External Review of Texas Tech University Department of Geosciences, Graduate Program in Geosciences

Introduction

The Texas Tech University (TTU) Graduate School assembled a committee of three TTU faculty and two external faculty to review the graduate program. This report is the report of Todd Halihan, Oklahoma State University, who is the external reviewer for the geosciences program. The on campus portion of the review was conducted on Feb 25-26, 2010. The faculty and students provided open and useful information to allow the committee to provide a thorough review of the graduate program.

The geosciences group at TTU is composed of 13 tenure/tenure track faculty, a part time instructor, two adjunct faculty and support staff. The group offers B.A., B.S., M.S. and Ph.D. degrees in the geosciences discipline.

The group has a number of areas of strength including remote sensing, geochemistry, geophysics, paleontology, and petroleum geology. A large number of their graduates enter the petroleum industry. The research program has a good balance of field and laboratory based research.

Faculty

There is a good mix of faculty ranking and experience levels giving the department a cohesive team to work towards departmental goals. There are a number of full professors which allows some flexibility in long term planning for the department.

In discussions with students, there is a high regard for the faculty as a group. The students felt that the faculty provided a good academic environment where people cared about their success as students.

Strengths and Measures to Improve the Program

What follows is my assessment of the strengths of the geosciences graduate program and an assessment on measures that can be used to strengthen and build the program. These include both internal and external measures, some of which can be completed by the department and others which require assistance from the university administration.

The strengths of the department include a strong ability to train students in formation characterization for placing students in the petroleum, environmental or mining industries. They have a strong group in geophysics which is difficult to build and needs to be maintained. Additionally, they have a balanced group of paleontologists who are active and maintain a strong program. The faculty have enough geochemists to maintain a core group for productive research. Finally, the faculty have a group of remote sensing research faculty who can investigate this planet or others. These are difficult groups to build and the department has done well to build these areas of specialization.

Additionally, the department has ready access to atmospheric scientists, petroleum engineers, civil and environmental engineers, physicists, chemists and geographers. These departments can be crucial to building the graduate program.

Separate conversations with students, untenured faculty, tenured faculty and the department chair suggest the geosciences group faces several challenges in sustaining and improving its graduate programs.

1. *Graduate course loads limiting productivity:* Students in the graduate program in geosciences are required to take large course loads, have large teaching loads, and often pursue internships. This was listed as a time management problem by the students and the faculty. The heavy course-load leaves students insufficient time for research and there is little time for graduate students to take courses outside of the department. In discussions with untenured faculty, this time constraint was cited as the primary cause for low graduate student research productivity, and it was suggested this low productivity has affected faculty research productivity. Discussions with the department chair suggest this policy can be changed by a departmental level decision of the faculty for the undergraduate and master's program, but that for the Ph.D. program, the problem is at the graduate school level.

I investigated the course loads for the graduate program in comparison to the schools listed in the graduate program review document and also included some Big 12 comparison schools. The results of the comparison indicate that a typical course load for a Master's in Geology is 24 hours or 8 courses (Figure 1, Table 1). This 24 hour requirement is also consistent at the TTU graduate school level. However, on the departmental level two additional courses (6 hours) are required. This would generate an additional semester of work at TTU for graduate students or limit research training and productivity.

The results of the comparison for Ph.D. programs indicate some variability in their coursework requirements (Figure 2, Table 1). Not as many schools are listed in this comparison because some schools leave much of the programmatic decisions on course work to the Ph.D. committee. However, the TTU Graduate School can require an additional 20-30 hours of coursework above standard levels at peer institutions. The intent of the 60 hour total coursework requirement is that 30 hours would be provided at the Master's level and 30 hours of Ph.D. level coursework. Unfortunately, for many Ph.D. students in the TTU program, their Master's work is not fully counted towards the first 30 hour requirement leaving them to take a large amount of coursework above and beyond peer institutions. At the Ph.D. level, flexibility needs to be granted at the committee level to determine an appropriate amount of coursework for a student. This is especially important for a program that may attract Ph.D. students with Master's degrees from physics, chemistry, or biology programs that will not have the same Master's coursework as existing geoscience students. The requirements should be shifted towards Ph.D. committee decisions and not centralized single standards that limit innovation in interdisciplinary research.

