Middle Tennessee State University
Master of Science in Professional Science (MSPS)
Graduate Program Review

February 2015

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1. Brief Introduction of the Department

1.A. History

Middle Tennessee State University (MTSU) was approached in 2002 by the Alfred P. Sloan Foundation, the originator of the master of business administration (MBA), in regards to offering a new type of graduate degree that combined business and science. The program is nationally known as the Professional Science Master's (PSM). The Sloan Foundation funded a feasibility study ($7500; 2003) in which three concentrations were justified based on the intersection of regional industry needs and MTSU's programmatic strengths: Biostatistics, Biotechnology, and Nursing Informatics. MTSU was then selected in a national grant competition by the Sloan Foundation to develop the MSPS program (Master of Science in Professional Science, $105,000, 2003). This grant supported faculty reassigned time to develop the curriculum, secretarial support, and travel to relevant conferences, such as the PSM national meetings. Following curriculum development and program approval, MTSU began offering a Professional Science Master Degree program, named the Master of Science in Professional Science (MSPS), in 2005.

1.B. Degree Content

This degree program is unique from the traditional content/research-based master's program in that it combines business and science courses with a culminating real-world internship experience. The two-year program consists of nine credit hours of business classes, three credit hours of statistics, 21 credit hours of concentration-specific classes, and three credit hours of internship experience. Currently, there are six concentrations: Actuarial Science, Biostatistics, Biotechnology, and Engineering Management, Geoscience, Health Care Informatics. Biostatistics, Biotechnology, and Healthcare Informatics were the founding concentrations. Actuarial Science and Geoscience were added in 2010. Engineering Management was added in fall 2012. The program was designed with input from industry representatives and the Sloan Foundation to prepare students for careers in the high-tech, cutting-edge fields. The education students receive prepares them not only for discipline-specific work, but also for leadership and administrative positions within science- and mathematics-focused companies, government agencies, and academia.

1.C. Program Mission

The goal and mission for this degree is to bridge the gap between science and business by providing strong concentrations which emphasize the integration of natural sciences and mathematics with training in a select core of business management skills commonly found in the traditional MBA program that are beneficial for scientific management and leadership. The combination of science and business training assists individuals in the region to meet current and future employment needs and to develop new workforce opportunities. In keeping with the real-world focus of the degree, the MSPS program requires a capstone internship experience in which students gain valuable real- world experience in an industry setting. These activities not only encourage collaborative interactions with local, state, and national high technology industries but also enhance MTSU's reputation within the community. Therefore, the program's mission aligns well with the continuing goals of MTSU, which are "to advance academic quality; to promote success and individual responsibility; and to develop partnering relationships and outreach" (MTSU 2015 Academic Master Plan). First, program outcomes and student outcomes highlight academic quality goals and successful attainment of those goals. The interdisciplinary nature of

the program and the strong connections among University Departments and with professionals in industry show that partnering relationships are a priority and strong facet to this program.

1.D. Program Management

The program is coordinated through the College of Basic and Applied Sciences by the Associate Dean with a faculty advisor/coordinator for each concentration from an appropriate department: Actuarial Science and Biostatistics from the Mathematics Department, Biotechnology from the Biology Department, Engineering Management from the Engineering Technology Department, Geosciences from the Geology Department, and Health Care Informatics from the Sociology and Anthropology Department. The Business Core includes three departments: Business Entrepreneurship, Management, and Accounting from the Business College, and is coordinated by a faculty member in that college. The 103 courses within this program are taught by 45 discipline-specific faculty. Please see the curriculum section (5) for more detailed information.

1.E. Enrollment and Graduation

Enrollment in this program was three students in the first year (spring 2005), increased to 57 students in the fall of 2009 (the semester of the last review period), and currently is 110 students. There have been 245 graduates since the beginning of the program, with 200 graduates since the last review period. This shows a more than 400% increase in graduates over the last review period.

1.F. Program Admission, Advising, and Retention

Program outcomes include application of consistent admission and retention standards, student orientation, and appropriate student supervision.

1.F.1. Program and Concentration Admission and Retention Requirements

Admission to the Master of Science in Professional Science has the same requirements as existing graduate programs including: application for admission, application fee, and undergraduate transcripts. The MSPS program specifically requires three letters of reference, and a Graduate Record Examination (GRE) score of 900 (prior scoring system) or 286 (new scoring system) for consideration for unconditional admission (except HCI, which does not require the GRE).

Additionally, the applicant must have the appropriate undergraduate preparation for the area of concentration. This requires meeting the general MSPS requirements and the requirements listed for the particular concentration:

1.F.1.a. Actuarial Sciences Concentration Admission Requirements

- an earned bachelor's degree from an accredited university or college with a course in Multivariate Calculus (MATH 3110 or the equivalent) with a grade of C (2.00) or better and a course in Linear Algebra (MATH 2010 or equivalent) with a grade of C (2.00) or better;
- basic competency in word processing, electronic mail, library retrieval systems, presentation graphics, spreadsheets, and databases;
- appropriate undergraduate preparation for advanced study of actuarial sciences.

1.F.1.b. Biostatistics Concentration Admission Requirements

- Completion of Multivariate Calculus with a grade of C (2.0) or better (MATH 3110 or the equivalent);
- Completion of a course in Linear Algebra with a grade of C (2.0) or better (MATH 2010 or the equivalent).

1.F.1.c. Biotechnology Concentration Admission Requirements

- Either an undergraduate biology or chemistry major including a genetics course, or
- An organic chemistry course and at least 3 undergraduate courses related to biotechnology, including genetics.

1.F.1.d. Engineering Management Concentration Admission Requirements

- hold a bachelor's degree in engineering or a related area.

1.F.1.e. Geoscience Concentration Admission Requirements

- an earned bachelor's degree from an accredited university or college with a major in geosciences, anthropology, or related areas;
- basic competency in word processing, electronic mail, library retrieval systems, presentation graphics, spreadsheets, and databases.

1.F.1.f. Health Care Informatics Concentration Requirements

- An undergraduate or graduate degree in a relevant field including the health sciences, information technology, allied health professions, business, or statistics, and a commitment to developing the necessary analytic and program management skills and expertise required of today's health informatics professional. Contact the program coordinator if you have questions about the relevance of your degree.
- Applicants possessing intermediate proficiency with multiple computer programs, including but not limited to word processing, data management/presentation, and statistical analysis packages commonly used in business and healthcare industries. Familiarity with these programs is required and serves as the foundation upon which other skill sets are developed.
- Applicants with backgrounds and experience outside of the common student profiles described above, or without a relevant degree or work experience, may be conditionally admitted to our program, with the expectation that the admitted student complete appropriate prerequisite coursework. Contact the program coordinator for details or for more information.

1.F.2. Admission Decisions

Final admission decisions are made by the Graduate School based on the recommendations from the concentration coordinator. The concentration coordinator evaluates each student's documents in a holistic manner and makes a recommendation to the graduate school: recommended for admission, recommended for conditional admission, or not recommended for admission. Conditional admission is reserved for students who do not meet the minimum

requirements but appear to have significant ability as determined by the coordinator's evaluation of the student's documentation. If conditional admission is recommended, the concentration coordinator suggests appropriate conditions, such as the student must make a B in each course the first semester. Once admitted, student grades are monitored by the Graduate School and the concentration coordinator.

1.F.3. Student Orientation, Advising, Supervision, and Retention

The executive aide for this program, Elizabeth Lamb/Darlene Fults, helps all students, but especially new and international students, with getting course over-rides, filling out paperwork, and other activities that help the student feel connected to MTSU and the MSPS program. New MSPS Graduate Assistants are expected to attend the Graduate School orientation given prior to each semester, but all students are expected to see their concentration coordinator for course advisement prior to registration each semester. During the first advising session, the coordinator and student select courses for the degree plan, fill out the required paperwork (advancement to candidacy and intent to graduate), and discuss any student issues, such as internship placement or retention. Retention standards for the MSPS program coincide directly with that of the Graduate School, as stated in the Graduate Catalog.

2. Finding and recommendations from previous review

2.A. Issue 1: Need for a New Science Building

Dr. Chapman noted in several places in the report that we are in desperate need of a new science building. We concur whole-heartedly! However, the reality of the situation is that severe budget issues have put the new building on hold for an indefinite period of time. We continue to do our best with the available resources and to seek alternatives.

UPDATE: We are happy to report that the new 250,000 ft^2 Science Building opened for classes in Fall 2014. The Biology and Chemistry Departments now reside in this new facility with modern classrooms, teaching laboratories, student meeting spaces, extensive technology, and shared laboratory research spaces.

2.B. Issue 2: Effect of Restructuring Colleges

The restructuring of the colleges is currently an ongoing process, so the exact placement of the program relative to the supporting departments is unknown. We do not anticipate the change in college structure to affect our program for several reasons noted below; however, we will deal with issues as they arise. First, the current MTSU academic master plan (2007-2017) pledges support to interdisciplinary programs that involve partnerships within and outside the University. Second, the program has strong faculty and departmental support, as well as Graduate School support. Additionally, regardless of which of the proposed college structuring proposal is adopted, only one additional college will be included. Finally, it is of the utmost importance for the continued success of this program, that MSPS program leaders/supporters apprise new

administrators (the deans and provost) of our strong record of quality and success and lobby for them to value the program accordingly.

UPDATE: The Colleges were re-structured and the effect was minimal. All core business departments remained in the College of Business. All six concentrations are housed in the College of Basic and Applied Sciences. Initially, five of the six concentrations resided within the College of Basic and Applied Sciences with Healthcare Informatics being housed in the College Behavioral Sciences. However, this concentration was moved to be directly in the College of Basic and Applied Sciences and a qualified coordinator/advisor was found in the College of Liberal Arts within the last 18 months.

2.C. Issue 3: Key Personnel Changes

The retirements of Dr. McGrew and Mrs. Feagans will impact us all, as they are/were both core and valuable members of our student-centered team.

Mrs. Feagans' interactions with students, her coordination and support of student programs, and her motherly attitude toward students were a phenomenal asset to the program. Careful selection of a personable and capable replacement, particularly one that would work full-time with the MSPS program, is of the utmost importance. The current College Associate Dean, who is also our program director, will be involved in the selection and we trust he will make a good choice. Realistically, though, this position will be a shared (½ + ½) executive aide position with the new Ph.D. programs.

Beginning July 1, 2010, the business core will be coordinated by Dr. Steve Lewis, who serves as Department Chair in the Department of Business Communication and Entrepreneurship. Dr. Lewis is committed to working with College of Business faculty and the MSPS Committee to ensure a smooth transition from the current coordinator. Dr. Linda McGrew will provide him with the appropriate information to assist in overseeing the internship course as well. He plans to attend the April 29, 2010 presentations and the meeting that will follow.

UPDATE: Dr. Vincent Smith replaced Dr. Steve Lewis after 1 year. Dr. Smith continues to be a strong advocate for this interdisciplinary degree. His contributions and leadership, particularly in the internship course, are a great benefit to all the MSPS students. Mrs. Elizabeth Lamb replaced Linda Feagans. Mrs. Lamb left to pursue other opportunities at the beginning of Fall semester 2015. Mrs. Darlene Fults has since joined the program as the executive aide. She uses her extensive knowledge of the inner workings of MTSU to help the program, students, faculty, and program coordinator accomplish their goals.

2.D. Issue 4: Additional Graduate Assistants

The Dean of the Graduate School determines the number of GA positions to be given to departments and programs. Dean Allen is and has been very supportive of the MSPS program in this respect, by adding additional GA positions. However, with the current financial crisis, we cannot expect additional GA positions, at least for the near future. The program director will ask for three additional GA positions for the year 2011/2012.

