

**Duke University, Fuqua School of Business**  
**Summary of Document for the Proposed Master of Quantitative**  
**Management (MQM)**

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## Dean's Letter of Support



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Dear Review Committee:

I am writing in support of the Master of Science in Data Science (MDS) program being proposed by the Social Science Research Institute (SSRI) and the Initiative for Information at Duke (IID). As you may be aware, the Fuqua School of Business is proposing a Master of Quantitative Management (MQM) which we believe is highly complementary to the MDS program. We have discussed potential synergies between MDS and MQM with Professor Tom Nechyba (one of the proposers of the MDS program).

We believe the programs complement each other in several ways. First, the MQM program is more applied than the MDS program, and has a narrower focus on business-related data analytic career paths. Second, the MDS has a much more interdisciplinary focus than MQM. Third, and related to the second point, we believe the courses being developed for the MQM program will offer greater breadth of elective choice for students in the MDS program. While the MQM program does not currently anticipate MQM students taking courses outside of Fuqua, this is a feature that we might re-consider in the future, particularly if there was value elsewhere in the University for such a change. Fourth, and most importantly, having two programs with focus on data science and data analytics will draw together and strengthen the scholarship across Duke in this area.

In summary, I support the MDS proposal and think it would be a valuable addition to Duke's graduate offerings.

Sincerely,



William Boulding

# MQM Degree Proposal<sup>1</sup>

## I. Overview

The Fuqua School of Business is proposing a new master's degree, the Master of Quantitative Management (MQM). With any new degree, we require it meet several objectives:

- Intellectual fit with tenure track faculty
- Portfolio fit with existing programs at Fuqua and at Duke
- Distinctive curriculum relative to other programs in market
- Confident market demand for graduates
- Scalability
- Minimal financial risk

We believe the MQM program meets these objectives. Briefly, the MQM degree seeks to fill a growing need among businesses for well-trained analysts and data scientists who also possess knowledge of the business function in which they work (e.g., finance, marketing, business analytics, forensics) and strong problem solving, communication and teamwork skills. The MQM curriculum will mirror these needs with its three components: (a) data science and business analytics courses; (b) functional area expertise; and (c) critical thinking, collaboration and communication courses and skills.

The 10-month (July-May) MQM will target undergraduates with strong quantitative backgrounds and 0-3 years of work experience. We anticipate the program will be attractive to students with undergraduate degrees in STEM disciplines (such as computer science, math, engineering, sciences) as well as students with undergraduate degrees in business and economics. Our design of the MQM program includes "tracks" reflecting distinct areas of functional expertise; our proposal models four such tracks in finance, marketing, business analytics, and forensics. We anticipate admitting about 50-60 students in Year 1 of the program, or an average of 10-15 students in each track. The four track model has a breakeven point of about 67 students.

Our proposal considers the MQM as a stand-alone degree that is not integrated with other masters programs at Fuqua or at Duke University. Regarding Fuqua programs, we believe there is a possibility of sharing some courses across the master's programs; however, we would prefer to defer that decision or option until we have a deeper understanding of the student composition of the MQM program. Importantly, our financial budget for the MQM program adopts the most conservative perspective and does not consider any sharing of costs. Regarding related Duke programs, we believe there is potential for collaboration with a complementary program being proposed -- Master of Data Science -- being developed jointly by the Social Science Research Institute (SSRI) and Initiative in Information at Duke (iiD) at Duke. This program is focused on real world problems being studied in the social science and humanities areas. This program's curriculum will be highly interdisciplinary in nature and structured around the concept of the "Data to Design" cycle. In addition to expanding the intellectual community interested in data science issues, the development of these programs will enhance Duke's brand in an

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<sup>1</sup> This proposal was prepared by the Deans Office, Fuqua School of Business, with collaboration with a Fuqua faculty committee consisting of Alex Belloni, Victor Bennett, Fernando Bernstein, Michael Brandt, David Hsieh, Pino Lopomo, Bill Mayew, Carl Mela, Sasa Pecec, and Jack Soll. Additional thanks go to Jeremy Petranka and Adrienne Baroff for their help.

intellectual and pedagogical space that is expected to experience significant growth over the next several decades.

## II. The Current Data Analytics Landscape

Studies estimate that by 2020 the world will generate 50 times more data than it did in 2011.<sup>2</sup> As a result of this trend, there is a surge in demand for graduates who can manage and assess large amounts of data (“big data”). In light of this, it is perhaps not surprising that the role of “Data Scientist” has been described as the “sexiest job of the 21st Century”<sup>3</sup> and that analytics is recognized as one of the fastest growing fields. A much-quoted report by McKinsey Global Institute anticipates that “by 2018 the United States alone could face a shortage of 140,000 to 190,000 people with deep analytical skills.”<sup>4</sup> Data from the 2015 GMAC Survey Report shows more than half of the companies in sectors ranging from energy and utilities to products and services plan to hire recent business graduates to fill data analytics positions.<sup>5</sup>

Our market analysis indicates there are currently more than 150 programs worldwide offering degrees in data analytics fields. In the United States, we identified 109 Masters programs with titles ranging from “Business Analytics” to “Predictive Analytics”. Figure 1 shows the distribution of these masters programs throughout the US. Of these 109 programs, about 40 reside in business schools with the remainder housed within schools or departments of statistics, mathematics, computer science or engineering.<sup>6</sup>

**Figure 1. Distribution of Masters Degree Programs in “Data Science” in the US**



<sup>2</sup> The Measurement Standard, *Why “Data Scientist” is Being Called The Sexiest Job of the 21<sup>st</sup> Century*, July 1, 2015

<sup>3</sup> Davenport, T and Patel, DJ *Data Scientist: The Sexiest Job of the 21<sup>st</sup> Century*. Harvard Business Review, October 2012 Issue

<sup>4</sup> McKinsey Global Institute, Report. *Big data: The next frontier for innovation, competition, and productivity*. May 2011

<sup>5</sup> GMAC Corporate Recruiter Survey 2015 Survey Report

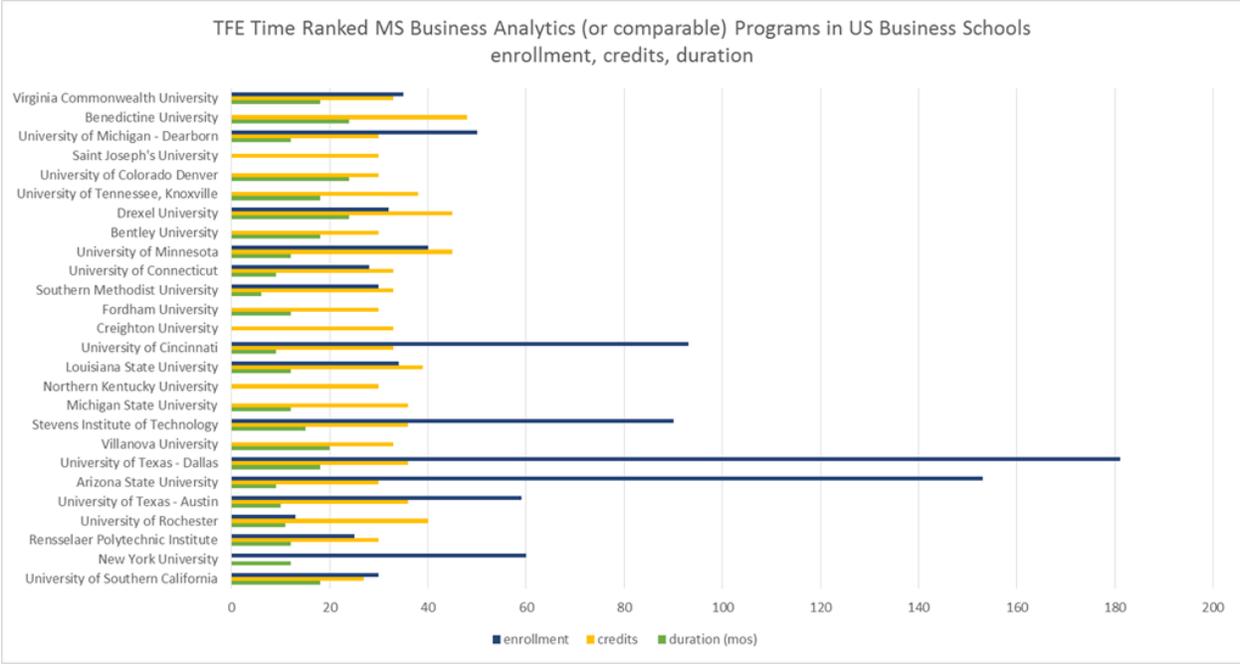
<sup>6</sup> Data compiled from the <http://data-science-university-programs.silk.co/> data base, from Ryan Swanstrom's “Data Science 101 Blog”, and has been curated over time by various Silk users.