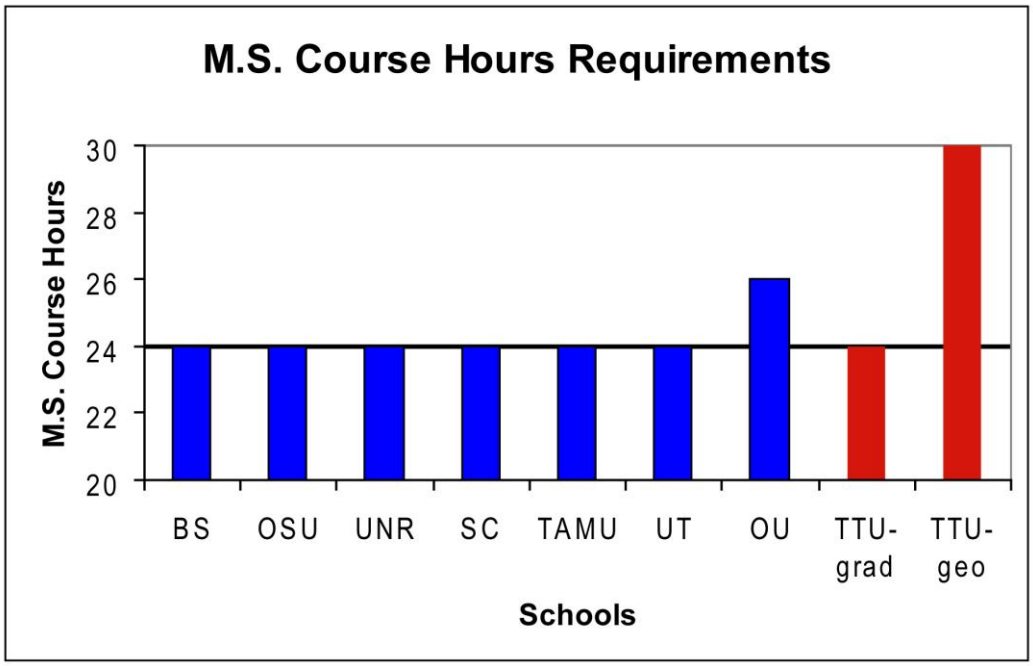

Figure 1. Comparison of course hour requirements for Master's Degree in Geology at TTU and seven other universities. As the departmental level requirement is different from the graduate school requirement, there are two listings for TTU.