UPDATE: The MSPS program began with an allocation of 5 graduate assistantships in 2006, which had increased to 12 graduate assistantships at the time of the last review in 2009. Due to the growth of the program and the support of the new Deans and Provost, our director has been able to successfully argue for steady increases in assistantships for the program, which now has been allocated 18 full-time graduate assistantships as of Fall 2015. These assistantships currently support 26 students. However, with the added new concentrations and the subsequent additional growth of the program, we will be asking for new assistantships to support additional students.

2.E. Issue 5: Alteration of GRE Minimum Score Wording

The MSPS Program committee will take this under advisement and decide as a group.

UPDATE: We revised the wording to read 'recommended score' rather than minimum.

2.F. Issue 6: Minority Enrollment Discrepancy

This discrepancy is noted and the percentage should read 24%, in accordance with the nationally recognized minority student definition.

UPDATE: The error was corrected.

2.G. Issue 7: Biostatistics Course Options

Dr. Chapman notes that students in the biostatistics concentration expressed a wish for more course offerings. The two obstacles in the past to offering more statistics courses have been the low number of students eligible for these courses and the small number of faculty with the background to teach them. The first obstacle is being addressed by restructuring the prerequisites for several statistics courses so that more students can sign up for more courses. It will also be somewhat alleviated by the new Ph.D. programs, since students from those programs will be required to take some statistics. The second obstacle, the lack of faculty, is under discussion in the math department. We are looking at which courses can be taught by mathematicians who are not trained in statistics. We will also institute a review of what other statistics courses are offered on campus to see whether they can be included in the program.

UPDATE: We now get students in our statistics courses from several other degree programs, so having the courses make each semester has not been a problem. The lack of faculty is still a problem and, in fact, we lost a faculty member to retirement. However, we are hiring a statistician this year with the goal of supporting this program.

2.H. Issue 8: Student Recruitment

Dr. Chapman noted that it would be beneficial to survey our students to determine how they found the program in order to develop a more specialized recruitment plan. We also think this would be beneficial and will do a short survey. However, we do not wish to depend solely upon recruitment plans that attract only the students similar to those we already attract. It is our goal to recruit students that will benefit from the program and provide an educated workforce for the region.

UPDATE: To gain data about student recruitment from existing students, exit interview questions were added to address this information. Students have been introduced to the program by a number of routes including: friends, their employers, web searches, graduate school recruitment officials, visits from faculty to undergraduate classes, the national PSM meeting, and the MSPS Club. In 2010, recruiting for our program was done primarily through the Graduate School Recruiting office, however, we felt this was insufficient due to our high graduation rate (about 50 per year). Therefore, we began to seek a dedicated recruiter for this program. In fall 2015, we were granted a position for the MSPS internship placement and recruiting. This position is being advertised currently.

3. Learning Outcomes

Program outcomes for this degree program are multi-faceted and include not only learning outcomes for students in all six concentrations but also beneficial outcomes for the community and MTSU, such as industry partnership formation, collaborative scientific activities, workforce development, and enhancement of MTSU's reputation. The program outcomes, challenges, needs, and issues are monitored regularly by several groups. The MSPS director and coordinators meet monthly. The MSPS Advisory Board, which includes the director, coordinators, and industry professionals, meets at least once a year. Members of industry and any available Advisory Board members also meet at the end of each semester during the internship luncheon to discuss program initiatives and direction. We are currently in the process of electing a new Advisory Board Chair.

3.A. Program Outcomes

The goal for this degree is to provide science and business education at a master's level that allows students to learn theoretical knowledge, gain practical experience, and finally utilize all their learning and experiences in a real-world, multi-disciplinary internship. This goal is achieved by providing strong content-specific training with specific business management skills needed in scientific industry. It is expected that a graduate will have the skills and knowledge necessary to begin high-level productive work in a pure science, science management, or scientific business capacity. The selection of appropriate coursework, which was undertaken with input from industry professionals, allowed significant progress in achieving program and learning outcomes.

3.A.1. Core and Concentration-specific Outcomes

The core of the degree program and each concentration have specific outcomes. The core addresses aspects related to all students within the program and are related to real-world scientific business situations. Each concentration as specific outcomes, related to professional preparation for that discipline of science.

3.A.1.a. Business and Quantitative Core Outcomes

Business and quantitative education form the core of this program. All students participate in training in corporate communication, financial and risk management, leadership and professional development, and quantitative skills. The primary goal of business core courses is to prepare students to accept and function effectively in supervisory,

management, and leadership roles in their selected place of employment. Students learn concepts and skills necessary for preparing budgets, reading financial statements, handling legal issues, leading and motivating employees, and communicating with all levels of employees.

3.A.1.b. Actuarial Sciences Concentration Outcomes

Students with an actuarial science concentration are expected to understand fundamental principles of probability and statistics, financial mathematics, risk management, life contingencies, and loss models, as well as to understand the value and role of the actuaries in insurance industries and risk managements. The actuarial concentration core and elective courses prepare students for professional actuarial examinations from the Society of Actuaries and the Casualty Actuarial Society, and train application problem-solving skills. The seminar talks given by local actuaries and industrial people provide students precious lessons from working experience and help them build professional skills.

3.A.1.c. Biostatistics Concentration Outcomes

Students with a biostatistics concentration are expected to understand and be able to use probability theory, statistical interference, statistical computing, regression analysis, experimental design, as well as parametric, non-parametric, and multivariate analysis. The curriculum includes both theory and application courses. An advanced mathematical statistics sequence teaches the theory of probability and statistics. An introduction to biostatistics course and a two-course sequence in biostatistics focuses on topics specific to the application of statistics to biology and the medical sciences, including clinical trials, categorical data analysis, and survival analysis. Finally, students choose at least two of four courses on the general application of statistics. Students are exposed to several different statistical software packages, including R and SAS, in the different courses and are expected to communicate the statistical results in language understandable to nonstatisticians.

3.A.1.d. Biotechnology Concentration Outcomes

Students with a biotechnology concentration are expected to understand principles of commonly used biotechnology tools and applications, apply basic principles to new situations, plan and evaluate experiments, comprehend learning as a life-long pursuit, and understand the value and role of the team in scientific investigation. The two required concentration courses train students in biotechnology theory and practical skills (BIOL 5550) and prepare students for real world problem-solving in a team atmosphere and life-long learning (BIOL 6770). Each course within the concentration elective list is focused on modern biotechnology, has a laboratory component, and has an extensive open-ended research project to build knowledge and professional skills.

3.A.1.e. Engineering Management Concentration Outcomes

The Engineering Management concentration is specifically designed to provide engineers, scientists, and technicians with business and management tools needed in leadership positions. Intended for working professionals, the program can be completed on a part-time basis over two years. Classes are held in the evening and many online. The program

helps equip master's candidates to implement and manage competitive process innovation and product development. Graduates should interact comfortably and intelligently with scientific researchers as well as business leaders by developing the skill set of both. The Engineering Management degree is industry-recognized, and credits are transferrable. Students are taught to apply science to solve business issues, while simultaneously developing valued business skills including management, policy, law, project management, finance, and managerial accounting. The program emphasizes writing and communication skills. A final project or team experience, as well as an internship, is required.

3.A.1.f. Geosciences Concentration Outcomes

Students within the Geographic information systems, Environmental geosystems, and General geoscience career paths of the Geoscience concentration are expected to incorporate geoscience theories, principles, and concepts -- as well as professional standards of practice -- into a well-integrated perspective on the geosciences profession. All geoscience courses include theoretical concepts and their application, with pedagogy employing a variety of approaches: e.g. problem sets, professional writing exercises and presentations, collaborative exercises and projects, and discussion of professional conduct and ethical dilemmas. We are especially concerned with developing student awareness of their role as geoscientists in protecting the safety of, and maintaining quality of life for, the general public. The Geographic information systems career track requires students to learn standard GIS practices and work protocols utilizing a variety of software packages, integrated macro and standalone programming languages, and typical computer hardware configurations. Students pursuing the Environmental geosystems career track learn basic to advanced concepts of contaminant geology, including ASTM protocols for Phase I and Phase II environmental assessments. The General geoscience career track allows students to pursue a more generalized academic path, e.g. developing strengths in both geology and GIS preparatory to a career in environmental consulting, government, or geoengineering-related areas.

3.A.1.g. Health Care Informatics Concentration Outcomes

The Health Care Informatics concentration emphasizes the skills and experience that will prepare the next generation of professionals to be competitive in the business and healthcare information technology workforce. Health Care Informatics is designed around concentration courses in information systems applications and security, project management, business intelligence/analytics, and healthcare law, and electives in valuable specialty areas like Six Sigma and Lean Productivity Systems. This concentration is supplemented by a core of business courses in accounting, statistics, managerial communication, leadership, and a capstone internship experience. The program supports both part-time and full-time students, and limited graduate assistantships are awarded on a competitive basis.

3.A.2. Program Outcomes Related to Industry

As a program, we constantly interact with industry professionals. Industry mentor ratings of internship students, student employment in industry, as well as industry support comments indicate satisfaction with the program and students.

3.A.2.a. Internship Mentor Student Ratings

Industry mentors for the internship students are asked to evaluation interns twice during the internship course, at midterm and at the end of the internship. Data gathered during the internship and utilized in the Institutional Effectiveness indicates that they are satisfied with student performance (Table 1, following page and Appendix B), as nearly all values average over 95% for the eleven semesters analyzed.

3.A.2.b. Student Employment

A large number of students remain employed in the company where they do their internship. Companies have even created jobs within their companies to be able to employ interns following graduation. See Appendix C for internship and employment data.

3.A.2.c. Industry Support

Industry representatives have provided supportive comments for this program. The iLab Solutions, Chief Product Officer wrote: "It was a pleasure having [Nandini Ovalasumuthovu, Health Care Informatics, 2015] intern with us and I was sorry to see the internship end. Nandini was knowledgeable in the field, quite conscientious in work and added a great deal of value to our team." In addition, support letters from Environmental Science Corporation and Sarah Cannon Research Institute, and Blue Cross/Blue Shield of Tennessee can be found in Appendix D.

Table 1. Industry Internship Mentor Ratings of Interns

Concentration	Measure*	Sp12	Su12	F12	Sp13	Su13	F13	Sp14	Su14	F14	Sp15	Su15	Mean
All	1.2	100	100	100	100	98	100	100	100	100	90	100	98.9
All	2.2	100	100	98	98	100	100	100	100	100	90	100	98.7
ACSC	4.1	75**	100	na	na	100	100	100	100	100	100	100	97.2
ACSC	5.1	75**	100	na	na	100	100	100	100	100	100	100	97.2
BIOS	4.1	100	100	100	100	100	100	100	100	na	100	100	100.0
BIOS	5.1	100	100	100	100	100	100	100	100	na	100	100	100.0
BIOT	4.1	100	100	100	100	100	100	100	100	100	70	100	97.3
BIOT	5.1	100	100	100	100	100	100	100	100	100	70	100	97.3
EM	4.1	na	na	na	na	na	100	na	100	100	na	100	100.0
GEOS	4.1	na	na	na	na	na	na	na	100	na	100	100	100.0

* Column 2 (Measure) indicates the Outcome and Assessment method listed on the Institutional Effectiveness Plan. For example, Measure 1.2 (row 1) indicates Outcome 1 and Assessment Method 2.

** This value resulted from the question not being answered, rather than from known dissatisfaction.

See Appendix B for each Outcome and Assessment method. Values are listed as average percentages for each semester. The notation "na" is used when there were no graduates from that particular concentration for that semester.