We collected detailed information about the 109 US-based programs, including information on their curricula, enrollments, duration and credits. Generally speaking, master’s programs housed in business schools tend to be less technical than those housed in non-business schools (i.e., the latter tend to go much deeper into the data science aspects and focus less on application). Curricula across the 40 business-based programs vary greatly: a few are very technical, most are less so. A typical curriculum for a master’s program residing in a business school consists of a small number of core business courses (in statistics, accounting and information systems), 4-6 courses in data analytics, and either no, or a small choice set, of functional electives. Most of the 40 master’s programs are about 1-year in duration. The vast majority do not contain a required internship experience. Most of the business analytic master’s programs are young, with several only starting a year or two ago.

The Financial Engineer Times (TFE Times) reported the 2016 Master of Business Analytics rankings in October 2015. Appendix 1 shows the 2016 TFE Times MSBA rankings and methodology used by TFE Times to determine the rankings. Of the 31 schools listed on the TFE ranking, 26 are housed in business schools. Additionally, the program length (for US and on-campus programs only) ranged from 6-24 months and required as few as 27 credits and as many as 48 credits for completion. The class sizes ranged from as small as 13 to as large as 181. None of the 31-ranked programs is housed in a business school with the national reputation and ranking that Fuqua holds.

Figure 2 displays the business school Master of Business Analytics (or comparable) programs listed on the TFE. The chart compares enrollment, credits for completion, and program duration.

**Figure 2. Enrollment, credits, duration top ranked business school Master of Business Analytics (or comparable) programs**



At the local level, there are currently two Master of Data Analytics (or comparable) programs in North Carolina. The first is housed in the Institute for Advanced Analytics at North Carolina State University

(NCSU). The NCSU Master of Data Analytics degree is a technically-oriented program. The second is a Professional Science Master of Data Science and Business Analytics (PSM DSBA) program at the University of North Carolina, Charlotte Graduate School. The program is offered both part-time and full time and focuses on core courses such as Visual Analytics, Machine Learning and Database Systems.<sup>7</sup>

We also conducted targeted market research, using faculty contacts, career services, and connections at companies. In addition, we presented the idea to Fuqua's Board of Visitors in November 2015, during the annual Fall meeting. The response was enthusiastic. Companies that indicated a good to very strong interest in hiring graduates from the MQM program included: Anthem, Bank of New York Mellon, Bloomberg, Boston Consulting Group, CBS Interactive, Citigroup, Colgate Palmolive, Continuum Analytics, Deloitte, Ernst & Young, Hewlett Packard, IBM, Johnson & Johnson, Microsoft, Price WaterhouseCoopers, Proctor & Gamble, SAP, Time Warner, Twitter, UPS, Walmart, Yahoo, and ZS Associates.

*Summary: With the exponential growth in data comes an increased need for (a) well-trained individuals who can not only make sense of the data but also (b) have the ability to understand the business process and (c) can collaborate and communicate in increasingly complex and data-driven managerial decision-making processes. Focused outreach conducted by Fuqua faculty in the preparation of this proposal confirmed the large and growing demand for graduates with these three sets of skills. Importantly, nearly all companies confirmed the need for graduates with all three skill sets: technical, functional, critical thinking and communication. We, therefore, designed the MQM curriculum with these three skill sets in mind. We believe the curriculum is unique, across all data analytics masters programs, in its balanced focus. The MQM program also has many synergies with Fuqua's strengths and brand. In particular, our faculty have strong expertise across all major functional areas of business (accounting, decision sciences, economics, finance, management, marketing, operations, and strategy). Last but not least, Fuqua is a leader in its ability to impart critical thinking, collaboration and communication skills to students. The MQM degree provides a unique opportunity to draw on Fuqua skills and strengths to contribute to a large and growing area of business.*

### III. The MQM Program in Detail

#### Proposed Curriculum

The 54-credit program is designed to be completed in 10 months, beginning in July and completing the following spring, with graduation in early May.

We have modeled the MQM program as having four tracks representing distinct business disciplines or sets of domain-specific knowledge. The four tracks we propose are: finance, marketing, business analytics, and forensics. Across all tracks, the MQM curriculum will consist of:

- (a) required courses in data science and analytics;
- (b) required courses in critical thinking, communication and collaboration;
- (c) required courses in the functional discipline or track;
- (d) choice of elective courses.

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<sup>7</sup> Both NC State and UNC offer master's degrees at lower tuitions than Duke. Other factors that enter into a student's decision to attend Duke include reputation, curriculum, faculty, and network. With regards to NC State University's Master of Science in Data Analytics program, it is technical in nature, and therefore, not a direct competitor to the MQM program. Were any local universities to develop a direct (applied-focus) competitor for MQM, we would compete with it on the same dimensions as we do for our other master's programs.

Required courses in (a) and (b) are common across all tracks. Required courses in (c) are specific to each track. Elective courses in (d) allow for students to select distinct courses from other tracks to provide breadth for their course of study. More specifically, in a typical 6-week term, an MQM student would take: a data-analytics course, a critical thinking/communications course, a functional course specific to his/her chosen track, and the choice of a fourth course from the set of functional courses available for other tracks. Our faculty have worked hard to ensure that most of the functional electives are designed so there is no critical prerequisite, thus providing for greater choice each term for students.

Figure 3 shows a graphical representation of a typical term course outline. Each track is designated by a different color (green, pink, orange, or purple) with common data-analytics courses in grey, communications skills in pale green and elective courses in yellow.

**Figure 3. Typical Term Course Schedule**

Typical Term (6 weeks)			
Track 1	Track 2	Track 3	Track 4
Track Specific Course	Track Specific Course	Track Specific Course	Track Specific Course
Data Science and Data Analytic Course Common to all Tracks			
Collaboration and Communication Skills Courses Common to All Tracks			
Choice of Elective Course from Track Specific Courses in Other Tracks			

Figure 4 provides a more detailed description of the curriculum for each of the four tracks. Here we outline the course names for each term and track. For ease of understanding, the tracks are color coded as are the courses: gray (data-analytic courses, common to all tracks), pale yellow (communications and collaboration courses, common to all tracks), green (Finance track), pink (Marketing track), purple (Business Analytics) and orange (Forensics). Brief descriptions of the courses are contained in Appendix 2, along with projected course credits.

**Figure 4. Proposed Courses**

Finance	Marketing	Business Analytics	Forensics
<b>Summer</b>			
Critical Thinking and Collaboration			
Applied Probability & Statistics			
Business Fundamentals	Business Fundamentals	Business Fundamentals	Business Fundamentals
<b>Fall 1</b>			
Investments	Market Intelligence	Operations Analytics	Financial Accounting
Data Science for Business Analytics			
Financial Accounting	Elective	Elective	Elective
Business Communications 1	Business Communications 1	Business Communications 1	Business Communications 1
<b>Fall 2</b>			
Corporate Finance	Customer Relationship Management	Competitive Analytics	Financial Statement Fraud
Decision Analytics and Spreadsheet Modeling			
Derivatives	Elective	Elective	Elective
Business Communications 2	Business Communications 2	Business Communications 2	Business Communications 2
<b>Spring 1</b>			
Fixed Income Securities	Digital Marketing	Product Management	Information Security Risk
Data Infrastructure and Visualization			
Elective	Elective	Elective	Elective
Presentation Skills	Presentation Skills	Presentation Skills	Presentation Skills
<b>Spring 2</b>			
Financial Risk Management	Pricing	Advanced Business Analytics	Due Diligence and Fundamental Analysis
Ethical & legal Issues of Data Analytics			
Elective	Elective	Elective	Elective
Team Project	Team Project	Team Project	Team Project

### Certificate in Research

An additional Fall term (consisting of Fuqua's Fall 1 and Fall 2 terms) is proposed for students who wish to pursue a Certificate of Research. In order to pursue the Certificate in Research, interested students must apply by the end of the Spring 1. Note that students pursuing the certificate would not graduate in May, but defer their graduation until completion of the Certificate in Research, in December.

The Certificate and additional term provides flexibility for two types of students. First, students who may be interested in pursuing a PhD degree in business. These students could be identified and matched with one or more faculty members to work on research over the Summer. In the Fall term(s), these students would work on guided research (Independent Study supervised by one or more faculty members), and enroll in 1-2 relevant PhD seminars. The independent study would be done at the individual student level, under the supervision of a faculty member, and would focus on developing the student's research skills. Students would also enroll in 1-2 advanced MBA classes in each of the Fall terms. The selection of those courses would depend on the functional area the student was planning to pursue for doctoral studies (e.g., finance, accounting, marketing, etc.). Including the summer and fall periods together, this group of students would gain about eight months of research experience which we believe will dramatically improve their preparedness for a PhD program, as well as their success in admissions to PhD programs.