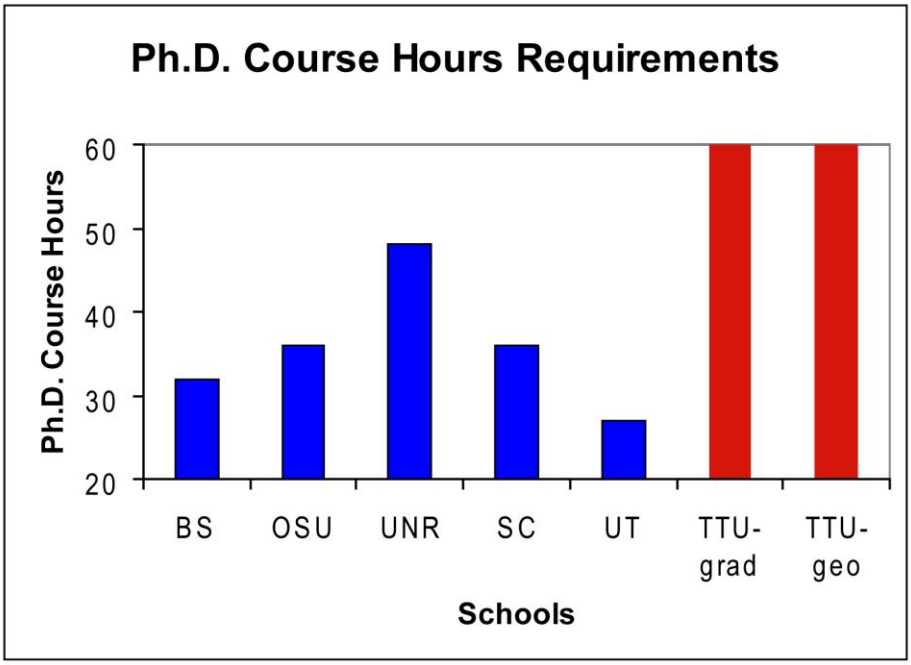

Figure 2. Comparison of course hour requirements for Doctor of Philosophy Degree in Geology at TTU and five other universities. As the departmental level requirement is different from the graduate school requirement on the M.S. level, there are two listings for TTU.

School	Boise State	Oklahoma State	U of Nevada - Reno	U of North Dakota	U of South Carolina	Texas A&M	U of Texas at Austin	U of Oklahoma	Texas Tech - Grad College	Texas Tech - Geosciences
Graduate Requirements										
M.S. Degree										
Course Hours	24	24	24	?	24	24	24	26	24	30
Research Hours	6	6	6	?	6	8	6	4	6	6
Total Hours	**30**	**30**	**30**	**30**	**30**	**32**	**30**	**30**	**30**	**36**
Ph.D. w/o M.S.										
Seminar Hours		4			0-8		2-3	determined by committee		
Course Hours	32	36-56	48	?	36	?	27 min		60	60
Research Hours	18	30-50	24	6-18	?	?	6 min		12	12
Total Hours	**67**	**90**	**72**	**90**	**72**	**96**	**?**	**90**	**72**	**72**
Ph.D. w/ M.S. degree										
Seminar Hours		2			0-8		2-3	determined by committee		
Course Hours	32	18-38	24	?	21	?	27 min		30*	30*
Research Hours	18	20-40	24	6-18	?	?	6 min		12	12
Total Hours	**67**	**60**	**48**	**60**	**42**	**64**	**?**	**60**	**42**	**42**

* if M.S. coursework approved by TTU

Table 1. Comparison of graduate degree requirements among a range of geosciences programs. The first set of universities were drawn from the comparisons presented in the graduate program review, the remaining universities are additional Big 12 universities for comparison. As the geosciences department requirements differ from the graduate school requirements, two columns are presented for the TTU data.

2. *Curriculum rules and policies:* While the curriculum and course offerings in geosciences are very strong, their scheduling and organization is affected by rules that don't seem to advance the department goals. Graduate students are required to take 12 hours each semester and the 30 hours of Master's coursework is required to have sufficient enrollment in graduate courses each semester. During discussions with the faculty, the procedure is prior to each semester, the university administration evaluates class size and if 5 students are not enrolled in a graduate course, the course is not offered. The number was 10 for undergraduate courses. In order to have courses pass this requirement, students are required to take extra departmental courses to increase the student population. However, by requiring extra courses, the number of people taking a single course is decreased again. All of the requirements are not motivated by curriculum issues, but by trying to achieve credit hours for the department and to have graduate courses achieve the five student threshold.

In addition, in discussing course loads with faculty, the untenured faculty thought that their course load was a 2:2 with two courses offered by each faculty each semester. When discussing course loads with the department head, the load was cited as a 2:1. This indicated that curriculum issues need to be evaluated on a departmental and university level. The financial difference between an enrollment of 3 students and 5 students in a graduate course is not significant for the university, so the arbitrary line does not make significant sense. If a few low enrollment exemptions were available to the department each year, then curriculum needs could be met without penalizing students or faculty productivity and the department would have much easier times with curriculum decisions.