3.B. Student Learning Outcomes

A number of items indicate the successful attainment of the program goals, including success in courses, program enrollment and graduation, placement in professional employment or education, and the building of a national reputation.

3.B.1. Course and Program Assessments

Summative evaluation through assignment and project grading by faculty allows the assessment of whether the student has satisfactorily understood concepts in those areas and displays skills expected of professionals. All students must maintain a GPA of 3.0 in order to graduate. Of particular importance is the culminating internship course in which students are placed in a real-world setting and evaluated by the internship mentor, as well as the internship coordinator.

In addition to summative assessment made by content specialists, the program director and internship coordinator conduct a graduate exit interview. Program effectiveness data are also gathered on four-five outcomes as part of the exit interview and internship course. The first three outcomes are common among the concentrations and the remaining are specific to each concentration. Please see Appendix A for interview questions and Appendix B for the Institutional Effectiveness assessments for each concentration. Each outcome was met for all semesters in which data was able to be collected. In addition, strategies for further improvement were also noted; see Appendix B for specific details).

3.B.1.a. Common MSPS Outcomes

Outcome 1: Master of Science in Professional Science students will demonstrate effective written communication skills.

Criterion 1: 75% minimum
Evaluation 1: MET
Details 1: mean =98.8%, range 93.3%-100%, 11 semesters of data

Criterion 2: 75% minimum
Evaluation 2: MET
Details 2: mean =99.9%, range 90%-100%, 11 semesters of data

Outcome 2: Master of Science in Professional Science students will demonstrate effective oral communication skills.

Criterion 1: 100% minimum
Evaluation 1: MET
Details 1: mean =99.6%, 95%-100%, 11 semesters of data

Criterion 2: 75% minimum
Evaluation 2: MET
Details 2: mean =98.7%, range 90%-100%, 11 semesters of data

Outcome 3: Master of Science in Professional Science students will apply business core competencies to their major area of study.

Criterion 1: 75% minimum
Evaluation 1: MET
Details 1: mean =87.3%, 75%-100%, 11 semesters of data

3.B.1.b. Actuarial Science-specific Outcomes

Outcome 4: Master of Science in Professional Science students in the Actuarial Science Concentration will demonstrate the ability to calculate and explain appropriate actuarial present values, premiums, and reserves.

Criterion 1: 75% minimum
Evaluation 1: MET
Details 1: mean =97.2%, 75%-100%, 9 semesters of data

Outcome 5: Master of Science in Professional Science students in the Actuarial Science Concentration will demonstrate the ability to utilize actuarial models in insurance applications.

Criterion 1: 75% minimum
Evaluation 1: MET
Details 1: mean =97.2%, 75%-100%, 9 semesters of data

3.B.1.c.Biostatistics-specific Outcomes

Outcome 4: Master of Science in Professional Science students in the Biostatistics Concentration will demonstrate the ability to calculate and explain appropriate descriptive statistics.

Criterion 1: 75% minimum
Evaluation 1: MET
Details 1: mean =100%, no range, 11 semesters of data

Outcome 5: Master of Science in Professional Science students in the Biostatistics Concentration will demonstrate the ability to perform statistical inference.

Criterion 1: 75% minimum
Evaluation 1: MET
Details 1: mean =100%, no range, 11 semesters of data

3.B.1.d. Biotechnology-specific Outcomes

Outcome 4: Master of Science in Professional Science students in the Biotechnology Concentration will demonstrate the ability to understand and perform laboratory techniques common to molecular science.

Criterion 1: 75% minimum
Evaluation 1: MET
Details 1: mean =97.3%, 70%-100%, 11 semesters of data

Outcome 5: Master of Science in Professional Science students in the Biotechnology Concentration will demonstrate the ability to utilize problem solving skills in a real world setting.

Criterion 1: 75% minimum
Evaluation 1: MET
Details 1: mean =97.3%, 70%-100%, 11 semesters of data

3.B.1.e. Engineering Management-specific Outcomes

Outcome 4: Master of Science in Professional Science students in the Engineering Management Concentration will demonstrate the ability to utilize problem-solving skills in a real world setting.

Criterion 1: 75% minimum
Evaluation 1: MET
Details 1: mean =100%, no range, 3 semesters of data

3.B.1.f. Geosciences-specific Outcomes

Outcome 4: Master of Science in Professional Science students in the Geosciences Concentration will demonstrate the ability to utilize problem-solving skills in a real world setting.

Criterion 1: 75% minimum
Evaluation 1: MET
Details 1: mean =100%, no range, 3 semester of data

3.B.1.g. Health Care Informatics-specific Outcome

Outcome 4: Master of Science in Professional Science students to apply theoretical principles from their Health Care Informatics program of study to real world situations.

Criterion 1: 75% minimum
Evaluation 1: MET
Details 1: mean =94.4%, 70%-100%, 9 semesters of data

3.B.2. Program Enrollment and Graduation

The astounding growth of this program, graduation rate, and the placement of graduates in industry positions or higher education are also good indicators of the program's success. The numbers of students enrolled and graduated are noted in Table 2 (following page). Of these graduates, most of those we have been able to track are employed or have gone on to additional higher education training. See Appendix C for the full list of interns, internship companies, and current employment locations. Finally, the MSPS program at MTSU has become a nationally recognized model program by the Council of Graduate Studies and the national PSM program. The director has been asked to speak at numerous conferences and other schools have visited or scheduled visits to examine the program.

Table 2. Enrollment, Graduation, and Minority Data

Status	Fall 2005	Fall 2006	Fall 2007	Fall 2008	Fall 2009	Fall 2010	Fall 2011	Fall 2012	Fall 2013	Fall 2014	Fall 2015
Full-Time*	7	13	20	25	31	39	29	54	56	47	46
Part-Time	13	26	31	34	26	34	47	51	84	67	64
Total	**20**	**39**	**51**	**59**	**57**	**73**	**76**	**105**	**140**	**114**	**110**
% Full-Time*	**35%**	**33%**	**39%**	**42%**	**54%**	**47%**	**62%**	**49%**	**60%**	**59%**	**58%**
Graduates in the Calendar Year Listed**	**0**	**1**	**4**	**19**	**21**	**20**	**22**	**29**	**34**	**44**	**51**
Minority Enrollment						**24.7%**	**21.1%**	**23.8%**	**25.7%**	**21.1%**	**18.2%**
Female Enrollment						**65.8%**	**57.9%**	**45.7%**	**52.9%**	**55.3%**	**49.1%**
Graduates / All Enrolled	**-**	**2.60%**	**7.80%**	**32.20%**	**36.80%**	**27.40%**	**28.95%**	**27.62%**	**24.29%**	**38.60%**	**46.36%**

* Please note that the number of full-time students is artificially low because the Enrollment Office will count a full or half-Graduate Assistant or a S-STEM scholar who has a full–time load of six hours as a part-time student.

**The total number of MSPS graduates for this reporting period is 200 graduates with 245 graduates total since the beginning of the program in 2005. This is a more than 400% increase in graduates over the first reporting period.

3.B.3. Partnership Formation and Continued Industry Involvement

Active partnerships were initiated by including the regional scientific industry community in designing the degree program. They are continually fostered through the activities and interactions of MSPS Advisory Board, industry scientists, faculty, and students. First, the MSPS Advisory Board includes 30 industry professionals from eighteen companies, five units within academia, and three government agencies, and meets formally once per year. We are currently in the process of electing a new Advisory Board Chair. Members of industry and any available Advisory Board members also meet at the end of each semester during the internship luncheon to discuss program initiatives and direction. Additionally, faculty seek out and include industry problems in numerous courses, arrange seminars with industry speakers (over 30 per year), and take students to visit industry sites (three-ten per year). Finally, faculty, students, and industry representatives collaborate to build internship experiences in which students gain valuable real-world experience and industry gains a trained workforce. Faculty and/or students have arranged internship-based partnerships at over 95 different companies including:

- Aegis Lab Sciences
- Blue Cross/Blue Shield of Tennessee
- Advanced Breath Diagnostics (now Cairn Diagnostics)
- Community Health Systems
- Covance
- Environmental Science Corporation
- GenHunter
- Hospital Corporation of America
- ICON Clinical Research
- InCellDX
- Industrial Microbiology Laboratories
- InMotion
- Jack Daniels Distillery
- Med Solutions
- National Healthcare Corporation
- Sarah Cannon Cancer Research Institute
- SIGMA Actuarial Consulting
- Stonecrest Medical Center
- Tennessee Department of Health in the Vector Borne Diseases and Diabetes sectors
- Tennessee Bureau of Investigation
- United South and Eastern Tribes, Inc.
- V.A. Hospital, Murfreesboro
- Vanderbilt Ingram Cancer Center
- Vanderbilt Technologies for Advanced Genomics
- Vi-Jon Laboratories

3.B.4. Collaborative Scientific Activities

Through the internship experience and the inclusion of real world problems in courses, this program has fostered collaborative research activities. A number of students have participated in original research in their internship experiences and graduate assistantship or scholarship assignments. At the end of the internship experience, each student presents his/her internship work in a formal seminar format, which can include professional scientific research and/or the scientific business activities performed in the real world.

3.B.5. Workforce Development

The region is therefore gaining a highly trained, skilled workforce through the activities of this program. Scientific businesses have access to highly trained students, particularly in the internship experience. Businesses have hired students during the course of the internship and even created specific positions for them. In addition to supporting existing scientific enterprise, the availability of skilled workers makes the region more attractive for scientific businesses to relocate and develop.

3.B.6. National Reputation

The MSPS Program at MTSU has received national, as well as local, distinctions and recognition. On a local level, the MSPS program is the fastest growing master's level program at MTSU. On a national level, this MSPS program has been recognized by the Council for Graduate Schools as a model program. In addition, faculty and administrators from other universities have invited MTSU's MSPS Director, Dr. Saeed Foroudastan, to come to their campuses and provide leadership about how to have a successful program. Other universities have elected to send a team of faculty to MTSU to meet firsthand with the MTSU MSPS leadership team.

3.B.6.a.Program Awards

The MSPS program at MTSU received the Tennessee Board of Regents Academic Excellence Award in 2010. This award is given to an outstanding program in the Tennessee Board of Regents System. Dr. Saeed Foroudastan, MSPS program director at MTSU, is a co-organizer of the National Professional Science Master's Association (NPSMA) conference and a NPSMA board member. He was surprised with the President's Award in late 2015, which is presented to a PSM member for outstanding contributions and services to the PSM initiative. He accepted the award on behalf of the students, faculty, industry, and university because without them he would not have had the support to make this program as successful as it is. Dr. Foroudastan appreciates every person involved in establishing and maintaining this program for student's seeking a Professional Master's degree. He is the only NPSMA member to receive both the Board of Directors Award in 2012 and President's Award in 2015. Finally, the MTSU Actuarial Science (ACSC) program has been nominated for the Center of Actuarial Excellence for the Society of Actuaries.

3.B.6.b. National Presentations by Students

Students from the MSPS program have also been invited to present at the National and Regional Council of Graduate Schools and at the biannual Professional Science Master's

National Conference. Ms. Karly Danhausen and Ms. Chelsea Nihill presented at the 2015 PSMNA conference in fall 2015. In addition, students have also presented in national concentration-specific conferences. For the past 3 years, ACSC students participated in the Actuarial Research Conferences. Kim Page's presentation entitled "Predictive Analytics for Minor League Baseball Pitchers" won honorable mention and a cash award from the conference held at Toronto University in August 2015. Biotechnology students regularly present at regional and national conferences. For example, Ms. Mahsa Majedi participated in the Tennessee Academy of Science and received a second place award in the Cellular and Molecular Biology Section in 2014. Geosciences students regularly present at national conferences as well. For example, S. W. Williams, A. Gilley, and A. McCloud have presented at AutoCarto conferences.