The second type of student is one where a formal summer internship is advantageous (or possibly required) by their chosen career path or employer. Internship experiences would be identified and developed by Fuqua's career management center. These students could engage in the internship in the summer following their coursework, then return to Fuqua for Fall 1 and Fall 2 to deepen their professional skills. The primary objective here is to provide flexibility for some career paths where an internship may be viewed (by employers) as essential to the overall professional development of the student. The Fall 1 and Fall 2 curriculum for these students would include an Independent Study and extended communication courses customized to the needs of the students, as well as enrolling in 1-2 advanced MBA electives relevant to the career path. We anticipate that the Independent Study would be done at the individual student level and would be supervised by a faculty member. The focus of the Independent Study would be a project that deepened the student's data-analytic skills in the functional track being pursued. In addition, these students would work closely with the career management center in pursuing employment opportunities.

For both types of students, we plan to make available work-study opportunities as research assistants and teaching assistants. While we expect both the prospective PhD group and the internship group to be small, it would be beneficial to have a formal mechanism, such as the Certificate in Research, to accommodate these distinct needs, should or when they arise. For purposes of the financial projections, we have assumed that 5% of the prior year class would seek the certificate in the following year.

### Experiential and Collaborative Learning

We anticipate that learning will also occur inside and outside of the classroom. As one example, our experience in helping students learn how to be more collaborative is to create many opportunities for team-engagement. These engagements include course-work related assignments (cases, projects, presentations), team bonding activities (Triangle training, Duke basketball experience, Habitat for Humanity, etc.), and social and emotional exercises (creating team charters, learning how to have and respond to difficult conversations, understanding how and why diverse teams are more effective than non-diverse teams, etc.) The MQM experience will incorporate our learnings from other Fuqua programs.

A second example concerns programming or software skills necessary for a given functional track. Our research indicates that while some skills (such as coding in R) are broadly needed, other skills can be track specific, and therefore, do not lend themselves to inclusion in common data-analytic courses. We therefore propose to have bi-weekly workshops that students can attend to learn/hone these skills. This design also allows us to account for the heterogeneity in students' prior experience with languages and software.

### Target Audience

The MQM program would target undergraduates coming from more quantitative backgrounds and STEM majors (science, technology, engineering, and mathematics) as well as business and economics degrees, and with 0-3 years of work experience. Our experience with other programs suggest that our likely marketing plan will include: Google search advertising, LinkedIn advertising (inMails and sponsored updates), content marketing, and media relations.

### Admissions

The admissions process and admissions decisions will be conducted by the Fuqua School of Business. The application will require:

- Undergraduate degree from an 4-year accredited program
- Academic transcripts and graduate transcripts as relevant
- Responses to essay questions to assess readiness and interest
- GMAT or GRE scores; for the pilot program we will also consider SAT scores
- Two letters of recommendation
- Interview
- Appropriate readiness in statistics and computer skills

We expect the student profile will be similar to that of our MMS: FOB students with the exceptions that: (a) we anticipate the MQM will attract students with more quantitative backgrounds and undergraduate degrees in STEM majors (likely resulting in higher GMA scores); and (b) there is likely a larger fraction of foreign students interested in pursuing the MQM degree. Statistics for our current MMS student are: average age 23; average work experience, about 1 year; women, 49%; underrepresented minority, 10%; international, about 50%; average undergraduate GPA, 3.4; GMAT (middle 80%), 570-750.

Assuming a July 2017 start to the MQM program, we propose four deadline dates for the MQM program: end of October, 2016; end of January, 2017; beginning of March, 2017; beginning of April, 2017. Students will be notified after each round whether they have been accepted, waitlisted, or rejected.

Students will apply for admission to a particular track and, if admitted, would be guaranteed enrollment in the classes in that track. It is possible that some students may wish to pursue a second track, by carefully selecting classes for their electives. Provided space is available, that flexibility is valuable and we would support a student pursuing a second track.

### Career Services

As noted in section II of this report (in the context of researching and describing the market for the MQM program), we talked extensively with both our Career Management Center (CMC) and our Board of Visitors. Fuqua faculty and CMC staff reached out to contacts at a number of companies where we

have either research relationships or firms that currently recruit at Fuqua for MBAs, EMBA's, or MMS students. The responses we received ranged from Moderate ("we might have an interest in hiring such a person") to Highly Enthusiastic ("we have a very strong need for graduates with the skills you describe for the MQM"). Nearly every person we talked to commented on the value proposition of business analytic skills combined with functional knowledge and leverage by an ability to think critically and communicate ideas. There was general agreement that the demand for such graduates would only increase in the future.

*Summary: We believe the structure of the MQM program has several features that will make it attractive to students and recruiters. First is its balanced emphasis, within and across terms, on analytics, functional knowledge, and critical thinking, communication and collaboration skills. All of the market research we have conducted indicates that all three sets of skills are required. Second, the design allows the student to apply to a specific track, thus allowing them to signal to recruiters prior to the completion of their course of study the type of functional position they wish to pursue. This signaling is important as recruiting begins as early as Fall for some positions. Third, students are exposed to functional knowledge early in the program (Business Fundamentals in Summer, and more specific functional courses beginning in Fall 1); this early positioning ensures students are prepared for job interviews that occur as early as fall. Fourth, students have the ability for students to take elective courses in most terms. If desired, students could also choose to pursue two tracks, rather than a single track. (Note that this is not possible for students admitted to the Finance track.) Fifth, the program blends traditional and more experiential courses, culminating in a final team based project. Sixth, the Certificate of Research assists those students with career paths that benefit from an additional semester.*

#### IV. Fit with Faculty Research

A data-driven revolution has taken place in most areas of business. The combination of new technologies to collect, store and process data has generated numerous questions on whether and how to best use and/or monetize this new information. These changes impact research interests of many business scholars. Fuqua faculty are well-positioned to craft state of the art program content given their own business analytics related research. This leadership is evidenced by numerous publications and editorial positions held in top journals, as well as numerous awards in INFORMS (arguably the top professional society in the world for professionals in the field of operations research, management science, and analytics) and other professional societies.

The proposed MQM program offers opportunities to leverage Fuqua's research capabilities on issues and questions relating to big data and business analytics. The research interests cut across all eight functional areas of the Fuqua School: accounting, decision sciences, economics, finance, management, marketing, operations management, and strategy. We briefly summarize these linkages.

Fuqua is renowned in the domain of managerial decision making, which encompasses analytical, behavioral and mathematical modeling approaches. Notably, this strength transcends functional areas within the school. For example, the Decision Sciences faculty develop analytic approaches to making better decisions by leveraging applied probability, optimization, and statistics. They have also been engaged in developing MBA level courses in Big Data.

Our Management faculty conduct research on individual cognition and organizational decision making, group behavior in organizations, organizational leadership, and ethics. They have deep expertise and interest in the psychology of judgment and decision making, where they probe systematic biases to

which people fall prey, including biases drawing inferences from data and reasoning about uncertainty. Our faculty also seek to develop methods for improving decisions and overcoming bias. This work is especially relevant when decision problems are ill-structured and ambiguous, and thus require good judgment in addition to applying modeling skills. Faculty also work in the areas of diversity and collaboration. Research shows that decisions are most effective when organizations can bring multiple perspectives to bear on a problem. Our faculty study the psychological and organizational challenges of diversity, as well as methods for overcoming these challenges to manage conflict constructively. Relatedly, our faculty also examine the conditions for effective teamwork, including in a global environment in which team members are geographically dispersed and interact only virtually.

The Operations Management faculty use optimization approaches to solve complex production, distribution, and retail systems. As an example of this work, faculty study the process by which online retailers personalize assortments offered to customers based on their profile information (called assortment personalization). Given the abundance of customer and product attribute data, this assortment process may be extremely computationally intensive. The goal of the project is to propose a dynamic clustering approach that adaptively adjusts customer segments and personalizes the assortment offerings to maximize cumulative revenue. The Operations area has recently engaged in a collaborative agreement with the retail division at Oracle to jointly explore ideas about a product recommendation system based on customers' transaction data.

The Marketing area excels in customer, pricing and advertising analytics that leverage big data by combining them with statistical and economic models. In marketing, data analytics focuses on applying economic and statistical approaches to create, communicate and deliver value to customers. In the domain of value creation, Fuqua faculty have developed new approaches to developing goods and services that align with customers' needs and created tools for managing customer relationships over time. In the context of value communication, the Marketing area has been at the forefront of modeling digital media and brand messaging.

