Academic Program Review
External Reviewer Report

Department of Statistics
Institute of Agriculture and Natural Resources
University of Lincoln, Nebraska

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Academic Program Review External Report

The external review team

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Executive Summary

1 **Expand the department** by hiring faculty (tenure-line and specialized for teaching), academic professionals and staff members as well as assigning more space to the department to support the undergraduate program and other proposed future programs. Given the many initiatives and ambitions of the Department, IANR, and the University, we think it is appropriate to aim for at least 20 tenure-track FTEs along with several teaching faculty. An expansion to this size will take several years but given current priorities, there is an impetus to hire multiple faculty within the next two years.

2 **Grow the undergraduate major(s).** The new Statistics and Data Analytics major and the forthcoming Data Science major will provide a steady stream of graduates who are well trained for the modern workforce. These graduates will provide benefits to the State of Nebraska. The majors align with the land grant mission of the university.

3 **Establish a solid mentoring system** to nurture the junior faculty. Mentors should help the junior faculty set and realize their career goals. For many junior faculty, a career goal will involve an interdisciplinary research path--a path whereby the junior faculty will make significant contributions to Statistics while conducting substantive collaborative research.

4 **Support the SC3L.** In the absence of support from the center, the department should consider restructuring the consulting team and policies. Charging clients (or their home departments) could recover some of the cost of massive and repeated use of the SC3L by a small number of individuals. Alternatively, restricting the number of free visits could control some of the overuse of the SC3L. Stronger support would allow the expansion of service to other units on campus and could potentially bring revenue to the department.

5 **Expand department administration.** Over the next several years, and with anticipated growth in the department, establish an Associate/Vice Chair and an Undergraduate Program Chair to share governance and to reduce the workload of the Chair. This will facilitate the development of the next generation of departmental leadership. Additional benefits include greater transparency in departmental affairs. This will facilitate regular communication between faculty, staff and students during a period of growth (and change) for the department and its educational programs.

Introduction

The External Review Team had a virtual visit to the University of Nebraska in early April, 2021. The external members of the review team were supplemented with several individuals from UNL, including a faculty member from Biological Systems Engineering (Yufeng Ge), the UNL Academic Planning Committee Monitor (Frauke Hachtmann), and graduate (Jessica Hauschild) and undergraduate (Lauren Niesen) student representatives. We met with the senior leadership of the Institute for Agriculture and Natural Resources, the Chair of the Department of Statistics, faculty, staff, graduate students, and heads and school directors from across IANR. Prior to the zoom meetings, we were provided with extensive information about the department in the form of the Statistics APR document. The internal members of the review team were present for all meetings with the exception of those where members of the Department requested to meet the external reviewers separately.

The department's self-assessment was well done. Upon reading it, the review team understood the dramatic changes that the department has experienced over the past decade and where the department is headed. The six questions posed in the review document speak to the department's desire to grow their programs and their impact on UNL and on the profession while creating a healthy and supportive environment for members of the department.

We were asked to examine the department, its programs and opportunities, and to respond to the questions in the self-assessment. In this report, we describe the department, provide our take on its constituent elements, and answer the questions posed in the self-assessment. We also provide recommendations for how to realize the department's goals.

Statistics - a field in transition

Statistics is a young and dynamic discipline. It sprung from its parental disciplines of mathematics and agricultural applications, and it has since grown into a discipline that touches much of the world. It seems that no matter where one looks, all see the value that data and quantitative models bring to decision-making. Examples abound, from precision agriculture, to personalized medicine, to prediction of extreme weather events, and beyond. The revolution is driven by the three features of automated data capture (Big Data), increased computational power to unlock the information in the data (algorithms), and a clear understanding of how to make optimal inference (analysis). The corporate, academic and government worlds are all demanding modeling and data analysis under a variety of names, whether it be "Data Analytics", "Data Science", or the more traditional "Statistical Analysis and Inference". The uptick in demand is not temporary, but is rather a long-lasting change. The value attached to the discipline of Statistics has sharply increased, and fortuitously we find that adding faculty is revenue-generating, in terms of return on students taught and grant overheads.