3.B.6.c. Grants in Support of Students

MSPS program personnel were able to secure a National Science Foundation award ($599,076) over four years (2007-2011) to support MS and MSPS graduate student scholarships. This type of S-STEM award is particularly well-received and indicative of the quality and need of the programs (MSPS, MS Biology, and MS Chemistry) since these awards are rarely given to support graduate students. This grant supported a stipend and ½ tuition and fees for four MSPS students each in spring 2010, fall 2010, and spring 2011 and two students each in summer 2011 and 2011. In addition, Dr. Don Hong, coordinator of the ACSC concentration, received $10,000 actuarial science program grants in total from the Casualty Actuaries of the Southeast (CASE) since 2007 to reimburse students exam fees from the professional actuarial societies. Dr. Henrique Momm, coordinator of the GEOS concentrations has submitted several nationally competitive grants and received support for two graduate assistantships. For more information, please see the support section (9) and the curriculum vitae of these faculty.

4. Curriculum

4.A. Curriculum Overview

The two-year program consists of 36 credit hours of coursework/experiences:

Description	Credit hours (36 total)
Business Core	9
Quantitative	3
Concentration-specific courses	21
Internship	3

Currently, there are six concentrations: Actuarial Sciences, Biostatistics, Biotechnology, Engineering Management, Geosciences, and Health Care Informatics. The business core and each concentration will be discussed separately as they each have different goals and challenges.

4.A.1. Prior Overall Challenges and Resolution

The most significant prior overall challenge for the program and its graduates was its originality. This degree has become more common across the country and the National Professional Masters Society has taken on the challenge of spreading the word about this degree. Another significant challenge for this program was workload. Faculty time was spread thin, particularly in the biostatistics and health care informatics concentrations, but also regarding our executive aide, whose time allocation to the MSPS program was only 50% of her time. Hiring, reallocation of time, and curricular changes have alleviated some of these issues. There are now more biostatistics faculty, curricular changes have been implemented in the HCI concentration, and the executive aide now has 70% of her time for MSPS.

4.B. Business Core Description

A core of business education coursework is found in each of the MSPS degree concentrations. All students experience critical thinking and problem solving in managerial communication, financial and risk management, and leadership/professional development. The goal of the business core courses is to prepare students to accept and function effectively in supervisory, management, and leadership roles in their selected place of employment. Students learn concepts and skills necessary for preparing budgets, analyzing financial statements, handling legal issues, leading and motivating employees, and communicating with all levels of employees. To support classroom experiences, students apply their learning and investigation to the career environment by completing a required internship experience during one of their last two semesters in the program. The Business Core consists of the following courses (3 credit hours each):

BCED 6820	Managerial Communication
MGMT 6740	Leadership and Motivation
ACTG 6100	Accounting and Legal Issues for Managers
BCED 6910	Internship

Course syllabi which provide detailed information on course objectives are found in Appendix E.

4.B.1. Prior Core Challenges and Resolutions

One challenge encountered by faculty teaching in the business core was offering courses convenient for Blue Cross/Blue Shield students enrolled in the program. A workable solution was for business faculty to teach the courses on selected Fridays and Saturdays at Blue Cross in Chattanooga during summers.

4.B.2. Current Core Challenges

With the initial plan to seek a full-time Internship Coordinator/Recruiter for the entire MSPS program, a need exists for a graduate assistant position to be shared with the Internship Coordinator/Recruiter and BCED 6910 Internship Supervisor to coordinate efforts to collect assessment data from interns for Institutional Effectiveness and program improvement efforts.

With continued growth of the program, scheduling of the required internship presentation in a one-day format will be reviewed. With the limited time available on a single day to bring

interns in for live presentations to faculty, students, employers, and peers, scheduling will need to be reconsidered.

4.C. Quantitative Core Description

The purpose of including a common quantitative course, STAT 5140, within the program core addresses a need for all scientific professionals in today's world to have an understanding of mathematical and statistical concepts within the realm of science.

4.C.1. Prior Core Challenges and Resolutions

The previous challenges faced by including this course in the core were staffing issues, but this has been resolved and the course is offered each semester.

4.C.2. Current Core Challenges

Now that the course is regularly taught, is scheduled routinely, and there is sufficient student interest and faculty expertise, there are no current challenges.

4.D. Actuarial Sciences Concentration Description and Challenges

The Actuarial Sciences concentration is one of the relative new programs in the MSPS degree at MTSU. This discipline trains students to make practical use of probability theory and statistical analysis for managing risks and solving problems in insurance, pension, and financial management business. Graduates well positioned to fill the growing need for individuals with this highly specialized training in the financial services and consulting industries in addition to the traditional insurance and health care industries.

Required	Course Number and Name (Required plus select 12 hours)	
X	ACSI 6020	Construction and Evaluation of Actuarial Models
X	ACSI 6030	Actuarial Models for Life Contingencies
X	ACSI 6040	Actuarial Models for Financial Economics
	ACSI 5220	Mathematics of Corporation Finance
	ACSI 5230	Mathematics of Compound Interest
	ACSI 5240	Mathematics of Interest Theory, Economics, and Finance
	ACSI 5330	Actuarial Mathematics I
	ACSI 5630	Mathematics of Risk Management
	ACSI 5640	Mathematics of Options, Futures, and Other Derivatives
	ACSI 6010	Credibility Theory and Loss Distributions
	ACSI 6600	Problems in Actuarial Science
	ECON 6070	Econometrics II
	STAT 5200	Statistical Methods for Forecasting
	STAT 6160	Advanced Mathematical Statistics I
	STAT 6180	Advanced Mathematical Statistics II
	MATH 6603 OR MATH 6604 OR MATH 6605	Problems in Mathematics-Mathematics of Finance OR Problems in Mathematics-Mathematics of Life Contingencies OR Problems in Mathematics-Numerical Analysis

4.D.1. Current ACSC Challenges

The most significant challenges for this concentration involve: 1) providing graduate assistantships or tuition waiver financial support to excellent students recruited from out state or overseas and 2) recruiting more companies to support additional internship opportunities for students.

4.E. Biostatistics Concentration Description

The Biostatistics concentration provides training in statistical methods that can be applied to biomedical and health-related fields. These methods involve using mathematics to solve real-world problems that influence health. Statistical areas of study include clinical trials, experimental design, categorical and longitudinal data analysis, and survival analysis. Graduates will ideally work in professional settings including health care agencies; governmental agencies such as the National Institutes of Health, the Centers for Disease Control and Prevention, and the Environmental Protection Agency; and the pharmaceutical industry.

The curriculum includes the following:

Required	Course Number and Name (Required plus select 8 hours)	
X	STAT 6020	Introduction to Biostatistics
X	STAT 6160	Advanced Mathematical Statistics I
X	STAT 6180	Advanced Mathematical Statistics II
X	STAT 6510	Biostatistical Methods
X	STAT 6520	Advanced Biostatistical Methods
	STAT 6602	Regression Analysis
	STAT 6603	Nonparametric Statistics
	STAT 6604	Experimental Design
	STAT 6605	SAS Programming

4.E.1. Prior BIOS Challenges and Resolutions

A prior curricular challenge was the dependence of later courses on earlier courses as prerequisites. Courses have been redesigned so that the only prerequisite for STAT 6180 is STAT 6160 and STAT 6510 and STAT 6520 can be taken in either order.

4.E.2. Current BIOS Challenges

We do not have a class in Bayesian analysis. We offered one as a special topics course in the Fall of 2015, but it did not get enough interest from students and was cancelled. Also, we need to incorporate the analysis of very large data sets into some of our application courses.

4.F. Biotechnology Concentration Description

The biotechnology concentration was designed to reflect the breadth of scientific skills and knowledge encompassed by biotechnology. Each course in the curriculum is current and includes a hands-on, semester-long laboratory research experience. Two courses are required, Biotechnology (BIOL 5550) and Issues in Biotechnology (BIOL 6770), to provide a common scientific foundation (BIOL 5550) and to enhance life-long learning and team-based problem

solving using real industry problems (BIOL 6770). The remainder of the concentration (16 hours selected from a list of 14 courses) is flexible to allow the student to specialize in an area most beneficial to her/his personal career goals, such as genetics, microbiology, or plant biotechnology.

The curriculum includes the following:

Required	Course Number and Name (Required plus select 16 hours)	
X	BIOL 5550	Biotechnology
X	BIOL 6770	Issues in Biotechnology
	BIOL 5460	Human Genetics
	BIOL 5510	Food/Industrial Microbiology
	BIOL 6350	Biostatistical Analysis
	BIOL 6380	Experimental Immunology
	BIOL 6390	Advanced Cell and Molecular Biology
	BIOL 6410	Advanced Transmitting Electron Microscopy
	BIOL 6430	Clinical and Pathogenic Microbiology
	BIOL 6440	Advanced Virology
	BIOL 6450	Advancements in Molecular Genetics
	BIOL 6500	Special Problems in Biology
	BIOL 6590	Environmental Toxicology
	BIOL 6650	Seminar
	BIOL 6660	Seminar
	BIOL 6720	Advanced Animal Development
	BIOL 6730	Advanced Microbial Physiology and Biochemistry
	BIOL 6750	Advanced Plant Biotechnology
	BIOL 6760	Bioinformatics
	CHEM 6510	Biochemistry II
	CHEM 6530	Biochemical Techniques

4.F.1. Prior BIOT Challenges and Resolutions

Students and faculty who participate in this concentration have faced challenges that have focused on the high demand for certain courses, such as BIOL 5550. This dual-listed course previously combined undergraduate and graduate students with only five graduate-level seats per semester. Additionally, it is required for numerous other programs, so students were generally waiting several semesters before they are able to register for it. The Biology Department recently separated the dual-listed course so that there is now a full class of graduate students. Another set of challenges for this area was the space and facilities of the science building. MTSU opened the new science building facility in Fall 2014 with 250,000 sqft of dedicated space. Faculty and students are now able to utilize the most modern facilities and equipment.

4.F.2. Current BIOT Challenges

The most significant unresolved challenges for this concentration involve: 1) recruiting new students for the program (inside and outside the region) and 2) recruiting biotechnology companies to support additional internship opportunities for students. This should be

alleviated at least in part by the hiring of the new MSPS internship coordinator/recruiter this spring.

4.G. Engineering Management Concentration Description

The Engineering Management concentration is specifically designed to help equip master's candidates to implement and manage competitive process innovation and product development. Students are taught to apply science to solve business issues, while simultaneously developing valued business skills including management, policy, law, project management, finance, and managerial accounting. The program emphasizes writing and communication skills. A final project or team experience, as well as an internship, is required.

Required	Course Number and Name	
X	ET 6010	Safety Planning
X	ET 6190	Six Sigma
X	ET 6300	PMI Project Management
X	ET 6390	Productivity Strategies/Lean Systems
X	ET 6620	Methods of Research
X	ET 6870	Engineering Management Systems
X	ET 6810 or ET 6520	Engineering Management Theory and Application
X	ET 6520	Advanced Topics in Technology

4.G.1. Current EM Challenges

One significant challenge to this concentration area is faced by managing the classes to suit the working professional. This may be addressed by incorporating more flexible course delivery for at least some of the EM concentration courses.

4.H. Geosciences Concentration Description

The Geosciences concentration provides training for students seeking careers as geoscientists in private industry and government agencies, as well as working professionals seeking advanced training in the geosciences. There is a high demand for well-trained and experienced geoscientists in areas such as geographic information systems and environmental geology. The goal of the Geosciences concentration is to provide each student the knowledge, skills, and experiences necessary to secure employment as a professional geoscientist, and/or to advance into managerial positions within the profession. Students may elect to complete specializations in either Geographic Information Systems or Environmental Geosystems, or may elect to complete a general Geoscience program of studies.