3. *Undergraduate Curriculum:* The undergraduate curriculum is also affecting productivity on the graduate level. The B.S. degree plan has little flexibility with only one elective course available in the major. Additional flexibility and changes will strengthen the graduate program by allowing students to add a course of two of specialization to their undergraduate studies and prepare them for a graduate program at TTU or other universities. Two primary changes seem in order for the undergraduate curriculum. First, the undergraduate research component should be optional. The number of faculty at TTU is not sufficient to effectively run a graduate program at the Ph.D. level and provide undergraduate research for 90 undergraduate majors. The undergraduates that are prepared for research should be encouraged to take on projects, but the weaker students cannot be effectively mentored at the current faculty size. The number of undergraduate students have roughly doubled but the number of faculty have not. This requirement only decreases faculty and graduate student productivity. Second, if 3-5 courses can be designated as electives, emphasis areas can be established for the undergraduate degree. This will allow a small amount of specialization and potentially add some undergraduates to a limited number of graduate courses. For the TTU program, the obvious emphasis areas would be Petroleum Geology, Paleontology, GIS or Remote Sensing, Geophysics, and Atmospheric Sciences. The emphasis area courses should be made flexible so that if particular courses are not taught in a given year, the students can still graduate on time. The number of emphasis areas should be limited between three and five. An example of this type of curriculum is provided as Appendix A.

4. *Research Equipment:* Research equipment is limited in the department. A few pieces of strong research equipment exist, but the building and equipment is limited. This can be remedied by a partnership between TTU, the departmental alumni and their corporate contacts.

5. *Graduate Teaching Positions:* The higher the teaching requirements for the graduate students, the weaker the research for the degree or the longer the degree will take. The faculty indicated that as the enrollments have increased in the department, the amount of funds provided by the university for teaching assistantships have not increased in proportion to the needs. Additionally, the department has indicated few graduate fellowships were available.

6. *Fundraising*: No alumni board exists for the department. No fundraising objectives were indicated by the faculty. A significant number of TTU alumni from geosciences exist in industry and have a strong affection for the department. This resource is functionally untapped for graduate fellowships and departmental equipment. Either an alumni board needs to be formed or an alumni liaison needs to be chairing a committee to improve this situation. As a significant number of full professors and a former president exist in the department, a strong pool of candidates are available for this effort. This should be able to generate a minimum of $50-200K/year for the department. The objectives for fundraising should be based on alumni interest, but should include graduate fellowships and equipment funds. During discussions with the tenured faculty it was suggested that the department was training oil geologists, not oil finders, and was hesitant to be overly associated with the petroleum industry. While faculty do need to manage this relationship to ensure that students are receiving degrees, not just training, this attitude is adversely affecting the department resources from private and industry donations.

The future

1. *Strategic Planning*: The strategic plan indicated a potential hire in hydrogeology. This would fit well with the current faculty and should be made as soon as possible. The choice of a strong field hydrogeologist or a computational person does not seem to be an issue for the department, so either choice would be great depending on the needs of the faculty.

Strategic planning also mentions diversity, but does little to plan ahead or change the situation in the department. If this is a need mandated by the administration, then the administration should support the need financially through faculty lines or though graduate fellowships to meet diversity needs. If this is a serious focus of the department, it should have a developed action plan.

2. *Integration with Atmospheric Science and Geography*: Department planning documents express an interest in greater integration between atmospheric sciences, geography and geosciences, and they suggest this would be facilitated by having a single

building. While such integration would be useful for the department, faculty expressed little enthusiasm for such integration, at least if it is carried out only for its own sake. They point out that the principal area of research within atmospheric sciences offer only limited opportunities for collaboration. At the same time, the Geography department will soon be integrated with Geosciences. Geographers commonly have research interests with that would correspond with the interest of the geoscience faculty, either in climate change, remote sensing or resource production. The students indicated that the research day was productive for the department, but one of the only times that the department did something as a group. Additional integration would be useful for the atmospheric sciences program to recruit students and give them an undergraduate presence. For the geosciences, the atmospheric science program can provide graduate students for courses to increase enrollment. These student also have significant quantitative skills to collaborate with geoscience students who may be lacking in this area. This integration planning might be done in a workshop in which all faculty participate. Additionally, faculty from other universities that have done this integration should be invited to present their experience. The University of Arkansas at Fayetteville is one such department.