Leading universities are aware of this change, and all across the country, resources are being funneled into faculty lines (research) and programs providing training in the area (education). A hallmark of modern statistical research is its melding of core knowledge of the discipline with serious applications that strengthen both Statistics and other areas of the university. This inevitably spills beyond the university to local corporations (outreach). Competition for strong

faculty is fierce. This competition has increased the size and number of departments and has spiked demand for statisticians and data scientists.

Universities are wrestling with the need to develop new educational programs at a variety of levels and to provide quality training for massive numbers of students who wish to gain some familiarity with statistics, while at the same time providing the environment that will attract strong research faculty and will provide them with the time and resources to engage with extra-departmental colleagues. We note that teaching loads for tenure-track faculty at R1 institutions are dropping from the old 3 semester courses per year to 2.5 per year or even 2 per year to reflect the demand for contributions from statistics faculty to interdisciplinary research teams. Startup packages are vastly different than they were even a few years ago. Many universities are moving to a model with two tracks of faculty--traditional tenure-track faculty who have substantial expectations in terms of research and whose primary teaching is at the upper-level undergraduate and graduate level, and teaching-track faculty who teach a greater number of courses and who have minimal research expectations. These latter positions are rarely tenure-track but are permanent positions.

Universities find it easy to react to modest changes in the value of a discipline. Positions are reallocated from one department to another at a modest pace, budgets increase a little more for one department than for another, or a department undergoes a more modest budget cut. However, a substantial re-valuation of an entire discipline, as is now happening with Statistics, is a rare event--think Physics with the development of quantum mechanics, or Computer Science with the transition from mainframes and punch cards to the PC. The usual mechanisms do not provide the resources needed to build a future powerhouse or even maintain strength in such an environment. The big winners will be those universities which see the resources, current and future, generated by Statistics/Data Science and which direct them to invest in the development of statistical methodology, to grow the interdisciplinary connections between the field of Statistics and the nascent Data Science community; the losers will be those which poach this revenue stream to patch other holes in their budgets. Sound direction of resources is needed both for the intrinsic value of the discipline and for the future economic value that Statistics brings to the university. (For economic value, Statistics is one of the few touchpoints for universities and corporations in an era where corporate connections will be increasingly needed as state support for universities dwindles). We note that UNL stands in an excellent position to foster collaborations between statistics, particularly through its quality consulting, and several disciplines, including those in the Institute for Agriculture and Natural Resources.

The Department at Nebraska

Overview

Statistics is a small department with outsized impact on IANR -- it is remarkable how much the department is accomplishing with the relatively small number of faculty. However, the current activity level is not sustainable given current size/resources of the department. There is a real danger of faculty burn-out as duties not only remain at a high level, but increase with the number and scope of new initiatives and interests of IANR and the university.

- the department supports research in many IANR units and other departments across campus. The research support is not only service support but also serious collaborative support in the "team science" mode
- the department's visibility and research reputation in the statistical community are rapidly increasing
- the department teaches and provides consulting service for graduate students in many other departments
- the new undergraduate Statistics and Data Analytics program
- the new undergraduate Data Science program

With the support of IANR leadership, the department has changed dramatically over the past decade. The APR document describes many of these changes and much of the external review team's discussion surrounded them. The team finds these changes exciting, forward looking, and strongly in keeping with the department and university's mission. We highlight six among those changes

- the move from a four course load to a three course load has allowed the department to develop new initiatives and to hire faculty with a stronger focus on research
- the group of excellent new faculty that the department has recruited, particularly via the cluster hire in 2019, brings new expertise; this impacts both the kinds of research as well as educational initiatives that the department can be involved with in the future
- being housed entirely in IANR clarifies the flow of resources to the department and will ensure follow-through on commitments made to the department
- the retooled graduate program provides PhD students with the type of training that the external committee members look for when hiring faculty
- the development of new undergraduate majors is very important not only to UNL but more broadly to the state of Nebraska given the urgent need for highly trained statisticians and data scientists. Furthermore, this program will generate substantial resources for IANR; the department needs resources to develop, deliver, and grow these programs
- the SC3L (a.k.a., the Statistics Help Desk) provides valuable and valued service to students and faculty in IANR and in other units across the university; additionally, it provides experience in the practical use of statistics that is vital for the Statistics graduate students who are involved in it