The curriculum includes the following for the Geographic Information Systems (GIS) emphasis:

Required	Course Number and Name (Required plus 3 credit hours)	
X	GEOL 6030	Geosciences Colloquium
X	PGEO 6040	Geospatial Systems and Applications
X	PGEO 5560	Intermediate GIS

X	PGEO 5570	Advanced GIS
X	PGEO 6050	Programming for Geospatial Database Applications
X	INFS 6710	IT Systems Development Project Management
	Plus 3 (three) credit hours from the following	
	INFS 6500	IT Project Management Planning and Implementation
	INFS 6510	IT Project Risk Assessment and Control
	INFS 6520	IT Project Management Case Studies
	Electives	
	PGEO 6070	Quantitative Methods in Geosciences
	PGEO 5511	Advanced Remote Sensing
	PGEO 6060	Advanced Topics in Geosciences

The curriculum includes the following for the Environmental Geosystems emphasis:

Required	**Course Number and Name (Required plus 3 credit hours)**	
X	GEOL 6030	Geosciences Colloquium
X	PGEO 6040	Geospatial Systems and Applications
X	GEOL 6020	Advanced Hydrology
X	GEOL 5040	Engineering Geology
X	GEOL 6000	Environmental Geosystems
X	GEOL 6010	Case Studies in Environmental Geosystems
	ABAS 5340	Soil Formation and Remediation
	ABAS 5350	Soil Survey and Land Use
	GEOL 5150	Environmental Applications of Hydrogeology

The curriculum includes the following for the General Geosciences emphasis:

Required	Course Number and Name (Required plus)	
X	GEOL 6030	Geosciences Colloquium
	Plus 12 (twelve) credit hours from the following	
	PGEO 6040	Geospatial Systems and Applications
	PGEO 6050	Programming for Geospatial Database Applications
	GEOL 6030	Advanced Hydrology
	GEOL 6000	Environmental Geosystems
	GEOL 6010	Case Studies in Environmental Geosystems
	Plus 7 (seven) credit hours from the following	
	PGEO 5380	Cartography
	PGEO 5490	Remote Sensing
	PGEO 5510	Laboratory Problems in Remote Sensing
	PGEO 5560	Intermediate GIS
	PGEO 5570	Advanced GIS
	GEOL 5000	Petrology and Petrography
	GEOL 5020	Geomorphic Regions of the United States
	GEOL 5030	Invertebrate Micropaleontology
	GEOL 5050	Meteorology
	GEOL 5060	Principles of Geoscience
	GEOL 5070	Sedimentation and Stratigraphy
	GEOL 5080	Structural Geology
	GEOL 5100	Geophysical Prospecting
	GEOL 5130	Hydrogeology
	GEOL 5140	Inorganic Geochemistry
	GEOL 5150	Environmental Applications of Hydrogeology
	GEOL 5040	Engineering Geology
	GEOL 5401	Field Course
	INFS 6500	IT Project Management Planning and Implementation
	INFS 6510	IT Project Risk Assessment and Control
	INFS 6520	IT Project Management Case Studies
	INFS 6710	IT Systems Development Project Management

4.H.1. Current GEOS Challenges

With three separate career paths we face a range of challenges, some of which are unique to the career path. In Geographic Information Systems (GIS), undergraduate students come to the program with a very wide range of knowledge and experience in the use of GIS. That makes it difficult to provide a “one size fits all” curriculum. However, this is partially addressed by having three different courses (Intro, Intermediate, & Advanced) in GIS techniques so students can begin the program at whatever level is most appropriate to their background. A further challenge is the disconnect between a student’s historically-based expectations of financial assistance and the current financial reality of the financial assistance available.

4.I. Health Care Informatics Concentration Description

The Health Care Informatics concentration emphasizes the skills and experience that will prepare the next generation of professionals to be competitive in the business and healthcare information technology workforce. The M.S. in Professional Science is a groundbreaking master's degree in the sciences, technology, engineering, and mathematics (STEM) disciplines that helps equip students for work in public and private business enterprises and in academia.

Health Care Informatics plays an important role in all aspects of health care delivery in today's industry. This degree is designed around concentration courses in information systems applications and security, project management, business intelligence/analytics, and healthcare law, and electives in valuable specialty areas like Six Sigma and Lean Productivity Systems. These will help graduates manage and communicate data, information, and knowledge across multiple health care settings. They will also help students effectively manage and communicate with colleagues and clients. This interdisciplinary degree is well suited to traditional students as well as working professionals, and graduates of this concentration will fill the growing need for data science leaders in the business of health care.

The Health Care Informatics concentration program of study was reviewed and updated during 2014 with updates being phased in beginning in Spring 2015. The first class of students under the new curriculum will potentially graduate in Summer 2017, depending on their respective course loads. The 2014 program revision was substantial, and largely reflects shifting industry demands. All concentration courses were replaced with updated offerings, shown below, to better match the various skill-sets sought by employers in the very competitive environments of data science and health care information technology. Already existing courses at MTSU comprised most of the new additions to the health care informatics curriculum, with two exceptions: Applied Health Care Data Management, and Topics in Contemporary Health Care. These new course proposals are currently under development, for offering in Summer 2017.

The current curriculum is outlined below:

Required	**Course Number and Name (Required plus select 1 course)**	
x	BIA 6905	Applied Business Analytics
x	BLAW 6500	Legal Aspects of Healthcare
x	ET 6300	Project Management & Soft Skills
x	HCI 6420	Topics in Contemporary Health Care
x	HCI 6430	Applied Health Care Data Management
x	INFS 6300	IS Security: Management & Assurance
x	INFS 6835	Information Systems Applications
	ET 6390	Productivity Strategies/Lean Systems
	BIA 6910	Business Intelligence
	ET 6190	Six Sigma
	ET 6010	Safety Planning
	ET 6870	Engineering Management Systems

4.I.1. Prior HCI Challenges and Resolutions

Prior challenges to this concentration were an emphasis on medical records and the novelty of information systems at the time. However, close industrial connections have indicated that the data science and health care information technology jobs for which many of our graduates compete are today less clinical and more focused on the technical and management side of health informatics. Today's graduates should therefore possess a broad range of skills to meet the expectations of large health care corporations, not-for-profits, and public health agencies. The revised curriculum was designed with these goals in mind, and aims to prepare graduates for the workforce demands described above. So two things are important here: the industry appears to have shifted away from clinical applications and toward the business and management side of health care, while prospective employers expect job candidates to a breadth of skills ranging from information systems, leadership, business analytics, project management, etc. So, this is not so much of a challenge anymore; rather, the challenge has shifted a bit toward business and versatile skill-sets.

An additional challenge for this program track was attracting qualified health care informatics faculty. We would agree with the point about the challenge of luring informatics professionals away from industry, but one way to address this is to utilize working professionals as adjunct instructors. So, it's still a challenge, but can be resolvable.

4.I.2. Current HCI Challenges

The health care informatics program has a number of strengths and few weaknesses. One strength involves the curriculum's interdisciplinary structure, which draws from areas as diverse as data science, law, business intelligence and analytics, leadership, engineering, and project management. Such breadth prepares graduates to work across various boundaries and diverse groups of colleagues. The updated curriculum is also rigorously relevant, thereby preparing graduates to enter the workforce with skills that are very much in demand. Another strength involves direct contact with course instructors as a way to build collegial networks. This is one aspect largely missing from many online-only programs. Finally, the vast networks of industry and internship contacts associated with the health care informatics program also represents a significant strength.

Still, the health care informatics concentration is not without challenges. While we are in the process of phasing in a new and updated set of courses, our next challenge involves large-scale recruiting efforts to bring highly qualified students into this program. This is most definitely a challenge. Another challenge involves the ongoing transition into the new health care informatics curriculum as older nursing informatics courses are gradually phased out. Still, all programs experience the growing pains associated with curricular updates and program transitions, so while this is a challenge, this concentration will emerge from this period of change stronger and better positioned than before.

4.J. Capstone Internship Experience Description

An extensive internship experience serves as a capstone experiential learning activity requiring an industry placement designed to enhance and extend classroom experiences. This program involves interdisciplinary organization and approval by the major area advisor and the business

core coordinator. These internships serve to transition students into industry, provide students with the advantage of sharpening professional skills before entering the workforce, and introduce students to potential employers. During the internship, students are evaluated at midterm and at the end of semester by the business supervisor and the internship supervisor. Students submit a weekly journal which consists of hours worked and responsibilities performed.

A portfolio is submitted at the end of the semester. This portfolio includes the following: a reflective paper, cover letter and resume, summary of an interview of someone in major area, mid-term and final evaluations, and copy of PowerPoint presentation of special projects performed or activities completed. A formal presentation is required as the culminating professional experience. The MSPS Committee, the MTSU community, business supervisors, and Advisory Board Members are invited to attend these presentations. Such specialized on-the-job training prepares students for immediate employment upon graduation.

4.K. Course Offerings are Timely and Appropriate for Discipline

Courses are taught by Ph.D. level graduate faculty who are scholarly active and evaluated each semester. The courses in the program are offered on a timely basis as shown below with the average being greater than 4 times, a minimum of once, and a maximum of nine. Classes noted **in bold** were proposed specifically for this program or have been revised significantly to address MSPS student learning outcomes. Classes noted *in italics* were existing classes that have been added in recent years in response to student and/or industry suggestion.

Table 3. Course Offerings (2010-2015) for Core Courses

ACTG 6100	**Actg & Legal Issues for Mgrs**	**18**
BCED 6820	**Managerial Communication**	**14**
BCED 6910	**Internship Program**	**15**
MGMT 6740	**Leadership and Motivation**	**19**
STAT 5140	**Probabilistic Statistical Reasoning**	**11**

Table 4. Courses Offerings (2010-2015) for Concentration-required Courses

HCI 6420	Topics in Contemporary Health Care	**new**
HCI 6430	Applied Health Care Data Management	**new**
BIOL 5550	Biotechnology	23
INFS 6710	IT Systems Development Project Management	11
ET 6300	PMI Project Management	10
BIOL 6770	**Issues in Biotechnology**	**8**
STAT 6020	**Intro to Biostatistics**	**7**
ACSI 6020	**Construction and Evaluation of Actuarial Models**	**6**
ACSI 6030	**Actuarial Models for Life Contingencies**	**6**
ET 6010 (HCI/ET)	Safety Planning	**6**
ET 6620	Methods of Research	6
INFS 6300	IS Security: Management & Assurance	**6**
STAT 6160	**Advanced Math Stats I**	**5**
STAT 6510	**Biostatistical Methods**	**5**
STAT 6520	**Advance Biostatistical Methods**	**5**
BLAW 6500	Legal Aspects of Healthcare	**4**
ET 6190 (HCI/ET)	Six Sigma	**4**
ET 6390	Productivity Strategies/Lean Systems	4
ET 6520	Advanced Topics in Technology	4
PGEO 5560	Intermediate GIS	4
STAT 6180	Advanced Math Stats II	4
GEOL 6000	**Environmental Geosystems**	**2**
GEOL 6030	**Geosciences Colloquium**	**2**
INFS 6835	Information Systems Applications	2
PGEO 5570	*Advanced GIS*	*2*
PGEO 6050	**Programming for Geospatial Database Applications**	**2**
ACSI 6040	**Actuarial Models for Financial Economics**	**1**
BIA 6910	Business Intelligence	**1**
GEOL 5040	Engineering Geology	1
GEOL 6010	**Case Studies in Environmental Geosystems**	**1**
PGEO 6040	**Geospatial Systems and Applications**	**1**
ET 6870	Engineering Management Systems	**0**
GEOL 6020	Advanced Hydrogeology	0

