and pursuing possible funding in programs such as NSF's Broadening Participation in Computing program. Diversity in faculty hiring is also strong component of strengthening student diversity.

Furthermore, CS should be given TA FTE to convert undergraduate to graduate TAs in their lower division courses. More TA FTE will significantly help graduate student recruitment and PhD production. If possible, increased enrollment should also result in increases in faculty FTE. The CS department is comparable to a top 40 department in many aspects, but PhD production and faculty FTE need to be improved. More TA FTE could substantially increase PhD output, and add additional graduates per year to an existing output of 5-10 per year.

### **Areas of Investment**

If given additional FTE, we examine what strategic areas might best receive investment. The department has invested quite well for such a small number of FTE. We note that CS is nationally recognized in Computer Security. This recognition notwithstanding, we find that CS is under-invested in this area. An additional FTE in this area could greatly increase productivity and visibility. Looking to the future, we see opportunities in the relationship between CS and Social Science. In particular, research in issues of privacy, security, and networks (natural, social, and computer interconnections) are excellent opportunities for future investment.

Additionally, the students noted a need for greater expertise in Software Engineering. Future trends also indicate opportunities in databases, large-scale data, and large-scale systems. Addressing issues of scale, especially as applied to computational science, could allow CS to better leverage nationally-recognized regional strengths at LANL, Sandia, and the Sante Fe Institute.

## **Senior Leadership**

The CS department has very few full and associate professors and is in need of more senior and mid-career leadership. As Prof. Forrest's tenure as chair is due to end, an external chair search is recommended.

We also note that, although the excellent junior faculty have successful individual research programs, CS faculty only just started to plan medium-scale collaborative projects. These efforts are hindered by a lack of mid-career and senior faculty to lead such projects. Additional hires at the associate level are recommended.

Finally, we note that the ERC self study is a start at a strategic plan for the department, but that more strategic planning would be beneficial for the department.

## **Retention**

A highly-successful faculty indicates a danger of retention problems in the future, especially as the economy recovers at other institutions. Conversations with faculty revealed several potential retention issues. Low graduate RA stipends make it difficult to recruit and retain students. Low faculty salaries make outside offers more attractive. We note that more internal recognition, mentioned earlier, is a low-cost means of increasing retention.

Finally, we understand that the University is streamlining processes and making the transition to a more research-oriented institution. Although things have improved, we observe that faculty need more support for rapid proposals and for navigating IP agreements. We note that a 5-day internal lead time on proposals is not competitive with peer institutions, which often have a lead time of hours.

## **Special IT needs**

One of the key areas that CS is unique is in special needs in IT for research and teaching. Notably, the department's nationally-recognized security research and teaching are a challenge (an extremely worthwhile challenge) for any University IT organization. Additional needs for performance and flexibility also exist in data mining, networking, and systems research and teaching.

Although our conversation with the CIO was very encouraging, we recommend that a process be defined for approving special IT needs. The current approval rests with security personnel within the CIO's office. We recommend a committee led by academics with IT administration representation. To encourage the university mission of research, we feel that it is important to give the approval body a vested interest in this mission, as well as IT security and reliability.

We also recommend that the CS department be given control over computer laboratory facilities comparable to science laboratories. A computer lab is not just a collection of machines on some desks -- it requires 3 hour time slots and rapidly changing software. The latest educational studies and literature suggest that a true laboratory environment is essential to effective learning.

These laboratories need to be administered by CS technical support staff and additional FTE are recommended.

## **Math**

We note that the decline of the Mathematics and Statistics department is significant issue for CS, which is strongly related to both disciplines. The lack of a strong M and S department would adversely affect recruiting of CS undergraduates, training of undergraduate and graduate students in CS-related mathematics, and essential collaboration of CS faculty with experts in mathematics and statistics.

## **Space**

As mentioned earlier, CS space needs are critical. CS needs dedicated laboratory space. More importantly, CS needs improved building space. Not only is this a recruitment and retention issue, it is apparently a safety and code issue. At least one team member spent additional time visiting various labs and examining the space used by computer science more closely. The Computer Science department does a good job of grouping together students and creating a work environment where teams of student closely interact. It is possible that the Computer Science would have adequate space, but the way space is currently used is inefficient. A carefully thought out architectural plan could go a long way toward making the current space more functional and enjoyable at reasonable cost.