Responses to the six questions

1. What areas of expertise are most appropriate for us to emphasize, e.g., in research opportunities and future hires?

There are many hiring strategies that can successfully build a department. With full understanding of the local environment and how hiring is handled within IANR, the department is better positioned (than the external review team) to understand which hiring efforts best align with the university's goals. With this in mind, we add three comments.

The university will undoubtedly invest heavily in Data Science. Statistics is one of the two core disciplines that is essential for Data Science (the other is Computer Science). Some hires in this area should be directed to Statistics. The skill set for such faculty will tilt toward those that are useful for complex modelling and scalable analysis of Big Data. We recommend that, for positions that are not tied to a single department, Statistics play a leadership role in the search.

The growth of the undergraduate majors will necessitate the growth of teaching faculty. For the external review team members in Statistics departments, the smallest number of teaching faculty FTEs for 2021-22 is 6.25, with several additional FTEs of lecturers. It will be challenging to hire these faculty, as many universities are growing their teaching faculty. The healthy and sustainable model that many universities are gravitating toward is to treat teaching faculty very much like tenure-track faculty, including allowing them to spend some time on research and providing them with the opportunity for continued professional development (say, through the availability of travel funds).

One of the classic career patterns in Statistics is this: a faculty member who has strong training in statistical theory and methodology and who has a healthy respect for applied work finds themself in an environment where collaboration is valued and where collaborative opportunities exist. Over the span of a few years, the faculty member develops connections with faculty in other departments and deepens their understanding of applied work. They soon begin collaborative work, initially along the lines of consulting. With the exposure to a variety of problems, they see the need to create new statistical models and techniques. At this point, they are engaged in first-rate collaboration where a stream of research is produced, with some work directed to subject matter journals and some to statistics journals.

IANR has the environment that lends itself to this career path. When hiring, we encourage the department (and IANR leadership) to consider not only the past accomplishments of the candidates, but to forecast their future development, taking environment into account. Success in this path will be enhanced with a broader mentoring system (see 4 below).

2. What is the optimal tradeoff between being a resource to other Departments via collaboration while also ensuring that our faculty stake out their own independent reputations – without overburdening early career faculty members?

A healthy collaboration is always mutually beneficial for both sides. Statistics faculty may also lead projects aiming to develop new statistical theory and methods for interdisciplinary research. This type of work tends to be highly appreciated in the statistics community as the research is motivated by real applications. Strong interdisciplinary research collaborations require a sound understanding among the collaborators in order to ensure that the work will have a strong positive impact on each of the faculty and disciplines involved. Building and navigating such collaborations can be complex and hence it is crucial that junior faculty receive excellent mentoring from senior faculty on interdisciplinary research. In addition, seminars and other focused discussions involving scholars exemplary in collaborative research between Statistics and other disciplinary fields, both within and outside UNL, would be helpful to formally mentor early faculty members to set up the collaborative path they seek. Likewise, launching an internal

seminars series or other focused discussions involving faculty in Statistics and other disciplinary fields, both within IANR as well as other related units at UNL will provide opportunities for faculty to build collaborations.

IANR already has flat structures and an excellent "open tent" environment in place. Faculty are currently rewarded for their contributions to collaborative scientific work as much as for statistical methodology, by both department and IANR. It is important that this continue.

3. What are the most important ways to improve our existing programs or start new ones – online, certificates, degrees, etc. – to ensure we are aligning with current and future demands of the workforce, inside and outside academia?