Table 5. Course Offerings (2010-2015) for Concentration Electives

BIOL6380	Experimental Immunology	18
BIOL 6430	Clncl Pathogenic Microbiology	12
BIOL 6390	Adv Cell Molecular Biology	11
BIOL 6450	Advances in Molecular Genetics	11
BIOL 6350	Biostatistical Analysis	10
BIOL 6650	*Seminar*	*10*
BIOL 6660	*Seminar*	*8*
CHEM 6530	Biochemical Techniques	8
INFS 6500	IT Project Management Planning and Implementation	8
BIOL 5510	Food & Industrial Microbiology	7
CHEM 6510	Biochemistry II	7
INFS 6520	IT Project Management Case Studies	7
MATH 6603	Problems in Mathematics-Mathematics of Finance	7
MATH 6604	Problems in Mathematics - Mathematics of Life Contingencies	7
ACSI 5220	Mathematics of Corporation Finance	6
ACSI 5240	Mathematics of Interest Theory, Economics, and Finance	6
ACSI 5330	Actuarial Mathematics I	6
ACSI 6010	Credibility Theory and Loss Distributions	6
BIOL6440	Advanced Virology	6
BIOL 6500	***Special Problems in Biology***	***6***
BIOL 6720	Adv Animal Development	6
BIOL 6760	**Bioinformatics**	**6**
ECON 6070	Econometrics II	6
ACSI 5230	Mathematics of Compound Interest	5
ACSI 5640	Mathematics of Options, Futures, and Other Derivatives	5
BIOL 6410	Adv Transmit Electron Micros	5
BIOL 6750	Advanced Plant Biotechnology	5
STAT 5200	Statistical Methods for Forecasting	5
STAT 6604	Problems Experimental Design	5
INFS 6510	IT Project Risk Assessment and Control	4
MATH 6602	Problems in Mathematics-Number Theory	4
STAT 6602	Problems Regression Analysis	4
STAT 6603	Probs Nonparametric Statistics	4
STAT 6605	SAS Programming	4
ACSI 5630	Mathematics of Risk Management	3
BIOL 6590	Environmental Toxicology	3

PGEO 6060	**Advanced Topics in Geosciences**	**3**
BIA 6905	Applied Business Analytics	**2**
GEOL 5130	Hydrogeology	2
ABAS 5340	Soil Formation and Remediation	1
ABAS 5350	Soil Survey and Land Use	1
ACSI 6600	Problems in Actuarial Science	1
BIOL 6730	Adv Micro Physiology Biochem	1
GEOL 5050	Meteorology	1
GEOL 5060	Principles of Geoscience	1
GEOL 5401	Field Course	1
PGEO 5490	Remote Sensing	1
PGEO 5511	**Advanced Remote Sensing**	**1**
PGEO 6070	**Quantitative Methods in Geosciences**	**new**
ET 6810	Engineering Management Theory and Application	0
GEOL 5000	Petrology and Petrography	0
GEOL 5020	Geomorphic Regions of the United States	0
GEOL 5030	Invertebrate Micropaleontology	0
GEOL 5070	Sedimentation and Stratigraphy	0
GEOL 5080	Structural Geology	0
GEOL 5100	Geophysical Prospecting	0
GEOL 5140	Inorganic Geochemistry	0
GEOL 5150	Environmental Applications of Hydrogeology	0
GEOL 5150	Environmental Applications of Hydrogeology	0
PGEO 5380	Cartography	0
PGEO 5510	Laboratory Problems in Remote Sensing	0

5. Student Experience

A number of items make up the MSPS student experience including timely and relevant core course offerings, real world experience in the internship, interaction with industry professionals through seminars and industry visits, advisement by professionals, and exposure to diverse perspectives and working environments.

5.A. Relevant Course Offerings

Core course offerings are taught by business and quantitative specialists which were designed and are revised with direct industry input (see curriculum above). Discipline-specific courses are taught by content specialists and often designed and revised based on industry input (see bold and italicized courses in the curriculum above). For example, new courses in Biostatistics and Geosciences have been proposed, developed, and taught based on industry input and needs.

5.B. Internship

The culminating course for students is the 250 hour internship. They learn real world skills and have genuine experiences working and using knowledge they have gained in their coursework. In addition, they gain perspective and begin to form professional networks which will serve them during all of their careers.

5.C. Program Responsiveness to Industry

The MSPS director and program coordinators directly interact with industry professionals to respond to industry changes and needs. The addition of three new concentrations is the first evidence of this. Engineering Management, Geosciences, and Actuarial Sciences have been added since the last program review and are a direct result of regional industry needs. In addition, the Healthcare Informatics concentration was significantly revised based on industry changes. The core courses, Biostatistics concentration, and Biotechnology concentration have added and/or significantly revised courses based on industry input (see bold and italicized items in the curriculum). These changes directly affect the students in a truly positive way as they are better prepared for the real world at graduation. Finally, the Advisory Board Meetings and Internship Presentation Luncheon are tremendous sources of relevant industry information.

5.D. Industry Interactions

Students and faculty in the program frequently interact with industry professionals throughout the two year curriculum through industry site visits, such as visits to Environmental Science Corporation, GenHunter, Jack Daniels Distillery, and Aegis Sciences. Since 2010, there have been at least twenty visits to industry. Additionally, industry professionals have given seminars at a rate of more than two per month from companies such as Aegis Sciences, Caterpillar Insurance Services, Cigna, Covance, RGA Reinsurance Company, the Wells Fargo Company, and the Willis Group, Cardno ATC, Brown and Caldwell, and Iluka Resources. Students and faculty also interact with industry professionals by working on real-world problems in courses such as BIOL 6770 and on research projects with the Tennessee Insurance Rate Review and Alexanders & Preston's Extended Warranty Product Evaluation. Students additionally make connections through involvement in the MSPS Club, which takes trips to more distant industry sites, such as the Center for Disease Control in Atlanta, Alpha Hudson in Alabama, Research Triangle in North Carolina, and BioWorks in Memphis. In addition, MTSU actuarial science program will host the Spring 2016 Casualty Actuaries of Southeast Conference on March 22, 2016, which will bring a host of industry interactions. The program coordinators continually seek advice and help from the MSPS Advisory Board to remain current and responsive to industry needs and perspectives. The Advisory Board includes 30 industry professionals from eighteen companies, five units within academia, and three government agencies, and meets formally once per year. The Executive Committee of the Advisory Board meets each semester to discuss program initiatives and direction. Finally, there is a significant and powerful industry interaction associated with the required internship component in this degree program. This is evidenced by the high proportion of students that remain on as employees at their internship sites.

5.E. Advising

Students are advised by the concentration coordinators, who are members of the graduate faculty within the discipline, on course selection, advancement to graduation, paperwork, and internship placement matters. The concentration advisors also receive and distribute job advertisements from industry as they acquire them. The Basic and Applied Sciences Career Placement Advisor is also made available to them for additional job placement help. To aid in internship placement for the growing number of students, an internship coordinator position exclusively for this program has been approved and the job will be advertised this coming spring.

5.F. Diverse Perspectives, Experiences, and Working Environments

Science has been moving towards a team-based model of operation, as evidenced by an increase in federal funding for more interdisciplinary, group, and diverse initiatives. This means that students will be able to work in a team-based environment with individuals having different backgrounds and specialties. The faculty of the MSPS programs are committed to cultivating and utilizing the diversity of ideas and people in the program in a number of ways. For example, the core MSPS courses focus on the managerial, leadership, and communication skills that are key to working successfully within an increasingly diverse and dynamic workforce. The students that enroll in the MSPS programs also come from various demographic groups appropriate to the respective MSPS concentration areas. Currently, the program is 49.1% female (range 45.7%-65.8% for 2010-2015) and 18.2% minority (range 18.2%-25.7% for 2010-2015). In addition, these students reflect local but also national and international student populations and a wide variety of undergraduate degrees and work experiences. As a set of concentration areas, we work very hard to recruit a very diverse student body, and the MSPS program also accommodates traditional as well as non-traditional students and working professionals. Finally, MSPS leadership also reflects a commitment to diversity, and come from diverse subject areas, disciplines, research specialties, and demographic groups to create a leadership team that appreciates the significance of difference, and of cultivating an appreciation for diverse experiences and perspectives in our students and colleagues.

5.G. Professional Experiences

MSPS students are encouraged to become professionally active in organizations and make contacts with industry professionals, but each MSPS student is required to perform an internship in his/her concentration area. Additionally, the MSPS program Graduate Assistants (18 assistantships held by 26 students) are actively engaged in a variety of professional experiences on campus. Students can elect to attend seminars given by industry and academic scientists, which are sponsored by the MSPS program and content Departments like the Geosciences Colloquia, attend journal club talks given by peers and faculty, such as the Actuarial Math Student Association, BioMath Talks, and attend content-specific conferences, such as the Tennessee Academy of Sciences and the Casualty Actuary of the Southeast (CASE) conference. Along with content-specific organizations, MSPS students can join the MSPS club, which meets monthly and is actively engaged in making connections with industry scientists and traveling to visit industry sites. Finally, the ultimate professional activity in this program is the required internship. Regional and national content-specific professional organizations that students have joined include: Tennessee Academy of Sciences, Tennessee Life Sciences, American Institute of Professional Geologists,

Biology Graduate Student Organization, Sigma Gamma Epsilon for Earth Sciences, and the Actuarial Math Student Association.

The 250 hour internship project must be approved by the concentration coordinator prior to registration. The student works with an internship mentor at the industry site. Student activities and evaluation paperwork are monitored by the business coordinator to ensure an appropriate professional experience. The internship may take place with the student's current employer so long as a new or different project or set of activities than the regular job are undertaken. All students present their internship work in a final seminar, which can be attended by the MTSU community, the Advisory Board, and any interested industry professionals. Finally, students who are awarded a competitive graduate assistantship gain additional professional experience as their work assignment is made to match their discipline.

5.H. Graduation and Career Placement

Lastly, the MSPS program has graduated well-trained, skilled students in a timely matter, especially considering that a large number of students attend part-time. The MSPS students can be thought of as two pools; one pool represents the traditional student who has recently completed his/her bachelor's degree training and will attend as a full-time student, while the second pool represents the non-traditional student who is already working in industry, seeks additional training, and will attend as a part-time student. An increase in the number of graduates, up to 51 per year, has been observed, which is more than 46% of the number of students enrolled, as shown below. We believe that this is an impressive graduation rate (Table 2).

At a minimum, student career placement activities begin within the context of the internship. However, most students take advantage of seminars as opportunities to meet industry scientists. Also, students attend the industry-student-faculty mixer prior to the internship presentations to meet with industry professionals. Students are frequently hired by their internship sponsoring company, but others have attained employments in similar companies. Faculty in the program, particularly the coordinators, are often notified of job openings, particularly by graduates, and inform students. Also, the College of Basic and Applied Sciences Career Placement Officer is a good resource for additional jobs. Of the 245 graduates so far, 200 of these have graduated in the last 5 years. This represents over 400% increase in graduates in 5 years. Nearly all of these graduates that we have been able to track are employed within their discipline or are attending other schools, such as medical or pharmacy school.

