The University Senate of Michigan Technological University
Proposal 12-18
(Voting Units: Academic)

"A Proposal for a New PhD Degree in Statistics"
(Department of Mathematical Sciences)

Introduction The Department of Mathematical Sciences currently offers a PhD in Mathematical Sciences that can be completed with one of four focus areas: Computational and Applied Mathematics, Discrete Mathematics, Pure Mathematics, and Statistics. We propose to spin off the Statistics focus area to a stand-alone degree program.

1. **Date submitted:** October 11, 2017.

2. **Contact:** Mark S. Gockenbach, Professor and Chair, Department of Mathematical Sciences (msgocken@mtu.edu, 487-2068).

3. **Interdisciplinary support:** Not applicable.

4. **General description and characteristics of program:** Graduates are expected to achieve the five learning goals established for our M.S. in Statistics, along with two additional goals.

   (a) **Graduates can choose a statistical method that is appropriate for a given problem, can justify the choice theoretically, can apply the method, and can draw appropriate conclusions.**

   (b) **Graduates can use popular statistical software to solve realistic problems.**

   (c) **Graduates can summarize and explain the results of statistical analyses orally and in writing.**

   (d) **Graduates have experience working in teams.**

   (e) **Graduates know how to work with real data. They can clean the data, deal with missing data values, and generally appreciate the complexities of handling real-world data.**

   (f) **Graduates can carry out research in statistical science.**

   (g) **Graduates can access and read statistical literature.**

   Students are required to complete the coursework from our M.S. in Statistics, to do advanced courses in Probability and in Statistics, and to complete two "breadth" courses in mathematics or another cognate discipline. The Qualifying and Comprehensive examinations are used to ensure that the first learning goal is achieved. Goals (b)–(e) are achieved through coursework, while the last two goals are achieved through the process of writing a dissertation.

5. **Rationale:**

   (a) We are proposing the stand-alone degree for two reasons:
      i. To give more visibility to our program (students interested in studying Statistics may not even notice a degree in "Mathematical Sciences with a focus area in Statistics").
      ii. To remove a possible disadvantage for our graduates (employers who want to hire a Statistician might be suspicious of a candidate with a degree in Mathematical Sciences).

(b) "Statistician" is number seven on the Bureau of Labor Statistics (BLS) list of fastest growing occupations, with a predicted increase of 33% in positions over the period 2016-2026. (The average growth for all occupations is predicted to be about 7%.) According to the BLS, "[s]tatisticians typically need at least a master's degree in statistics, mathematics, or another quantitative field. However, a bachelor's degree is sufficient for some entry-level jobs."

Across the United States, the number of statistics degrees awarded has been steadily increasing, as shown in the following chart[1]:

STATISTICS AND BIOSTATISTICS DEGREES
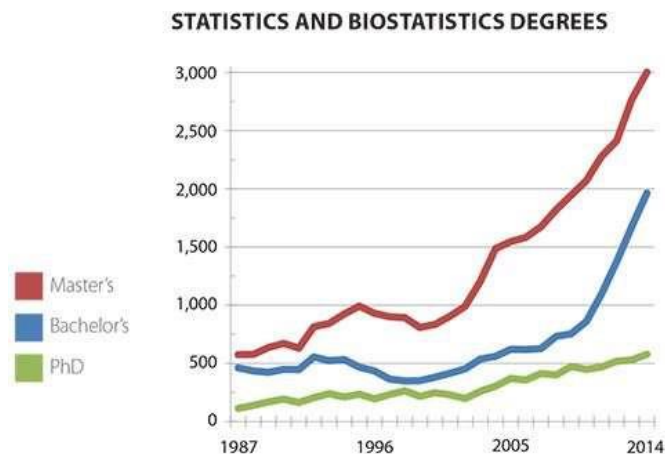
As these data show, there is strong demand for advanced degrees in Statistics, both from students and the job market. The proposed degree program, which already exists under a different name, has a record of preparing students for both the academic and non-academic job markets.

6. **Related programs:**

   (a) At Michigan Tech: none.