These data science approaches to addressing issues of policy and decision making extend into other areas as well including Strategy where faculty are developing new methodologies to better understand competition and incentives. For example, faculty in the Strategy area are engaged in research on the optimal structure, incentives, and resources for project teams. They also explore how firms compete and how competitive actions drive firm performance. Research advances in this area tie directly to the content in the competitive analytics course.

Several faculty in the Economics area are experts in auction theory and practice, with experience working on the design and implementation of electronic markets for public procurement and business-to-business e-commerce. For example, faculty have contributed to the design and of auctions used by the US Federal Communication Commission to sell spectrum licenses. Other Economics faculty use empirical approaches and have examined issues such as the economic value created by broadband Internet (using measures of new gross domestic product and consumer surplus) and measuring the effect that changes in retail formats have on consumers' purchasing behavior.

Large amounts of available data are driving new directions in quantitative and analytical research focusing on control and understanding of information control, flow and reporting. In addition to having strong interests in information reporting and control, Fuqua's Accounting faculty investigate cues that assist in the detection of financial statement fraud, including numeric cues from financial statements, linguistic cues from written prose, and vocalic cues from corporate speech. Research in this area has

been expanded to consider how cues can be combined, including how to combine human judgments with machine-based signals, to enhance fraud detection.

The Fuqua Finance faculty are exceptionally strong in quantitative research. Data-driven empirical work has been, for a long time, a cornerstone of financial economics. Traditional empirical approaches utilizing panel data sets on security prices and firm accounting data are being supplemented with new unstructured data-driven methodologies, such as machine learning and textual analysis. In addition to increasingly larger cross-sectional datasets, finance research also deals with increasingly finely sampled data. The use of transaction or tick data is prevalent in both financial practice and research, particularly in the areas of trading, risk management, and financial engineering.

*Summary: Our faculty have been, and continue to be, interested in advancing scholarship in questions that draw on big data and business analytics in their functional areas. These interests range from using data to make better decisions under uncertainty, to seeking optimization rules and models that enable more and different data to be brought to bear on business decisions. Fuqua faculty see many synergies between the content of courses in the MQM program and their own expertise. We seek to leverage the desire for the MQM curriculum to be timely and accurate in its understanding of business tools, with the opportunities that closer ties to data-driven business would bring, including questions of incentives, governance and ethics. In order to remain current in its understanding of the questions confronting business, as well as the tools to solve those problems, we will establish close ties with companies that are at the forefront of the data revolution. We see this as an opportunity for our faculty to deepen their understanding of complex business questions, and through their research, aid in identifying solutions.*

## V. Financial Projections

For the proposed four-track MQM structure, there are 28 courses, 54-credits, in total; 11 courses are common across tracks, 17 are distinct to tracks (but also serve as electives for other tracks). Based on current faculty expertise, we believe that a 50:50 ratio of tenure track (TT) to non-tenure track teaching (NTT) provides a good fit with program needs, intellectual/research interests, and financial resources. NTT faculty includes Professors of the Practice and adjunct faculty. In preparing this document, we reached out to a number of current and potential adjunct faculty as well as people in industry with whom we have collaborated in the past. Our goal was to understand the supply of people with expertise and a desire to work with our TT faculty to develop and teach courses in the proposed MQM program. The response was very positive. As a result, we believe there are many opportunities for TT and NTT to work together to co-create courses and an overall experience for the MQM student that is distinct and topical. It is important that this program have a close connection to industry, so that content can be continually updated for new trends, new techniques, and new issues that arise.

There is sufficient existing TT faculty capacity and interest at Fuqua to meet the needs of the MQM program for the initial 1-3 years of the program; additional NTT hiring is expected. Sufficient capacity is available for several reasons: we have several programs, and thus have flexibility for faculty to move across programs. Our current fraction of TT faculty teaching in our programs is very high (over 90%) relative to our peers (less than 60-70% in most cases), thus providing some flexibility for staffing in other programs. Demand across some of our programs is uneven, meaning that shifts across programs also derive from changes in demand. Fuqua is not seeking to immediately hire new TT faculty for the MQM program. Rather, we believe the MQM program should demonstrate success in its curriculum, in recruiting students to the program, and in identifying career paths for students, before any long term and costly commitment is made to changes in TT faculty size or composition linked to this program.

Based on the market research we have conducted, we believe the demand for this program will be sizable.<sup>8</sup> As such, we estimate an initial class size of 50 students, or an average of 12-13 students per track. We have assumed tuition of \$55,000.<sup>9</sup> This tuition is slightly higher than the tuition for Fuqua's 1-year Masters of Management Studies program (tuition for the MMS program will be about \$50,000 in 2016). Merit scholarship assistance (of 15% of tuition revenues) is budgeted. As with our other programs, we anticipate using scholarships to attract students that would otherwise be under-represented in the program; including URMs, women, and possibly domestic students. We would like to attract a diverse body of students in the MQM program. Our research indicates, however, that the preponderance of students pursuing STEM degrees lies outside of the United States. We will recruit globally, to attract as diverse a set of students as we can, using financial aid to incentivize the diversity component.

For students pursuing the Certificate of Research (in the year following the coursework for the MQM), we have assumed tuition of \$25,000. We have conservatively estimated that only 5% of the prior year enrollment will pursue the certificate in the following year.

Recent concern has been raised by a number of Duke faculty about the increased number of Master's programs at Duke University. This increase has raised concern about the University's long term ability to appropriately resource to meet the needs of this growing student population. The concern is amplified by the fact that a larger percentage of the master's program students are foreign nationals (as much as 92% in the hard sciences). These concerns require that any new master's program consider the cost of increased consumption of resources. Our financial plan assumes that, similar to its other master's degree programs, Fuqua will manage, conduct and pay for the incremental costs of admissions, student life, career management, IT, library services, marketing and communications, and administration of the new program. We expect that MQM students will live off campus (and we will assist them in identifying rental housing). We expect MQM students to pay for University health services – hence, incremental health costs that accrue to the University (such as use of CAPS), are borne by the student via the University-determined healthcare fee. In addition, we have budgeted for the expected cost of University shared resources, at the rate of 15% of direct costs. We expect this share of University costs would be used to cover incremental costs that Fuqua does not bear directly; for example, use of Duke buses by MQM students, use of broader Duke University library services by MQM students, etc. Our Career Management Center (CMC) currently works with the University career services office on mutually beneficial arrangements for our MMS students. Should such opportunities arise in the future with regard to MQM students, we would work with University career services to identify a mutually agreeable arrangement.

Our targeted date for the start of the MQM program is July 2017. The Thomas Center renovation is expected to be completed by January-February, 2017. At that time, we will regain access to two tiered classrooms as well as team rooms, which will solve any room constraints we might face. We have

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<sup>8</sup>To provide some context, the MMS: FOB degree at Fuqua receives about 1000 applications each year for approximately 120-130 slots. While the MMS: FOB degree and MQM degree differ, we do not expect the MQM audience to be appreciably smaller; in fact, if anything, we think the interested target audience will be bigger.

<sup>9</sup> The average enrollment in data analytics master's programs at other business schools is N=60, with a range of 13 to 181 (most current year data available). Tuition charged at these programs average \$48,000 and range from \$15,025 (University of Tennessee) to \$68,750 (NYU). As noted earlier in this report, no business school in our peer set currently offers a master's degree in data analytics. Of those business schools offering a master's degree in data analytics, we are most closely related to USC, NYU, Minnesota, Rochester and Texas; the average of these five schools' tuition is \$56,000.

confirmed the opening date is on target. Other shared spaces at Fuqua include the Fuqua library and Fox Center. Our assessment of the physical space indicates that the MQM program (in initial and later years) can be accommodated by our space. It is straightforward, for example, to revise the timing of classes for the MQM or other programs to avoid busy food service times at the Fox Center.

We assumed no integration of MQM with other Fuqua programs and no cost sharing in order to construct a conservative budget (i.e., overstate not understate costs). We believe there are potential ways that the MQM might integrate with other programs at Fuqua and at Duke. We think such synergies are best pursued once we have experience with the various operational aspects of the MQM program.

Our financial plan (Appendix 3) incorporates the above information. We have conservatively (i.e., upwardly) estimated incremental costs in all relevant program support departments, including admissions, student program support, career management, marketing, and administration. Our estimates for faculty costs are also conservative: we use fully-loaded TT compensation numbers (salary + summer support + research support) assuming a mix of faculty ranks, and use upwardly adjusted NTT salary numbers. Inflation is assumed at the rate of 2% per year. Other critical assumptions are provided at the bottom of Appendix 3. The budget indicates the MQM program will be profitable with enrollment of N=75 students, which we project will occur on or before Year 3. The breakeven enrollment for the program (not shown) is 67 students.