5.I. Student Satisfaction Comments

Lucy Zhang, Actuarial Science, 2014

Lucy Zhang, who earned her bachelor's degree from UCLA, chose the MTSU Actuarial Science program to pursue an M.S. degree. After she completed her internship at SIGMA Actuarial Consulting Group, Inc., the Brentwood company hired her full-time right after graduation from the master's program in August 2014. Zhang was working as an adjunct instructor teaching math learning support at Roane State Community College and decided to pursue a master's degree in Tennessee where her parents live. "After doing some research, I found out that MTSU was the only university in Tennessee to have a master's degree in actuarial science," she says. The mandatory internship attracted her to the program and gives students "a competitive edge," she says. Dr. Don Hong is active in helping students obtain internships and job opportunities. "I am very glad to have chosen this program over many others in the country," Zhang says.

Adam French, Actuarial Science, 2015

I graduated from the Master of Science in Professional Science (MSPS) program at Middle Tennessee State University (MTSU) in December 2015 with concentration in Actuarial Science. With a B.A. in Mathematics and two actuarial exams passed, I wanted to pursue an advanced degree that would help me develop my business skills and expand my knowledge of actuarial science. The professors in MTSU's actuarial science and business core departments were more helpful than I could have wished. My favorite feature of the actuarial science program was monthly visits from credentialed actuaries that explained details about the profession. In two years, my skills in business communication and actuarial science improved tremendously. This helped me to achieve my goal of earning an actuarial analyst position with Willis of Tennessee. My experience in MTSU's MSPS program was truly invaluable.

Jesse Beck, Biostatistics, 2015

My decision to enter and complete the MSPS program has been the most important decision of my academic and professional life. This program has prepared me to excel in all areas of my future career. Through my concentration specific classes, I have been able to learn and apply technical skills that are fundamental to my success in my specific job and career. Also, the MSPS core classes have taught me how to thrive in the business setting. The ability to develop strong working relations with both managers and co-workers, and understand the finer details of the business culture are just as critical as the technical skills I have learned. The MSPS program does a masterful job a balancing these two distinct skill sets through its designed course work and requirements. The experiences I have had in the classroom, and with peers and professors has set my career in motion. I am proud to say I have a Master's of Science degree from Middle Tennessee State University.

Daniel Getu, Biostatistics, 2016

The MSPS -biostatistics concentration program has equipped me with fundamental statistical, mathematical and business skills which I can confidently apply to solve problems in professional life. The statistical courses I took have boosted my skills in study design, data analysis, and interpretation of results while the business courses have introduced me to essential concepts in strategic communication, leadership, business law and accounting which I believe come handy to professionally and collaboratively conduct my responsibilities as Biostatistician in any business or academic environment. The MSPS program has also offered me an opportunity to work on research projects under supervision of my advisor. Such participation has helped me not only expand my professional networking but also gain a sense of independence and confidence in my own decision making with regard to statistical analysis, interpretation and communication of results. Last, but not least the tutoring responsibility assigned to me has improved my pedagogic skills thereby further expanding my repertoire of employable skills.

Tamara Tester, Biostatistics, 2016

MTSU's program is exactly where you want to be if you are interested in the field of biostatistics. The outpouring of support that the faculty offers students is exactly what you could want during your graduate level studies. The program is set up to prepare students to be easily integrated into the biostatistics field or to go on to a doctoral program. I do feel the expectations for the students are held to a high standard, and it is clear to see that this is because the professors see the potential in each student. I am more than happy with my decision to further my education at MTSU, and I can say this based on the skills and knowledge that I have gained within my first semester. My advice to anyone considering MTSU’s M.S. Biostatistics program is to not overlook it, truly you will find that a M.S in Biostatistics from MTSU is competitive and will give you the capabilities to succeed.

Kristina Hulsey, Biotechnology, 2010

I pursued a Master of Science in Professional Science degree because it combined science and business, and since graduating in 2010, my MSPS degree has opened up doors in both environments. I completed an internship at Vanderbilt Medical Center for the Biotechnology concentration, and that position led to several years' employment as a Research Assistant in genetics. The hands-on training in the program certainly helped prepare me for large-scale laboratory work. Working in a laboratory wasn't my end goal, though, and I am now employed by the legal department of the nation's oldest publicly traded senior health care company. I credit my rigorous biological training with creating within me the committed discipline that sets me apart from others in the administrative field. From a laboratory jacket to a suit jacket, the MSPS degree has served me well.

David O'Brien, Engineering Management, 2014

David O'Brien, among initial graduates of the Engineering Management M.S. program (June 2014), now works as a process engineer at Feintool Tennessee. O'Brien develops and implements protocol for the plant-wide continuous improvement program; analyzes current production processes at micro and macro scales; utilizes principles and practices from Lean, Six Sigma, and Kazan to streamline workflow; and designs and procures tools that enhance workflow, reduce waste, and increase product quality. His background includes regulatory compliance, project management, and technical training. O'Brien worked as a Siemens Healthcare process engineer during a 10-month internship, and also as a graduate assistant for MTSU's experimental vehicles program. "In addition to the program curriculum, experiences gained through the graduate assistantships and internship presented opportunities to further develop skills that are now adding value at my company," he says. O'Brien, who earlier studied Environmental Science (B.S., 2012) at MTSU, also served as president of the Graduate Student Association.

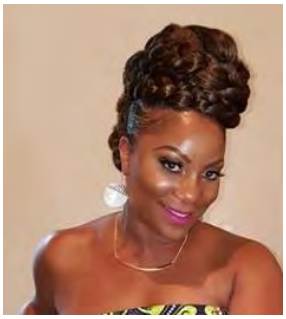
Alex McCloud, Geosciences, 2015

Choosing to pursue an MSPS degree in Geosciences has been one of the most professionally beneficial and rewarding decisions I have ever made. The Geosciences program allowed me to pursue my interests in both remote sensing and geographic information systems. This program placed special emphasis on highly marketable skills such as Python programming and emerging remote sensing techniques. Courses and professors focused primarily on ensuring students graduated with a true understanding of core concepts instead of succeeding through rote memorization. My education culminated with an internship at Digital Harvest; a precision agriculture company that combines aviation with remote sensing analysis. The MSPS internship allowed me the opportunity to apply my education and knowledge towards solving real-world problems. Upon completion of the program requirements, I was selected to attend Officer Training School to become a Space Operations Officer in the United States Air Force. I wholeheartedly believe that the skills I developed during my time in the MSPS Geosciences program set me apart in the field of other Air Force Officer applicants.

Scott L. Simms, Health Care Informatics, 2014

I earned my Master's in Professional Science with an emphasis in Health Care Informatics from Middle Tennessee State University in August 2014. I was interested in this program because it provided a unique opportunity to combine business and science in one degree. I particularly benefitted the class that focused on Accounting, Managerial and Legal issues. My internship work with the Vanderbilt Medical Group Clinical Operations Group piqued my interest in learning more about computerized provider order entry (CPOE), the implementation of these systems and how they can be used to improve health care. After graduation, I pursued a job in Health IT at Vanderbilt and was offered the position. MTSU's MSPS program was able to assist me in the achievement to this stage in my career and I am very proud to hold this decree of academic accomplishment from such a fine institution.

Kenyia Roberson, Health Care Informatics, 2014



I graduated from the Master of Science in Professional Science (MSPS) program at Middle Tennessee State University in May 2014 with an emphasis in Health care Informatics. With a B.S. in Cardio-Pulmonary Care and 10 years clinical work experience in the hospital industry, I wanted to pursue an advanced degree that would allow me to learn from a diverse point of view. In addition, one of the main attractions to the MSPS program was my desire to eventually move into an executive leadership role and I found with this degree, the combination of business/professional courses along with advanced technology course work to be ideal for my aspirations. This transition was a critical step that allowed me to encounter experiences and gain additional significant knowledge in the field of healthcare business and technology. Due to my educational background and my "hands-on" clinical experience, this program has exceeded my expectations. I accepted a position as a Team Lead with Community Health Systems Corporate in Franklin, Tennessee in Tier 2 Deployment division.

6. Faculty

Faculty in the program contribute to the program by their collaborative nature, breadth of research and industry experiences, and dedication to the students and program.

6.A. Faculty Collaboration

Faculty members in this program have numerous strengths individually, but their most important strength is the ability to work together. Members of the entire MSPS team are Dr. Saeed Foroudastan, Director of the MSPS Program; Dr. Vincent Smith, Professor of Marketing, from the College of Business, coordinator for the business core; Dr. Don Hong, Professor of Mathematics, for Actuarial Sciences, Dr. Lisa Bloomer Green, Associate Professor of Mathematics, and Dr. Ginger Holmes Rowell, Professor of Mathematics, for Biostatistics; Dr. Matthew Elrod-Erickson, Associate Professor of Biology, and Dr. Rebecca Seipelt-Thiemann, Professor of Biology, for Biotechnology; Dr. Vahid H Khiabani, Assistant Professor of Engineering Technology, for Engineering Management; Dr. Henrique Momm, Assistant Professor of Geosciences, and Dr. Clay Harris, Associate Professor of Geosciences, for Geosciences; and Dr. Brian P. Hinote, Associate Professor of Anthropology and Sociology, for Health Care Informatics (HCI); and Mrs. Darlene Fults, executive aide. While each person on the leadership team plays a critical role in recruitment, retention, scheduling, teaching, and being a liaison to their respective departments, each works collaboratively with others and with industry while remaining extremely committed to students. It is important to note that such successful interdisciplinary connections between business and science are extraordinarily rare. For example, excellent collaborations between faculty in sciences and business were developed at establishment of this program and continue today. The College of Business faculty developed new courses just for the MSPS students, and these have been a tremendous success. The College of Business faculty members have even been willing to go to Blue Cross Blue Shield in Chattanooga Tennessee to offer core courses on-site.

6.B. Faculty are Strong in Research and Industry Experiences

Faculty strengths in each of the concentrations include a breadth and diversity of research experiences and collaborative activities with industry, government agencies, and academic units. An additional strength is the willingness to apply for internal and external funding (state, national, and private) and the merit to acquire it for both educational and research purposes. For example, Dr. Don Hong received a grant of $700,000 in total for projects on rate review and staff training for the Tennessee Department of Commerce and Insurance (TDCI) during 2011-2013. Together with Drs. Ken Hollman of Insurance and Qiang Wu of Actuarial Science, and a group of graduate students in the program, the team completed an over 100-page RATE REVIEW REPORT for the TDCI and seven online training courses. Further details of all faculty support and research experiences can be seen in the attached faculty CVs (Appendix E).

Faculty who participate in teaching in this degree program fall into three major groups: 1) content specialists who regularly publish in peer-reviewed journals, 2) content-specialists who are engaged in industry activities as consultants, and 3) content-specialists who do both. Nearly all faculty have earned a terminal degree (41 of 43 or 95%) in their field. The faculty are actively engaged in scholarly work, as evidenced by an average of 18.1 articles published per faculty member (798 articles per 43 faculty members) and 16 awarded patents with 6 additional patents pending. In addition, all are engaged with industry in some way, whether by industry consulting, active industry collaborations, collaborations through courses, or internship relationships.

6.C. Faculty Dedication

Another faculty strength is the commitment and connection students feel to the program. Student exit interviews include questions that ask students to comment of the strengths of the program. Students responded with statements that indicate a strong commitment of faculty leaders in the MSPS program as well as the additional faculty who support the program by teaching the courses, mentoring students in research, and advising students related to both academics and careers. Students agree that faculty strengths continue to include:

- Availability of faculty members and their commitment to keeping students well informed about opportunities in the program and encouragement and assistance to students in their coursework.
- Integration of innovative instructional methods including experiential learning involving discipline-specific research and leading by example regarding the importance of effective communication among the different disciplines.
- Assistance in finding internships and mentoring students during the internship with business details as well as academic research components of the internship.
- Preparation of students for the job market through in-class and out-of-class activities and availability of faculty with expertise to provide a wide range of areas that are interesting and cutting edge.