## **Other Specific questions:**

*1. How does the department's research expertise match up with current trends in Computer Science? Are there areas where we are ahead? Are there noticeable gaps?*

The CS department clearly has strengths in computation at the interface between biology and computation. Much of this research is also cutting edge. There is also a strong theme of computer security in the department. And there is a clear emphasis on algorithms. There is also a number of faculty with interest and expertise in artificial intelligence.

There is some expertise in high performance computing, but a case could be made for additional hires in the area.

Similarly, while there is a strong theme of computer security in the department, security is an application area for some of this research and it is in some sense a secondary theme for many of the researchers who work in security. Again, a case could be made for additional hires in this area to reinforce and anchor current computer security research in the department.

One area that is noticeably missing in the department is software engineering. The department needs to access for itself if this is a strategic decision, or an deficit in the program. Clearly, it is difficult for a small department to cover all areas of Computer Science while still keeping the necessary critical mass of faculty in core areas of research.

2. *Would you hire one of our Ph.D. graduates for a tenure-track position in your Department? Why or why not?*

Perhaps. One of the team member's home-school Dean has expressed a strong preference for hiring students who earned their Ph.D.'s in top-20 departments, or else had a post-doc in a top-10 department. Exceptions have been made for some new Ph.D.'s with excellent publication records, and some U. NM students appear to have such records. However, it is definitely the exception rather than the rule to hire such students.

Another team member's institution hires the best people from strong research groups from a diverse set of institutions. In fact, we have often found that having a Ph.D. from a top-10 ranked institution is not always a good indicator of quality given the ability of Ph.D. students to become lost in over-sized research teams. An excellent Ph.D. student from UNM with a strong record would be highly competitive.

3. *Would you send your daughter to UNM if she planned to major in computer science? Why or why not?*

One team members would answer no. Because he wants a daughter (or son) who is going to major in computer science to be someplace where both the computer science department *and the mathematics department* are very strong. If the mathematics department were stronger, then yes: the computer science undergraduate program seems to be very good, and the atmosphere for women seems to be very good.

Another team member would say yes, particularly for a daughter. Computer Science departments have real difficulty attracting women and minorities to the undergraduate major. The CS department at UNM seems to have a particularly good atmosphere. The department could be more involved at a national level in this area;

for example, the National Center for Women in Information Technology (NCWIT) promotes a number of best practices to both promote and enhance diversity efforts.

4. *How do the physical infrastructure, staffing level, and graduate stipends of the department compare to similar departments at other universities?*

The graduate stipends are lower than in comparable departments elsewhere; this is particular true if UNM is competing with higher ranked CS departments for students. The lower graduate stipend likely has a negative impact on Ph.D. student recruitment.

The fact that the CS department at UNM continues to recruit high quality graduate students also suggests that its national reputation is better than national rankings such as the US News and World Report ranking would suggest. The CS department also benefits from its association with the National Labs in New Mexico, and its particular connections with the Santa Fe Institute.

Nevertheless, to continue to attract high quality Ph.D. students, the CS department needs to improve graduate stipends to keep pace with national averages as reported in the CRA "Taulbee Survey."

As discussed earlier, the quality of the physical space is below average. Correcting this problem seems to be a priority for the University. This is also an opportunity to make the most of the space that Computer Science occupies.

Staffing is at the low end of the "new normal" range for the current environment of economic stress and near-universal understaffing. Advising and technical support staffing will need increases if undergraduate enrollment is increased.

*5. What changes does the committee recommend in the two years remaining until our next ABET accreditation visit?*

The Department should reconsider its objectives in light of the technical ABET definition of objectives as *measurable* things that a program expects of its graduates around 3–5 years after graduation. Incidentally, these objectives are supposed to be a medium-high level "10,000-foot view" of what the Department hopes to achieve. A program is also welcome to spell out even more general high level "30,000-foot view" goals that may not be measurable. Very high

level goals are not "objectives" in the narrow ABET sense, and might instead go in, for example, a mission statement.