Appendix 3 shows a decline in profits in Year 4 (projected enrollment of 90 students) followed by an increase in Year 5 (projected enrollment of 100 students). The dip occurs because with a class size larger than 75, we need to run two sections of the common courses – thus, total faculty costs increase. At an enrollment of 93 students (not shown), the program generates profit of about \$417,000, roughly equal to that forecast for Year 3. Ideally, therefore, we would not increase enrollment above 75 unless we were confident we would attract at least 93 highly qualified students.

## VI. Risk Review

Overall, we believe the financial risk of the MQM program is low; however, it clearly is dependent on there being demand for the degree. We believe the forecasted demand shown in Appendix 3 is consistent with market research we have conducted. We also believe that we will be successful in identifying career opportunities for these students. Combined with the Fuqua brand, we believe initial success in career placement will increase demand for the program in future years. The MQM program is not, however, without risk. Key risks we have identified include:

- Demand for the program is less than we believe? It is worth emphasizing that master of data analytics programs differ as to whether they are more technical in nature versus more applied in nature. Applied programs, such as the MQM, are generally offered by business schools; however, no peer school to Fuqua has invested in this market. There is increasing demand and supply for both technical and applied master's programs, and perhaps especially so for applied programs – many of which have only recently started. In this regard, we believe Fuqua's MQM program: (a) is a relatively early, not late, entrant into the applied side of this degree market; (b) has a distinctive, balanced curriculum relative to competitors, and that is desired by recruiters; and (c) would be the only one housed in a top-ranked business school. We believe Fuqua's MQM would be viewed very strongly and enthusiastically by prospective students and prospective recruiters of these students.

Other evidence indicating strong demand is summarized as follows. First, corporate recruiter survey reports (prepared by the Graduate Management Admissions Council, GMAC) indicate that over 50% of surveyed companies will hire graduates to fill data-analytic roles in 2015, this reflects an increase from 44% in 2014. Second, numerous studies and surveys indicate that the demand for people with a deep understanding of data and how to analyze large amounts of data is large and growing. For example, a 2011 survey by McKinsey & Company estimated that by 2018, the US would need 140,000-190,000 more employees with deep-analytic skills and another 1.5 million data-literate managers. Third, the MQM is distinctive and innovative: it reflects the needs of many recruiters for candidates who have a strong quantitative understanding of data issues, but also understand how to put that data to business-use and how to articulate key issues to less data-literate management.

- Cannibalization of other Fuqua programs? There is a risk the MQM program cannibalizes enrollment in the MBA and MMS programs.<sup>10</sup> To the best of our ability, we have analyzed the possible cannibalization and concluded the following. There will be little to no cannibalization of the full time or executive MBA programs. Students in these programs (who have 5 or more years of relevant work experience) are looking to pursue primarily general management or leadership positions. The MQM program is more likely to provide moderate competition with Fuqua's MMS: FOB program.<sup>11</sup> Relative to the MQM program, the MMS program has no data-analytic courses, a smaller communications and critical thinking component, and the business courses are arguably less quantitative in their topics and instruction than envisioned for the MQM program. The MMS program provides a broader business education than MQM, and is geared to a student who does not have significant prior coursework in a STEM discipline. Given these numerous differences, we do not believe the MQM program could be implemented as a track or set of tracks within the MMS program.

We believe the potential cannibalization of MMS by MQM is not large and can be mitigated by careful monitoring, information dissemination, and marketing of the program. As context, the MMS: FOB program targets a broader range of students with 0-3 years of work experience post undergraduate, and provides them with a more general pre-experience business degree without a specific focus on quantitative management. We have a large applicant pool for the MMS program – roughly 1000+ students for the 120-130 spots in each class. Some of these students would have the necessary backgrounds to apply to the MQM program instead of, or in addition to, the MMS program. Most would either not have the background to pursue the MQM or would not want the data-analytic based career path offered by the MQM. The majority of MMS graduates take entry-level positions in consulting, marketing and corporate finance positions. Our review of the placement statistics of prior MMS classes indicates that very few MMS

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<sup>10</sup> The other master's programs at Fuqua are the master of business administration (MBA, both full time and executive) and the master of management studies (MMS, both the Foundations of Business and DKU variants).

<sup>11</sup> The Masters of Management Science (MMS) program at Fuqua is a 10-month program, aimed at attracting a variety of undergraduate majors, including liberal arts majors, with 0-3 years work experience. The program has a fixed curriculum that covers all business disciplines (accounting, decision sciences, economics, finance, management, marketing, operations, strategy). Relative to our MBA degree, the curriculum in the MMS program is more technical than management focused; that is, it is geared to helping students acquire technical business skills that are necessary in entry level analyst positions in consulting, finance, marketing, and other areas.

graduates over the past four years accepted positions that resemble the positions we expect to be the focus of MQM graduates.<sup>12</sup>

- Co-existence with related master’s programs at Duke University? We have done our best to understand the curricula of other master’s programs at Duke, and to consider the potential overlap with the proposed MQM. We identified the following programs, and briefly summarize their relation to the MQM. We review the concurrently proposed Master of Data Science in section VII.
  - Master of Engineering Management (MEM), is offered by the Pratt School of Engineering is designed for engineering or science undergraduate majors. The curriculum is flexible, but largely involves students taking four management courses, four technical elective courses (typically in engineering but could be in other areas of Duke as well), and a final project and presentation. Within the technical electives, MEM offers several technology foci including one in “data and decisions” and another in “financial engineering”. In examining the courses listed as electives in these two areas (and where many but not all of the courses are taught by Fuqua), we believe we have a good understanding of their content. It is our sense that the MEM program does not currently have a focus on data-analytics, and certainly does not have a program that blends the data-analytic, functional and critical thinking skills in the way the MQM program envisions.
  - Master of Science in Economics and Computation (MSEC), a joint degree offered by Economics and Computer Science. The curriculum of this program is more technical (in computer science) and more focused on econometrics and econometric modeling (in economics). According to the website, “The program is designed to train and develop programming skills linked to economics and related areas to prepare graduates for Ph.D. studies or related professions.” Our understanding of this program is that it reflects the more technical aspects of data science. The program does not have a business focus (and so is less applied than MQM) and also does not have a significant communications element.
  - Master of Science in Statistical & Economic Modeling (MSEM), a joint degree offered by Economics and Statistics. As compared to the MQM program, this program is more focused on statistical and economic theory. According to the website, “The focus is on theory and methods of statistical science and economics, computational statistics, Bayesian statistics, and interdisciplinary applications.” Our analysis of this program is similar to that of MSEC above: this program takes a more technical focus relative to the business application focus of the MQM on data analytics.
  - Master of Science in Financial Economics (MSFE), is a degree approved for offering by the Economics department. It is our understanding that while this degree was approved in 2014, the Economics department has not admitted students because of a shortage of faculty to teach relevant courses. It is difficult for us to evaluate the similarities between

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<sup>12</sup> It is worth noting that Fuqua’s experience with adding the MMS program four years ago is that MMS and MBA students are likely to benefit from the addition of an MQM program. This is because some employers recruit more intensively at schools where multiple hiring objectives can be met (i.e., entry-level, mid-level, senior-level).

the finance track of the MQM program and the MSFE program other than to note the MQM has distinct data analytic, business application, and communication components; in contrast and at least at its inception, the MSFE focused on deeper econometric and forecasting training with application in business and finance. It is possible there may be some similarities in finance training offered by the MQM finance track and the MSFE; however, it is difficult for us to judge that overlap at this time given that the MSFE program has not been offered.

Overall, the MQM fills a gap in Duke's offerings by providing a very applied masters in data analytics. It is our sense that the other master's programs currently being offered at Duke are more technical in nature. We note that we see an opportunity for Duke to think about the impact of these programs collectively -- to market and brand Duke as a place where students could pursue either deep technical expertise (MSEC, MSEM, MDS and MEM) or applied expertise (MQM), or both.

We are cautious about inferring too much based on our limited knowledge of these other programs at Duke where we are not experts -- although Fuqua is significantly involved with the MEM program (where we staff the core management classes and have historically had many MEM students take MBA classes at Fuqua, space permitting). That said, it is our sense that the MQM has a stronger and narrower focus on preparing data-scientists to become better communicators and decision makers so they are able to leverage their business-analytic skills within specific business domains. The pool of prospective students seeking this set of skills is large, and the demand for their services in business is large and growing. As a consequence, we do not think the MQM program would adversely affect these other master's programs at Duke.