Students have observed first hand that the MSPS leaders and faculty are committed to attracting new students to the MSPS program and to attracting local industries partners. Students also feel an ownership in the success of this program. They realize that their suggestions and those from industry partners are utilized to help improve the program. This speaks well for the MSPS

leadership who consistently invite participation and support from both faculty, students, and industry to be a part of the continuing growth of the MSPS program.

6.D. Faculty Responsiveness to Students

Faculty are also responsive to student needs and suggestions in addition to industry needs and suggestions. For example, students requested more flexible delivery for one of the core classes, Accounting and Legal Issues. This course was taught in this manner, but the students who actually took the class expressed a need for more face-face interaction. The course was re-designed a second time to be "on ground" and to utilize a team-taught approach with a professional in accounting and a professional in law. Students are very satisfied with this approach.

7. Learning Resources

The learning resources in the MSPS are most primarily the professionals who teach courses and the professionals in industry that interact with faculty and students. Additional learning resources include space and classrooms, library/technology resources, and flexible course delivery.

7.A. Professionals

As noted earlier, the faculty are professionals in their disciplinary areas and remain active in them. They also actively promote interactions with industry professionals through seminars, site visits, and the internship experience. In addition, professionals who work in industry and act as supervisors during the internship provide valuable experience, as well as informational and networking resources to students.

7.B. Space and Classrooms

Most of the courses in this program are also part of other graduate programs, such as MS Biology, MS Engineering Technology, MS Mathematics, or MS Chemistry. The newly opened science building has provided much needed space and new technologies for the Biology and Chemistry-related concentrations. The Actuarial Sciences, Biostatistics, and Geosciences concentrations reside in the Kirksey Old Main (KOM) Building, which is the oldest building on campus where classroom space and facilities are not ideal. The Geosciences Department is scheduled to move into the newly renovated Davis Science Building in December of 2016. The Mathematics and Computer Sciences Departments have begun the process of lobbying for a new building. Despite these challenges, the faculty, our colleagues, and the students do a wonderful job of working with what we have available.

7.C. Library and Technology Materials

The availability of library materials, both paper and electronic, as well as use of the library as a gathering and study space is important for this program. The library spent over $3 million dollars on library materials in 2015. These include access to nearly 14,000 print journals, and over 88,000 electronic journals. Additionally, the library has access to nearly 400 hundred electronic databases and specific articles by request through interlibrary loan services. The library also provides library tools and services including access to adaptive technologies, digital media studio, computers for student use, laptops for checkout, writing center, presentation practice rooms, library instruction, and research coaches. In addition the Desire2Learn course management system, which is utilized

in nearly every course now, allows for communication flexibility, efficient content delivery, and student group interactions.

7.D. Flexible Course Delivery

One aim of this degree program has been workforce development. This means that the degree program should be reasonably accessible to working individuals while also maintaining high content-specific standards.

7.D.1. Flexible Delivery in Core

The core courses (business and quantitative) are frequently offered for working adults in the evening and select weekends in a compressed format. On occasion, a core course, such as Accounting and Legal Issues has been offered online.

The internship experience allows students the opportunity to participate in experiential learning in paid or unpaid career activities anywhere in the world. Students secure their position and report their ongoing activities using the Desire2Learn/BrightSpace learning management system. Interns report weekly regarding their experiences and hours worked, interact with the internship supervisor and peers through discussion boards, and view other internship requirements in preparation for the submission of their portfolio and live presentation at the conclusion of the internship term. Through this hybrid format, students have completed internships across the state, nation, and internationally.

7.D.2. Flexible Delivery in Actuarial Science Concentration

Online courses are under consideration.

7.D.3. Flexible Delivery in Biostatistics Concentration

To increase availability of the initial biostatistics course (STAT 6020), it is offered online as well as on ground.

7.D.4. Flexible Delivery in Engineering Management Concentration

To accommodate the working students in the Engineering Management program courses are offered in the late afternoon, or exclusively online.

7.D.5. Flexible Delivery in Health Care Informatics Concentration

The health care informatics concentration strives to offer flexible course delivery options for both traditional and professional students without sacrificing the direct, face-to-face contact that many strictly online programs sometimes lack. In doing so, the curriculum offers courses in web-assisted and accelerated course delivery formats, as well as on-the-ground offerings around traditional 8-5 workday hours. There are also opportunities for course completion through multiple daylong Saturday sessions over a semester.

7.D.6. Flexible Delivery in Geosciences Concentration

To accommodate the working students in the Geosciences program, courses are offered in the late afternoon and the evening.

8. Support

MTSU has been supportive of this degree program in a number of ways, including an increase in Graduate Assistantships for student support and hiring faculty and staff specifically for the program. In addition, faculty have sought and been awarded funding to support the program, particularly for students.

8.A. Graduate Assistantships

At the last program review, MTSU supported twelve 12 month graduate assistantships. With the support of the Provost, Graduate School Dean, and College of Basic and Applied Sciences Dean, the MSPS now has twelve 12 month assistantships and six 9 month assistantships, which are currently supporting 26 students.

8.B. Faculty and Staff Hiring and Time Allocation

Dr. Vahid Khiabiani and Brian Hinote were hired specifically for their roles in the MSPS Program. In addition, new faculty in Mathematics were hired with the Actuarial Sciences and Biostatistics concentrations in mind. Due to the growth in the program, we are currently hiring an internship coordinator/recruiter dedicated to the MSPS program. In addition, the executive aide's duties have been shifted from 50% MSPS duties to 70% MSPS duties.

8.C. Student Support via Faculty Initiative

MSPS program personnel were able to secure a National Science Foundation award ($599,076) over four years (2007-2011) to support MS and MSPS graduate student scholarships. This type of S-STEM award is particularly well-received and indicative of the quality and need of the programs (MSPS, MS Biology, and MS Chemistry) since these awards are rarely given to support graduate students. This grant supported a stipend and ½ tuition and fees for four MSPS students each in spring 2010, fall 2010, and spring 2011 and two students each in summer 2011 and 2011. Dr. Rebecca Seipelt-Thiemann, coordinator of the Biotechnology concentration, submitted an 3 year NSF grant (Summer STEM Scholarships, $610,000) in 2013, but it was not funded. This grant would have supported summer stipends and tuition support for 93 students with ¼ of these allocated to MSPS students.

Dr. Don Hong, coordinator of the ACSC concentration, received $10,000 actuarial science program grants in total from the Casualty Actuaries of the Southeast (CASE) since 2007 to reimburse students exam fees from the professional actuarial societies.

Dr. Henrique Momm, coordinator of the Geosciences concentration, has been very active and successful in supporting students through grants from the National Science Foundation ($275,000) and the National Park Service ($65,119) which supports two Graduate Assistants. Additionally, four additional grants are pending, which would support seven additional Graduate Assistants via the Tennessee Department of Agriculture ($35,122), National Geospatial Agency ($270,441), Tennessee Department of Transportation ($396,157), and NASA ($106,194). Dr. Momm has submitted other grants that included student support for 5 Graduate Assistants that have not been

funded, including Environmental Protection Agency, USDA- NIFA, Tennessee Healthy Watershed Initiative, and USDA – AFRI.

9. Summary

Middle Tennessee State University, in conjunction with the Alfred P. Sloan Foundation, began offering a Professional Science Master Degree program in 2005 with three concentrations (Biostatistics, Biotechnology, and Healthcare Informatics). Three additional concentrations have been added since the last program review in 2010 (Actuarial Sciences, Geosciences, and Engineering Management). At MTSU, this graduate degree is called a Master of Science in Professional Science (MSPS) and has had remarkable success by preparing students for administrative careers in high-tech, cutting-edge STEM fields. This program exemplifies all three components of MTSU's Academic Master Plan (academic quality, student centeredness, and strategic partnerships with industry) and has immediately established a record of success that has been recognized throughout the nation. Highly dedicated and talented faculty and administrators worked in cooperation with highly motivated and education-minded people in business and industry to develop this degree program and continue to play integral roles in recruitment, retention, and curriculum changes. By creating an educational program with innovative curriculum, caring faculty and staff, real-world training, and excellent earning potential, these individuals have generated a magnetic program which attracts talented students and produces quality graduates in six actively growing STEM fields. MSPS graduates are so well prepared that several companies have created positions for these students following their culminating internship experience.

The success of this program is clearly visible not only in the extensive industrial connections and explosive growth but also in receipt of national awards and funding. For example, the program has supervised student internship collaborations in nearly 100 different regional industries. Several current and past students are now employed by their internship (or a similar) company or acquiring additional training. Enrollment in this program was three students in the first year (spring 2005), 57 students in fall 2009, and is currently at 110 (fall 2015) with a more than 400% increase in graduates over the prior 5 year reporting period. The MSPS program was awarded a S-STEM grant from the National Science Foundation in the amount of $599,076 over four years (2007-2011) to support graduate student scholarships. Four MSPS students received stipend and 50% tuition/fee support in spring 2010, fall 2010, and spring 2011 and two MSPS students received support in summer 2010 and 2011 from this grant. Faculty continue to pursue and earn awards for supporting students, such as the student exam fee support awards for the Actuarial Sciences concentration.

As a group we face numerous challenges in preparing students for high technology careers of the future. We are currently addressing issues such as program recognition, course over-filling, overload of faculty and administrative staff, course scheduling flexibility, attracting qualified faculty, maintaining high technology equipment and spaces, and actively pursuing collaborations and industry partnerships.

10. Future plans

Future plans for this program fall into four main areas: enhancing degree recognition, broadening collaboration, and increasing the number of students served.

10.A. Enhance Degree Recognition

The first future aim is to further enhance degree recognition. Well-prepared students form the first and foremost resource of this program within our region and are helping the degree to become better recognized. The director also speaks regularly at the National PSM conferences and has authored a paper regarding the need for additional marketing (Foroudastan et al, 2009). The National Professional Science Masters Association has taken on the challenge of making the degree more widely recognized. In addition, the Actuarial Sciences and Biostatistics concentrations have been approved as an accelerated degree, which will need help with degree recognition.

10.B. Increase Industry Interactions

The second aim of this program is to broaden collaboration. With the new position of internship coordinator/recruiter, we hope to be more proactive in both identifying industrial relationships for internships, collaborations, recruitment, and degree currency. With regular input and direction from this Advisory Board and the industry members, we will be able to create mutually beneficial collaborative activities and to increase the number of internship companies above the current level.

10.C. Increase Number of Students through More Aggressive Marketing

The final aim of the MSPS program is to increase the number of students served by this program and provide a full educational experience. We will be hiring an internship coordinator/recruiter whose workload will include more aggressive recruitment regionally, nationally, and internationally. Additionally, the coordinator/recruiter would coordinate student-related items such as an official new student orientation, student-industry-faculty mixers, as well as help with maintaining good industry and Advisory Board relationships. Any increase in the number of students will necessarily require an increase in faculty in those high-enrollment concentrations.

11. Literature Cited

Middle Tennessee State University Academic Master Plan. 2015. http://www.mtsu.edu/AMP/

12. Appendices

Appendix A: Exit interview questions
Appendix B: Institutional Effectiveness Assessments
Appendix C: Internship Placement and Employment
Appendix D: Industry Support Letters
Appendix E: Course syllabi (Business, Actuarial Science, Biostatistics, Biotechnology, Engineering Management, Geosciences, Health Care Informatics)
Appendix F: Faculty CV (Director, Business, Actuarial Science, Biostatistics, Biotechnology, Engineering Management, Geosciences, Health Care Informatics)