The undergraduate program plan is an outstanding one -- we are impressed by the vision and effort that has gone into this already. We think this is very important for UNL and the State of Nebraska, given the enormous demand for people who are highly trained in statistics. Based on what has been observed nationwide, we expect this program to grow very quickly--potentially to hundreds of majors in the near future. Hence, developing and teaching the courses, as well as addressing student advising needs will require considerable resources in terms of faculty and staff. It is important to be cognizant of the amount of time and effort required to build this program. We note that three members of the external review team are in large statistics departments that have many more tenure-track faculty and teaching faculty than Statistics at Nebraska. Even with our resources, we have found it to be a challenging undertaking to find the people hours necessary to build new majors.

We encourage the department to monitor the new majors closely. When rolling out a new major, it is common to find a need to adjust the contents of courses (occasionally in a major fashion) to allow for more effective and efficient delivery of the content to the students.

The hidden benefit to the two undergraduate programs is the long-run possibility of substantial fund-raising from graduates in the programs. Some of these majors will become incredibly wealthy! To encourage future donation, it is important that these students feel that Statistics (and IANR) has provided a personal and nurturing experience. It is therefore important to create space and an environment for the undergraduates to feel at home.

The faculty in the department will be stressed by the demands of supporting IANR research, building strong individual statistics research programs, and developing two new undergraduate majors (Statistics and Data Science; cross-disciplinary program in Data Science). With these efforts underway, it would be challenging to also begin other educational initiatives such as online courses, certificates, and digital badges. While these additional initiatives are of value, it is important for the department to preserve its focus to develop the new undergraduate majors and place them on a firm footing. We recommend that IANR and the department prepare to seize opportunities as they arise, though much will rest on expansion of the size of the faculty and staff of the department. An easy such opportunity may be creation of a certificate that involves only coursework being offered for the majors.

4. How can we best mentor junior faculty to further their professional development and ensure departmental continuity?

The good news is that the department (through the chair) is regularly communicating with junior faculty and providing them with feedback on their performance. The script for the annual conversation in the review document makes it clear that the annual conversation goes beyond mere feedback and involves a substantial amount of mentoring. However, much rests on the chair's shoulders.

The immediate difficulty faced by the department in developing a mentoring program is the relatively small number of senior faculty. As current faculty progress in their careers, this difficulty will naturally diminish.

We recommend that each junior (Assistant Professor, Associate Professor) faculty member have multiple formal mentors who work together but focus on different aspects of the mentee's career. The goal of the mentoring program should be much greater than merely surviving the tenure process; it should be to help the junior faculty identify their career goals, to help them progress toward these goals, and to move them toward excellence. As part of the mentorship, mentors may help the mentee establish connections with UNL, connect them to the broader professional community, and nominate them for awards and recognitions. Given the importance and value of interdisciplinary research at IANR and UNL, if resources permit, it would be ideal to have one mentor who is focused on building connections to others at IANR and UNL and to help the mentee "learn the ropes" of interdisciplinary work.

In addition to formal mentoring efforts, there are opportunities for informal mentoring. Regular departmental social gatherings, both formal and informal (the latter could include weekly informal lunch conversations or happy hour) could help both with mentoring of junior faculty as well as build community and further interactions among members of the department.

At times, faculty leave an institution for a two-body issue. One way to attract and retain outstanding faculty is to have a campus-wide effort to solve dual career problems whenever they arise--for current faculty members as well as prospective hires. Solutions may extend beyond the university to place partners in contact with local industry. A campus-wide effort of this sort would require the support from UNL administration.

5. How can we improve the visibility of our graduates, programs and research via intellectual output, professional service, or other means?

We suggest the following approaches for this purpose:

1 Develop a plan to provide travel support for faculty and graduate students. Presentation of research at national and international conferences is essential to providing visibility for the department. Given the cost of attending these conferences, a source of travel funding is needed. Potential example sources include alumni and faculty fundraising. If it is challenging to fund many students, the department may create student paper awards to support one or a few graduate students to travel to conferences.