- Brand confusion? The MQM degree must be carefully differentiated from the MBA and MMS degrees to ensure that prospective applicants, current students and alums understand the differences across these programs.
- Mapping of pedagogy to market needs? There is a risk that the proposed curriculum does not deliver a product that is valued by the market. Based upon the large market in data analytics and the absence of this type of program at a business school with Fuqua's rank and reputation this scenario seems unlikely. However, our faculty must be diligent and nimble in understanding and adjusting the content of their courses to continually adapt to the dynamic changes this industry experiences in the data-analytic space.
- The demand for graduates with data analytic skills exists, but we have misunderstood or mis-focused the functional content of the program? Stated differently, there is a risk we have selected the wrong tracks. We have tried to mitigate this risk by speaking with numerous companies to understand their particular business needs. Perhaps more importantly, the program is able to adapt to such an error by dropping a track or by altering a track to have a different focus. Of course, this would need to occur prior to the admission cycle for the next intake of students.

## VII. Opportunities

We believe there are several potential extensions of the MQM program. We have considered these as possible changes to the existing program, but concluded the design previously discussed has the highest probability of success, and therefore believe that design is best to start. In the future, we think the following ideas should be considered more deeply:

- The nature of the MQM program, and the strong worldwide demand for graduates with these skills, would lend itself readily to on-line courses, perhaps even a degree program.
- We believe that many working professionals would be attracted to an MQM-like program. Hence, one future avenue to consider is an MQM degree that is more tailored, both in content and format, to a more senior level targeted audience. Such a program might combine face to face with online instruction.
- We noted at the start of this report that we see complementarities between the MQM and the new proposed Master of Data Science (MDS, being developed jointly by the Social Science Research Institute (SSRI) and Initiative in Information at Duke (iiD) at Duke). The two programs differ in their focus: MQM focuses on preparing graduates for entry-level positions that require an understanding of and ability to communicate functional data-driven business problems; in contrast, the MDS program is more interdisciplinary in nature and draws more on the social sciences and humanities. Despite the difference in focus, there are several sources of synergies including a larger community of scholars (faculty, graduate students) interested in big data, data science and business analytics; a larger set of courses that might consider; and the ability of Duke to enhance its brand by develop multiple programs in this growing space.
- It is possible the MQM program would be helpful for PhD students from across Duke University, who have chosen to pursue positions in industry rather than academe. PhD students in many areas possess the kind of quantitative skill sets that are very attractive to private enterprise. But these same students may not possess understanding of the business context or have a good sense of the communication and collaborative skills that are necessary to be successful in business.

## VIII. Review and Assessment

Fuqua will collect and monitor a number of metrics regarding the new MQM program including:

- Number of applications generated
- Quality of applications generated
- Number of students enrolled
- Financial assessment
- Assessment of program and curriculum quality
- Number of firms recruiting MQM students
- Quality of firms recruiting MQM students
- Assessment of MQM's impact on other Fuqua programs

The Fuqua School will conduct a thorough review of the MQM program, including trends in these metrics, at the end of the third year the program is in place.

### Appendix 1: TFE Times MSBA Rankings and Methodology<sup>13</sup>

Rank	University	Program
1	University of Southern California	Business Analytics
2	New York University	Business Analytics
3	Rensselaer Polytechnic Institute	Business Analytics
4	University of Rochester	Business Analytics
5	University of Texas at Austin	Business Analytics
6	Arizona State University	Business Analytics
7	University of Texas-Dallas	Business Analytics
8	Villanova University	Analytics
9	Stevens Institute of Technology	Business Intelligence and Analytics
10	Michigan State University	Business Analytics
11	Northern Kentucky University	Business Informatics
12	Louisiana State University	Analytics
13	University of Cincinnati	Business Analytics
14	Creighton University	Business Intelligence and Analytics
15	Fordham University	Business Analytics
16	Southern Methodist University	Business Analytics
17	University of Connecticut	Analytics and Project Management
18	University of Minnesota	Business Analytics
19	Rutgers University	Business and Science
20	Bentley University	Business Analytics
21	Drexel University	Business Analytics
22	University of Tennessee, Knoxville	Business Analytics
23	Bowling Green State University	Analytics
24	Catholic University of America	Business Analytics
25	University of Colorado Denver	Business Analytics
26	Saint Joseph's University	Business Intelligence and Analytics
27	Saint Peter's University	Data Science with a concentration in Business Analytics
28	University of Michigan Dearborn	Business Analytics
29	Benedictine University	Business Analytics
30	Bellevue University	Business Analytics
31	Virginia Commonwealth University	Business with a concentration in Decision Analytics

<sup>13</sup> <https://tfetimes.com/2016-business-analytics-rankings/> and <https://tfetimes.com/msba-rankings-methodology/>  
MSBA Rankings and Methodology, November 14, 2014

## Appendix 2: Course Descriptions for MQM Curriculum

### Data Science and Data Analytics

- **Applied Probability and Statistics (3 credits) -**  
Management decisions are made under conditions of uncertainty. In turn uncertainty can be modeled via probabilistic tools and statistical tools. This course introduces a framework for thinking about problems involving uncertainty and develops tools for interpreting data. Topics: Foundations of probability (probability tree, conditional probability, central limit theorem); Foundations of statistics (summary measures, sampling, estimators, confidence intervals, hypothesis testing, ANOVA); Foundations of regression (simple linear regression, multiple linear regression, modeling)
- **Data Science for Business Analytics (3 credits)-**  
In this course, we will study the core ideas behind data mining, challenges associated with the data mining process, and the interplay between data science and business decisions. Fundamentally, it aims on how to extract value and monetize the data. We will focus on (i) general principles that are long lasting despite of the rapid changing technology; (ii) specific algorithms/technologies currently used in many industries; and (iii) “hands-on” analyses of actual datasets to develop methodologies. Topics: multiple hypothesis testing; predictive analytics and supervised learning (quantile regression, logistic regression, classification tree, over-fitting and out of sample performance, cross validation); similarity and unsupervised learning (clustering, K-means, hierarchical clustering, PCA); causality (Rubin model, experiments, A/B testing, observational studies, propensity score)
- **Decision Analytics and Spreadsheet Modeling (3 credits) -**  
Successful management requires the ability to recognize a decision problem, understand its essential features, and make a smart choice. However, many decision problems – particularly those involving uncertainty or many variables – are difficult to grasp intuitively. In these cases, we may benefit from using a computer-based model to explore and evaluate the possibilities in a systematic fashion. This course introduces several commonly used modeling frameworks and provides an introduction to the art and science of modeling decisions. Topics: Decision trees (decision making under uncertainty, risk aversion), Monte Carlo simulation (interpreting, choosing distributions, identifying main uncertainties); Optimization (linear, non-linear, integer programming).
- **Data Infrastructure and Visualization (3 credits)-**  
This course explores the fundamentals of data storage, cleansing, and retrieval. Examines structured versus unstructured data, relational database design, and data integrity issues. The second part of the course leverages software for visualization and effective communication in business. Topics: Principles of classic Infrastructure (e.g., database storage and information retrieval via SQL), and modern infrastructure for business (e.g., Hadoop, Spark, GPUs, distributed computation); Leveraging software for data visualization and effective communication in business (e.g., R, Tableau, Crystal Report).
- **Ethical & Legal Issues of Data Analytics (3 credits) -**  
Provides an introduction to the legal, policy, and ethical implications of data. The course will examine legal, policy, and ethical issues that arise throughout the full life cycle of data science

from collection, to storage, processing, analysis and use including, privacy, surveillance, security, classification, discrimination, decisional-autonomy, and duties to warn or act. Case studies will be used to explore these issues across various domains.

### Critical Thinking, Communication, and Collaboration

Aside from having technical expertise, as a successful analyst you must excel in three additional areas—critical thinking, communication, and collaboration.

- **Critical Thinking and Collaboration (3 credits)-**  
Data problems are typically ill-structured and ambiguous, at least at the outset. Critical thinking encompasses overcoming common cognitive biases, in addition to activities such as defining the problem appropriately, asking good questions, identifying the needed data, and exploring the data from multiple perspectives. The course also emphasizes developing the ability to explain analyses to others, capitalizing on diversity through teamwork, and negotiating effectively and creatively.
- **Business Communications 1 (2 credits) -**  
Introduces basic topics in business communications. These include developing individual and team presentation skills, collaborating effectively in teams, and interacting with clients. Also covers career management skills such as networking, preparing resumes and cover letters, and interviewing.
- **Business Communications 2 (2 credits)-**  
Explores techniques to help students learn how to effectively interact in the business environment. Building on Business Communications 1, this course will provide additional opportunities to develop presentation and career management skills. Additional topics include giving and receiving feedback, cross-cultural communication, and managing conflict.
- **Project Planning and Presentation (2 credits)-**  
Explores the basics of Project Planning, with specific emphasis on the Team Project. Team members will collaboratively generate and select an idea to pursue. Skills include defining goals, scheduling work, monitoring progress, and managing conflict and expectations.
- **Team Project (3 credits)-**  
In this capstone, students will what they have learned in the MQM program to a real-world problem of their choice, and present their analysis to an audience of peers and faculty.