Furthermore, the department must show that it is in fact measuring its success with each objective it has. These measurements may be qualitative rather than quantitative, but some data must be collected and examined on some regular schedule.

There is room for real efficiency gains in the UNM School of Engineering in general by moving the task of measuring objectives to the School of Engineering. Whereas learning outcomes are often measured at least in part by measurements in courses, by definition objectives have to be mentioned by doing such things as surveying young alumni and employers. It makes sense to have an Associate Dean of Engineering figure out the methodology and supervise the collection of measurement data instead of having each individual department wrestle with this.

The Department should consider carefully whether it has data showing that it is meeting the educational outcome it has set for itself that "[all students will have] an ability to function on multidisciplinary teams." If that is among the program's educational outcomes, then the Department must show that they are measuring success with this goal, and taking corrective action if they are not meeting it. Alternatively, the Department could weaken this outcome to

“function on teams,” as ABET CAC (computing) does not require a multidisciplinary goal, and it can sometimes be very difficult for Computer Science programs to achieve such a goal.

If the Department is finding its current measurement paradigm for outcomes onerous, it could modify it. Since outcomes are to be achieved *by every student* by the time of graduation, it is sufficient for each outcome to be measured in one or two required courses, typically required courses that come later rather than sooner. Measurements in the very first course probably don't contribute much, and measurements in elective courses can never give evidence that “every student” possesses a specific ability. There is nothing wrong with the Department's current system; it is simply an option to do a little less measuring work.

Based on discussion, the Department is now making sure that all students practice and demonstrate their ability to communicate effectively orally inside the discipline of computer science. However, this did not show up clearly in written materials in the self study for this visit.

The advising problem with students not yet admitted to the CS major in University College and in the Engineering School's pre-major mentioned elsewhere in this report must be addressed. If the visiting ABET team uncovers this problem, they will definitely rate it as either a Weakness or a Deficiency.

#### *6. What should the department do to improve its national rankings?*

National rankings, such as those published by US News and World Report are partly based on fact and partly on opinion polls. Department Chairs across the country are asked to rank other departments, and such opinions are often more impressionistic than factual. (A number of department chairs have also informally noticed that if a chair does not send in the US News and World Report survey, the ranking of that department drops significantly.)

Given the high quality of the Computer Science Department at UNM, if the department had 34 faculty instead of 17 and could also double Ph.D. graduation rates, funding levels and other metrics, it would no doubt be close to being ranked 40th (or better) in the nation. At the same time, the US News and World Report ranking of 79 seems wrong to us. The 2009 “Taulbee Survey” of the Computer Research Association (CRA) is the most recent and reliable source of factual information about Computer Science Departments nationwide. It reports summary information for departments ranked 36 and above, as well as departments ranked 37 to 145. The US News and World Report ranking would place CS at UNM in middle of the 37-to-115 ranked departments. CS at UNM is smaller than the average of this group (17 faculty compared to national average of 20), while its funding is almost double the national median (which is 103K per faculty compared to approximately 200K at UNM), and its Ph.D. production appears to be near the average, which is 7.6 students per year.

Computer Science departments ranked 25 to 36 according to the CRA Taulbee survey have a median funding level of 195K per capita and a mean funding level of 209K per capita. When viewed this way, the funding of faculty in the CS department at UNM is on par with much higher ranked departments.

In summary, the Computer Science Department is doing an excellent job, but it is hampered by its small size. The average number of faculty in a department ranked 1-to-36 is 36 faculty.

In terms of more practical advice, the department can attempt to increase the number of Ph.D.s that it graduates.

However, assuming an excellent output of 1 Ph.D. per year for every 2 faculty, the department cannot expect to graduate much more than 9 Ph.D.s per year given the size of the faculty. Certainly, continuing to recruit and graduate high quality Ph.D. students is important.

The department might do more to publicize its accomplishments. Many department widely distribute electronic newsletters to highlight and publicize major events.

## Summary

We wish to thank UNM, the SOE, and the Computer Science Department for their hospitality during our visit. We found the department programs, faculty and students to be of extremely high quality and to have significant future potential. In a nutshell, we see a future where more undergraduate enrollment leads to more FTE, resulting in higher ranking and visibility, better recruitment of graduate and undergraduate students, and increased external funding.

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