   (b) At other institutions: Numerous institutions in the region and around the country offer a PhD in Statistics. Here are three regional examples:

      i. University of Michigan, PhD in Statistics. This program requires six graduate courses in probability and statistics (chosen from a list of eight courses), a two-part qualifying exam, and a dissertation.
      ii. Michigan State University, PhD. in Statistics. This program requires 13 courses in probability and statistics, a preliminary exam that covers probability and statistics, and a dissertation.
      iii. University of Wisconsin, PhD. in Statistics. This program requires 12 courses in probability and statistics, a qualifying exam, an oral preliminary exam, and a dissertation.

   Our course requirement of ten courses is more than required by University of Michigan, but less than required by Michigan State University and the University of Wisconsin. In each case, there is significant overlap in the content of required courses. All programs require a year of Mathematical Statistics, at least one graduate course in Probability, and courses on statistical methods.

7. **Projected enrollment:** We expect a combined enrollment of about 15 students in the M.S. and PhD programs.

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[1] Taken from *Statistics Degrees Continue Strong Growth*, Amstat News (American Statistical Association), 1 October 2015, http://magazine.amstat.org/blog/2015/10/01/statistics-degrees-continue-strong-growth/

8. **Scheduling plans:** Regular.

9. **Curriculum design:**

   (a) Complete the following courses (equivalent to the requirements for our M.S. in Statistics):

      i. MA5711 and MA5712 (Mathematical Statistics I and II)
      ii. MA5731 (Linear Models)
      iii. MA5741 (Multivariate Statistics)
      iv. Two graduate electives in Statistics

   (b) Complete the following additional coursework:

      i. MA6700 (Probability)
      ii. MA6701 (Advanced Topics in Statistics)
      iii. Two graduate courses in mathematics or another cognate discipline

   (c) Pass the written Qualifying Examination on Linear Algebra and Mathematical Statistics before the end of the second year in the PhD program. (A student who fails to pass the Qualifying Examination by the stated deadline can complete a master's degree but cannot continue in the PhD program.)

   (d) Pass the written Comprehensive Examination on Mathematical Statistics and Linear Models. (By Graduate School rules, the Comprehensive Examination must be passed by the end of the fifth year in the PhD program. We recommend that it be passed by the end of the third year.)

   (e) Write and defend a dissertation describing original research.

10. **New course descriptions:** None.

11. **Model schedule:** For students entering without a master's degree in Statistics, the PhD is expected to take about five years:

    Years 1 & 2: Complete M.S. coursework, pass Qualifying exam.

    Year 3: Complete MA6700 and MA6701, pass Comprehensive exam, begin research.

    Year 4: Complete cognate coursework, continue research.

    Year 5: Complete research, write and defend dissertation.

    Note that we do encourage students to begin dissertation research before year three when possible.

    Model schedule for students entering with an M.S. in Statistics For such students, the PhD is expected to take three to four years:

    Year 1: Complete MA6700 and MA6701, pass Qualifying exam, begin research.

    Year 2: Complete cognate coursework, pass Comprehensive exam, continue research.

    Year 3 (& 4, if needed): Complete research, write and defend dissertation.

12. **Library and other learning resources needed:** None; current resources are adequate.

13. **Faculty resumes:** www.math.mtu.edu/~msgocken/StatisticsCVs.

14. **Description of available/needed equipment:** The Tech standard computer lab image includes the statistical software packages R and SAS, and also standard office productivity software. This is sufficient for students in the PhD in Statistics. No other equipment is needed.

15. **Program costs, years 1, 2, and 3:** No additional costs are expected. This degree is already being offered under the title "PhD in Mathematical Sciences." There is no intent to increase enrollment, and therefore no increased costs are expected.

16. **Space:** No new space is needed.

17. **Policies, regulations, and rules:** Admission to the degree follows usual departmental and graduate school policies.

18. **Accreditation requirements:** Not applicable.

19. **Planned implementation date:** Fall 2018

APPENDIX A

Department of Mathematical Sciences Information for

Financial Evaluation

Proposed Master of Science degree in Applied Statistics Proposed Master of Science degree in Statistics Proposed PhD degree in Applied Statistics

1. **Introduction**

The Department of Mathematical Sciences currently offers an MS and PhD in Mathematical Sciences that can be completed with one of four focus areas: Computational and Applied Mathematics, Discrete Mathematics, Pure Mathematics, and Statistics. We propose to spin off the Statistics focus area to a stand-alone MS in Statistics, and PhD in statistics. The financial evaluation focuses on the MS in applied statistics which is an additional program, with the MS in Statistics and PhD in Statistics being existing programs continuing under different names.