3. *Building the departmental strength:* Guidance is available on building strong departments from peer reviewed research. The discussions with faculty indicate many of the common recommendations are being followed by the department. Additional measures could include adding a student lounge for the department facilitating student and faculty interaction. Additionally, a seminar intended to provide talks that cross between the geoscience, geography, and atmospheric science disciplines would be useful. Appendix B provides some of the research on this issue.

Graded Assessment

As requested as part of the review process, a graded assessment of five areas is provided below.

1) Program Overview and Vision – Satisfactory
   The program is limited by lack of clarity with regards to how geography will be integrated into the overall program and whether a new building will be available. Little vision with regards to alumni support is apparent.

2) Faculty Productivity – Excellent
   The faculty are making excellent use of their resources to provide a productive scholastic environment to their students and their institution.

3) Quality and Quantity of Graduate Students and Graduates – Good
   With the current curriculum and graduate funding in place, the quality and quantity of graduate students is excellent. With changes in the curriculum to align with peer institutions, the number of students could be increased as current students could be trained more efficiently.

4) Curriculum and Programs of Study – Poor

The curriculum is designed to meet numerical rules or apparent requirements without accounting for the increases in the number of semesters required to finish degree programs. The curriculum is the primary factor limiting research productivity of the students and faculty.

5) Facilities and Resources – Satisfactory

The facilities and resources appear to be limited. Funds for large equipment are generally obtained through internal funds at TTU. Resources appear to be lacking for regular classroom equipment. These needs could be supplemented through organized fundraising efforts with departmental alumni.

Recommendations

Based on the above findings, the following recommendations could be used to strengthen an already strong graduate program in geosciences:

1. Reduce the course load for M.S. students to 24 hours total, in line with the TTU Graduate School.
2. Reduce the semester course load for graduate students to 9 hours to increase research productivity and decrease financial burden on the graduate students.
3. Petition the TTU Graduate School to reduce the course load for Ph.D. students to a level that is consistent with national standards for science degrees by allowing more decisions at a Ph.D. committee level. If incoming students have a M.S. from an accredited institution, their course work requirement should be changed based on the degree obtained, not on individual course or degree names.
4. Reduce/Discuss the course load for faculty such that a 2:1 course load exists for research active faculty.
5. Petition the TTU administration to increase the funding for teaching assistantships to accommodate the increased enrollment in TTU geoscience courses.
6. Petition the TTU Graduate School to allow the department head more flexibility in decisions on whether courses run with a low number of students.
7. Determine course offerings as far in advance as possible and distribute the information to the graduate students. Provide a signup sheet for the department ahead of registration if required to determine where interest lies prior to course changes.
8. Eliminate the undergraduate research requirement; make it optional instead.
9. Work to make the undergraduate degree more effective at preparing graduate students and integrate the various programs in the department by allowing additional flexibility.
10. Develop fundraising goals and a formal structure for interaction with the alumni. These goals would likely include graduate fellowships and equipment goals.
11. In advance of the integration of Geosciences with Atmospheric Sciences and Geography, plan for the integration so that it is effective at increasing the value of the unit instead of remaining as three parallel units under one administration.
12. Provide a student lounge for the faculty and graduate students to interact on an informal basis.

Summary

The Geosciences program at TTU is composed of a solid competent group of faculty that is difficult to assemble and maintain. They provide an engaging scholastic environment for their students with an educational program that is appreciated by future employers.

The program can be strengthened by a number of measures that can be enacted at the departmental level. Additional assistance is required at the TTU Graduate School level to assist the department. Many of the measures can be accommodated at little to no cost, but should have a strong effect on the department productivity.

Todd Halihan 3/5/2010 – revised 4/15/10

Appendices

A. Undergraduate Curriculum at Oklahoma State University Organized with Emphasis Areas to Add Flexibility to Undergraduate Course Structure

B. Article on Strengthening Departments: Hilborn, R.C. and Howe, R.H., 2003, Why Many Undergraduate Physics Programs are Good but Few are Great, Physics Today, v. 56, no 9, 38-44.