### Finance Track

- **Financial Accounting (3 credits)-**  
Addresses the construction and interpretation of corporate financial reports. Our goal is not to train you to become an accountant. Rather, we want you to become an informed user/auditor of financial statement information. We will focus on accounting for specific assets (e.g., Accounts Receivable, Inventories, Property, Plant and Equipment, Intangible Assets), liabilities (e.g., Bonds, Deferred Taxes) and owners' equity on a firm's balance sheet, including financial report footnotes. We will also focus on how a firm's performance is presented in the income

statement through Net Income, and in particular, discuss how different revenue and expense recognition practices affect this performance measure.

- **Investment (3 credits)-**

Provides a rigorous treatment of the fundamental principles of investments, investment management, and asset pricing. Topics include asset allocation, asset pricing models (including the capital asset pricing model (CAPM), factor models, and consumption based asset pricing), international diversification, active portfolio management, performance evaluation, the interaction between capital markets and the macro economy, as well as alternative investments such as hedge funds and private equity.

- **Corporate Finance (3 credits)-**

Examines the implications of modern financial theory for various decisions faced by corporate financial officers. The concept of NPV, suitably adjusted to account for taxes, uncertainty, and strategic concerns, is used to analyze how investment and financing decisions interact to affect firm value. Topics include valuation, capital budgeting, capital structure, leasing, the cost of capital, mergers and acquisitions, and international financial management. Theory, empirical evidence, and case analysis all play significant roles in the course.

- **Derivatives (3 credits)-**

Explores key issues in derivatives and financial risk management. It develops tools for valuing and modeling the risk exposures of derivatives, with the ultimate goal of deploying these instruments in a corporate or financial risk management setting. The course is divided into two parts: (1) linear instruments including forward, futures and swaps; and (2) non-linear instruments such as options. In both parts, emphasis is placed on practical implementation using hand-on data and computational-intensive applications.

- **Fixed Income Securities (3 credits)-**

Explores key issues in fixed income, financial engineering, and risk management. It develops tools for valuing and modeling the risk exposures of fixed income securities and their derivatives, with the ultimate goal of deploying these instruments in a corporate or financial risk management setting. The course has three parts: (1) basic fixed income securities, (2) fixed income derivatives and financial engineering, and (3) risk management. In all three parts, emphasis is placed on practical implementation using hand-on data and computational-intensive applications.

- **Financial Risk Management (3 credits)-**

Examines the evolving and expanding practice of financial risk management. Risk management is a complex process of identifying, quantifying and managing various risk exposures. The course analyzes and discusses the various sources of risk. Particular attention is devoted to regulatory risk management techniques such as Value at Risk (VaR), standard volatility models, and correlation models using simulation tools. The course also covers different types of financial risks not reviewed in other courses including volatility, correlation, credit and prepayment risk. Real data analysis and hands-on quantitative modeling are an important part of this course.

## Marketing Track

- **Market Intelligence (3 credits)-**  
Market data form the cornerstone of informed decision making. This course begins by linking the research question to the strategic goals of the firm, such as the determination of consumer preferences or how markets react to tactics used by the firm. The course then proceeds by detailing means by which to collect and analyze the information necessary to answer those questions. Topics: experiments, surveys and measurement, demand forecasting, marketing mix models, time series models, choice and count models, segmentation and targeting, multi-dimensional scaling and causality.
- **Customer Relationship Management (3 credits)-**  
Customer relationship management (CRM) involves the "acquisition to attrition" management of customer accounts. It optimizes customer touch points to maximize the lifetime value of that customer to the firm. CRM addresses questions such as which customers to acquire, how to get them to buy more and how to keep them from churning. CRM is a widely applied tool in industries with large customers, such as banks, automotive, telecom and many others. Topics: customer lifetime value; acquisition; cross-selling; upselling; churn and retention; share of wallet; propensity modeling; segmentation and targeting; customer satisfaction; loyalty programs; account management.
- **Digital Marketing (3 credits)-**  
Communication and distribution channels are rapidly evolving in the context of digital technology and consumer migration to the Internet. As a result, advertising budgets are shifting to display and search, and goods are increasingly marketed and purchased online. This course will overview digital markets along with the associated key performance indicators and the tools being used to improve the efficiency of digital marketing. Topics: advertising markets and Integrated marketing communication; attribution; ad networks and media buying; campaign performance measurement; social media; search marketing; auctions; e-commerce; marketplaces; assortment and pricing; omni-channel marketing.
- **Pricing (3 credits)-**  
While most of the firms' marketing activities (such as product design, sales or advertising) create value for the customer, pricing is the only marketing activity that creates value for the firm. Accordingly, there is considerable value inherent in crafting pricing strategies to maximize firm revenue. This class will cover the various tools and methods to improve the efficiency of pricing. Topics: customer price response; competitor pricing; price optimization; bundle pricing; price targeting and matching; auctions; channel pricing; services pricing.

## Business Analytics Track

- **Operations Analytics (3 credits)-**  
This course introduces the core concepts and tools related to the design, planning, control, and improvement of manufacturing and service operations. Topics include capacity analysis, inventory management, response time management, demand and supply risk mitigation, mass customization, quality management, lean operations, process improvement, and project management. The course focuses on data-driven modeling and analysis that helps managers to make effective operations decisions and improve the performance of recurring business

processes, increasing the value offered to customers in terms of response time, quality, product variety, and inventory availability.

- **Competitive Analytics (3 credits)-**  
Explores analytics tools currently used to analyze competitive scenarios. Topics include pricing analytics, quantitative market analysis, benchmarking, competitor analysis, and forecasting.
- **Product Management (3 credits) -**  
Product Managers are responsible with ensuring the profitability of the firms' product lines. Typical responsibilities include product design and marketing, and involve working with all internal departments of the firm and its key customers and suppliers. In this course, you will learn the responsibilities of this role and the strategies necessary to be successful.  
Topics: customer analysis; product line design, pricing strategy, distribution and channel analysis, developing product road maps, incentivizing and structuring product teams, measuring product performance, and managing relationships with vendors.
- **Advanced Business Analytics (3 credits)-**  
Building on the solid understanding on the foundations of data science and analytics, this course covers advanced analytics methodologies that are prevalent in and important for success of emerging business models. These advanced tools successfully address a range of issues from supply chain management, platform and market design, to risk management. Topics: networks (data, structures and optimization); information (text mining, recommender systems, collaborative filtering); real-time and on-demand analytics (streaming data, dynamic pricing, on-demand market-clearing)

#### Forensics Track

- **Financial Accounting (3 credits) -**  
Addresses the construction and interpretation of corporate financial reports. Our goal is not to train you to become an accountant, but to help you become an informed user/auditor of financial statement information. We will focus on accounting for specific assets (e.g., accounts receivable, inventories, property, plant and equipment, intangible assets), liabilities (e.g., bonds, deferred taxes) and owners' equity on a firm's balance sheet, including financial report footnotes. We will also focus on how a firm's performance is presented in the income statement through net income, and how different revenue and expense recognition practices affect this performance measure. The role of internal controls and auditing will be introduced in the context of generating financial statement data.
- **Financial Statement Fraud (3 credits)-**  
This course demonstrates the various aspects of fraudulent financial reporting, including the identification of fraud schemes, including computer fraud and methods of concealment, as well as the analytical technics in uncovering fraud. The course will also include an analysis of the general techniques used in working in litigation support services. Students will be exposed to financial statement analysis techniques for detecting financial fraud and an understanding of SAS 99 as it pertains to the consideration of fraud in a financial statement audit. Students will gain knowledge of and proficiency in using software tools and General Audit Software (GAS) as part of the investigation and case management process.

- **Information Security Risk (3 credits) -**

This course introduces general risk management principles as applied to information security. The course will cover foundational risk management concepts and activities in the context of identifying, analyzing, quantifying and responding to risks that originate in the cyber infrastructure. Students will obtain sufficient technical awareness and managerial competence that will enable them to apply risk management concepts and techniques in a real-world setting.

- **Due Diligence and Fundamental Analysis (3 credits) –**

This course provides students with the tools to critically analyze financial information in order to predict cash flows and assess risk (including information risk), for the purpose of understanding asset valuation. The tools covered in this course consist of various valuation models, with an emphasis on the role of financial statement data in equity valuation, using advanced problems and cases developed around actual financial statements. In addition to viewing equity valuation from a fundamentals perspective. Overall, the course provides students with a strong theoretical and applied understanding of the key equity valuation used by securities analysts, particularly in the role of due diligence engagements.