2 Make a priority of bringing high-profile speakers for seminars (including some virtual seminars, even after the pandemic ends). Make sure seminars are well attended by faculty and graduate students. Discussions during and after the talk should be highly encouraged to strengthen the research environment. Coffee or other opportunities for social interactions with the speakers and among the members of the department can help create a vibrant research environment and increase the sense of community among faculty and students.

3 Consider hosting small, focused research conferences or short courses to showcase the department and its connection to IANR. The department may invite speakers and attendants from industry to build relationships with them.

4 Social media such as Facebook, Twitter, and Instagram may be exploited to increase the visibility of the department, disseminate work by faculty and students, and engage with alumni and industry partners.

6. What resource deficiencies or other challenges will we have to overcome to implement the undergraduate program we have designed?

The department has a well developed plan for the new major. The main resources needed to implement the undergraduate Statistics and Data Analytics major and the forthcoming Statistical Data Science major are people and energy. The major requires the development of a considerable number of new courses. To develop these courses with only the existing faculty would require major sacrifices to faculty research programs and to their ability to collaborate with IANR and other faculty at UNL. New faculty will need to be hired to develop coursework for the majors. These could include teaching-faculty as well as regular tenure-lines. UNL requires an academic advisor for every 250 students; therefore the department should plan to hire an appropriate number of academic advisors. With a larger department with more faculty and students, more staff members will be needed to keep the department running efficiently.

New faculty, academic professionals, staff and graduate students need office space. To accommodate growth in the department, space will need to be increased considerably. Collaborative learning space for undergraduates would be needed to substantially enhance mixed-classroom learning and improve their experience (see hidden benefit in 3 above).

We expect UNL undergraduate Statistics and Data Analytics majors to be similar to those at other institutions. If so, a large number of these students will wish for a research experience as part of their training, to build their CV, and to have greater contact with faculty. To satisfy their needs, plans have to be made to stimulate faculty to work with these undergraduates.

Points to consider

1. Undergraduate program:

    a. Immediate offering of core courses, then grow elective offerings as department size increases
    b. Mix of teaching and tenure-track faculty to develop and deliver program
    c. Need for undergraduate chair, academic advisor, career advice within next two to three years
    d. Ideal to carve out some space for the program home

2. Faculty development and department growth:

    a. Notable excellence in applied statistics, connections with food/animal/plant sciences and agricultural biosystems engineering
    b. Strengthen research culture through seminar series and build collaborative faculty connections across departments / further afield (workshops)
    c. Formalize junior faculty mentorship for interdisciplinary research, revitalize prizes committee
    d. Establish alumni relations / fund-raising, increased visibility through travel

3. Internal structure:

    a. Need for a vice chair / undergraduate program chair
    b. Additional tenure-line faculty to provide desired collaboration; raise research activity across IANR; train high quality PhD students
    c. Consider creation of “teaching track” faculty to focus on undergraduate programs and undergraduate service courses
    d. Consider full time manager for SC3L - potential to increase external clientele

4. Quantitative sciences to strengthen institute:

    a. Modern science -- bring statisticians and scientists to work closely together, equal partners in working with science and data questions. Culture of IANR aligns well with this interdisciplinarity. Statistics plays a central role in research efforts across multiple units in IANR, as well as across UNL.
    b. Key to continue to hire and promote collaborative faculty who develop cutting-edge statistical methods. With the hiring of new faculty (5 recently, hopefully more in the next few years), even greater potential for strong interdisciplinary work across UNL.
    c. Need mentoring and initiatives (e.g. seminars, workshops) to bring together statisticians and scientists
    d. In addition to long-term collaborative efforts, the consultants at the Help-Desk are Invaluable to IANR / CAS / numerous units across campus, e.g. Dentistry

e. This also provides valuable practical experience for graduate students, making them very attractive to industry and government agencies.
f. How to make it more “valuable” to department, restructure the system
g. Add a full time manager or faculty with reduced teaching appointment. Challenging for current faculty to handle given other duties.