2. **Relation to university Strategic Plan** This proposal supports Goal 2 (A distinctive and rigorous action-based learning experience grounded in science, engineering, technology, sustainability, business, and an understanding of the social and cultural contexts of our contemporary world), especially the sub-goals listed under 2.3:

   a. expand Ph.D. and masters enrollments, degrees awarded, and scholarly productivity;

   b. improve access via non-traditional delivery of graduate programs;

The main purpose of this proposal is to increase enrollment in master's degree programs. The proposed hybrid option (part online, part on-campus) is intended to improve access to the degree program.

3. **Impact on university enrollment**

   (a) We plan for a steady-state enrollment of 25 students for the MS in Applied Statistics

   (b) We expect the enrollment to represent new students (i.e. students who would not other- wise have enrolled in a graduate program at Michigan Tech).

   (c) There is considerable evidence of an increased national demand for statistics degrees (see our original proposal for details). This appears to be uncorrelated with existing enrollment patterns at Michigan Tech.

   (d) The department currently enrolls 114 BS, 9 MS, and 31 PhD students.

4. **Impact on resources required by department in which the program is housed**

   (a) The program will require no new courses, but we expect to offer as many as four new sections of existing courses (certain courses will be offered twice per year instead of the current once per year). This equates to one tenure-track faculty line. However, the department is in the process of filling a Lecturer position in Statistics that may make it possible to cover the required sections without a new faculty line.

   (b) Existing computer labs are adequate for the anticipated increased enrollment.

(c) Advising will be done by existing faculty, detracting slightly from time otherwise spent on teaching and research.

(d) The department will have to perform regular assessment of the new program, adding somewhat to faculty service loads. As with advising, this will have a small detrimental effect on faculty efforts in research and teaching.

5. **Impact on resources required by other units within the university**

   (a) All required and most elective coursework will be delivered by the department. Students can take up to two cognate courses from other departments that count toward degree requirements. The additional enrollments should be small and spread out over various courses and departments. Therefore, this is not expected to be a significant burden on other departments.

   (b) Existing library and IT resources are expected to be adequate for the additional enrollment. There may be a small additional need for Career Services (advising and employer outreach).

6. **Assessment of the ability to obtain the necessary resources assuming requested funds are obtained** There is no question that it is difficult to hire and retain statisticians. Nevertheless, the department has hired three tenured or tenure-track faculty in this area in the past five years and is about to fill a Lecturer position.

7. **Past proposals** The department created a BS in Statistics (effective Fall 2014). We proposed to increase the number of students graduating with the bachelor's degree in statistics from

2.75 per year to 10 per year. (Note: 2.75 was the average number of students graduating each year with a bachelor's degree in mathematics and concentration in statistics, before the degree in statistics was created.) This increase was to occur over five to six years. In the first three years since the degree was created, we graduated an average of four students per year, whereas we had hoped to be up to six or seven students per year by now.

The cost of the new degree program has been minimal. No new faculty were associated with the bachelor's degree in statistics.

The bachelor's degree in statistics has only slightly increased enrollment in the department (possibly by a handful of students).

8. **Departmental budget contribution**

   (a) The Department of Mathematical Sciences General Fund base budget for FY17 was

$4,282,706. In addition, internal support for graduate students (GTAs) amounted to

$759,697, for a total of $5,042,403.

   (b) During FY17, the department delivered 22,812 Student Credit Hours (SCH) at the under-graduate level (14,433 lower division and 8,380 upper division) and 930 SCH at the gradu-

ate level. The approximate (undiscounted) tuition revenue was
$6,898,974+$4,433,020+$856,530, a total of $12,188,524.

9. **How do the benefits from this program compare to other alternatives that are currently under consideration or development?** The only other program being considered by the department is to offer this degree (M.S. in Applied Statistics) as an online degree. The approval of this degree will make that option possible. The department is not considering other programs at this time.