### Appendix 3: Five Year Financial Projections for MQM Program

	Year 1		Year 2		Year 3		Year 4		Year 5	
<b>Revenues</b>										
Enrollment: Base Program	50		60		75		90		100	
Tuition: Base Program	55,000	2,750,000	56,100	3,366,000	57,222	4,291,650	58,366	5,252,980	59,534	5,953,377
Enrollment: Certificate	0		2		3		3		4	
Tuition: Certificate	25,000	0	25,500	51,000	26,010	78,030	26,530	79,591	27,061	108,243
Total Tuition Revenue		2,750,000		3,417,000		4,369,680		5,332,570		6,061,620
Scholarship		15%		15%		15%		15%		15%
Net Tuition Revenue		2,337,500		2,904,450		3,714,228		4,532,685		5,152,377
<b>Faculty costs</b>										
TT costs	1,200,000		1,224,000		1,248,480		1,644,872		1,677,770	
NTT costs	580,000		591,600		603,432		870,191		887,594	
Faculty costs		1,780,000		1,815,600		1,851,912		2,515,063		2,565,364
Fringes	26%	462,800	26%	472,056	26%	481,497	26%	653,916	26%	666,995
Faculty costs with fringes		2,242,800		2,287,656		2,333,409		3,168,979		3,232,359
<b>Operating costs</b>										
Admissions		70,000		71,400		90,000		91,800		100,000
Career Services		100,000		102,000		110,000		112,200		150,000
Student Programming		50,000		51,000		52,020		70,000		80,000
Marketing		100,000		102,000		104,040		90,000		100,000
Administrative		60,000		61,200		62,424		63,672		100,000
Total operating (assume all salary)		380,000		387,600		418,484		427,672		530,000
Fringe benefits	26%	98,800	26%	100,776	26%	108,806	26%	111,195	26%	137,800
Pre-tax total expenses		2,721,600		2,776,032		2,860,699		3,707,847		3,900,159
University Tax	15%	408,240	15%	416,405	15%	429,105	15%	556,177	15%	585,024
Total expenses		3,129,840		3,192,437		3,289,804		4,264,024		4,485,183
Net profit/loss		-792,340		-287,987		424,424		268,661		667,194

**Key Assumptions:**

- Tuition: \$55,000 for base program; \$25,000 Certificate in Research
- Faculty costs: Tenure track faculty cost per course: \$100,000 (this is a projected blend of in-load and overload teaching by TT faculty); Non-Tenure Track cost per course: \$40,000; Communication cost per course: \$25,000
- Mix of faculty: 50% TT, 50% NTT
- Inflation factor, 2% per year

## Master's Advisory Council Discussion Notes

*Mary Story, Carlo Tomasi, John Klingensmith*

### Proposal Summary

#### **Program Nature and Target Audience**

This proposal envisions a stand-alone, 28-course, 42-credit, 10-month (July-May) master program aimed at training STEM, business, and economics undergraduates who have up to 3 years of work experience. The program covers finance, marketing, business analytics, and forensics, as well as the communication and teamwork skills required in business.

The profile of the target students would be similar to that of Fuqua's Master of Management Studies (MMS), but with a more quantitative background and a greater proportion of foreign students.

Fuqua's Board of Visitors, the dean, and the Fuqua faculty all endorse the program. Several companies have been consulted, and have expressed interest in hiring graduates from the program.

#### **Related Programs outside and within Duke**

There are at least 109 master programs in data analytics in the US—40 of which reside in business schools—and more than 150 worldwide. None of the 31 Master of Business Analytics programs ranked by the Financial Engineer Times is housed in a business school with Fuqua's ranking and reputation. There are loosely related programs at NCSU and UNC Charlotte.

There are also several related master's programs within Duke, in The Graduate School, Pratt and Fuqua itself, though each appears to have a different focus than MQM. The approved but as yet inactive MS in Quantitative Financial Economics, and the MS in Data Sciences, under proposal development, appear to be the most closely related.

#### **Program Structure**

The MQM program is divided into four tracks: finance, marketing, business analytics, and forensics. Students would be admitted into specific tracks, but can choose to pursue a second track as well. Tracks share core courses in data science/analytics and in critical thinking, communication, and collaboration. A mix of track-specific required and elective courses would be offered. Students would take four courses in each of five 6-week terms. Various experiential and collaborative activities would be offered, and biweekly workshops would help students learn or hone their programming skills.

An additional Fall term would be available for students who wish to pursue a Certificate of Research, and would graduate in December. This certificate targets students who want to pursue a PhD in business or who have a research requirement from their employers.

#### **Costs**

Courses would be taught by a 50/50 mix of tenure-track and non-tenure track faculty.

No integration with other Duke master programs is envisioned, and courses may be shared only

within Fuqua. No costs would be shared with other programs, either at Fuqua or elsewhere at Duke.

A \$55,000 tuition is envisioned, against a national average of \$48,000 for data analytics programs. The financial break-even point for enrollment is about 67 students, and 50-60 students would be matriculated in Year 1, with a target of 100 by the fifth year. The break-even point of 67 students is anticipated to be reached on or before Year 3.

Fuqua would manage, conduct, and pay for the incremental costs of admissions, student life, career management, IT, library services, marketing and communications, and administration of the proposed program.

## **Comments and Questions**

### **Relationship to Other Master Programs at Duke**

There are several Master programs at Duke that are related to the proposed program, and the proposal mentions six:

- Master of Engineering Management (MEM) in Pratt
- Master of Science in Economics and Computation (MSEC)
- Master of Science in Statistical and Economic Modeling (MSEM)
- Master of Science in Quantitative Financial Economics (MSQFE)
- Fuqua's own Master of Management Studies (MMS)
- Master of Science in Data Science (MDS), currently being developed as a proposal by SSRI and iiD

The relationship with these programs is only cursorily examined in the proposal (Section VI). It would be helpful if a comparison could be in a table format to more clearly see the similarities and differences.

There may well be room for an additional program. Specifically, the MQM seems to be geared towards STEM or Economics undergraduates who want to learn finance, marketing, business analytics, and forensics, and acquire the communication and teamwork skills required in business. In contrast, some of the other programs focus on the more technical aspects of statistical modeling (MSEM) and computation (MSEC) needed in economics or other fields (MDS).

It seems important for Fuqua to clarify differences and similarities among these programs. The MSQFE to be offered by Economics appears to be overlapping the finance track of the MQM. Pratt's MEM and MQM also seem *prima facie* closely related. Currently, there is a single, vague sentence on this comparison in the proposal:

*It is our sense that, relative to the MEM program, the MQM curriculum is more geared to the application of business-analytic tools to leverage data in specific business functions.*

Fuqua's own MMS program is also at least somewhat related, and should be compared against MQM in some detail. Is MQM a more specialized (quantitative) version of MMS, and will it draw from the same pool of applicants as MMS? Could it be conceived as a specialized track within MMS?

It would help avoid the brand confusion mentioned in the proposal if the differences and similarities between all these programs were outlined in greater detail. This would help the

broader Duke community understand why each of these programs occupies an important niche. It would also help Fuqua brand and market its program more clearly.

As one point of clarification, MQM is clearly not *about* big data. The proposal envisions four courses that are directly relevant to quantitative data analysis by computational means: data science for business analytics; data infrastructure and visualization; advanced business analytics; and decision analytics and spreadsheet modeling. With the only possible exception of data infrastructure and visualization, the descriptions of these courses point to traditional modeling techniques used for “small data.” All other courses are traditional business courses.

### **The MQM as an Alternative to Related Programs Elsewhere**

The proposal acknowledges that there are dozens of somewhat similar masters programs at other universities. It would be helpful to better explain why there is likely to be a very strong market (up to 100 matriculants per year!) for the MQM. Though Fuqua itself will certainly be a draw, there are advantages to other programs as well. For example, the NCSU Master of Science in Analytics, developed with the strong and active support of SAS, has had excellent placement in various businesses and is much less expensive for NC residents, at \$22,170 for the 10 month program. This is much less than half of the MQM tuition (also a 10 month program). Why should applicants choose MQM instead?

### **Certificate of Research**

The proposed MQM program is designed to be completed in 10 months (July to early May) and courses occur in 6-week terms: Summer, Fall 1, Fall 2, Spring 1, Spring 2. On page 7, the Certificate in Research is presented as an additional Fall term and the cost would be an additional \$25,000. This part of the proposal could be further developed. It is not clear exactly what this certificate would consist of. It says in the proposal this would be an additional Fall term but it is not clear if this is 6 weeks or one semester. The research component is not clear. What would be the outcome for students- a capstone project? Is this individual or group? It says students would enroll in 1-2 relevant PHD seminars, or enroll in 1-2 advanced MBA electives. For a research certificate this needs more thought. If it is indeed just a 6 week term, this seems to be a very short period for any significant research, especially while the student takes additional MBA courses and perhaps works as a RA or TA.

Also under the section on ‘Certificate in Research’ it says students could also engage in a formal internship but this is not really research focused. What is the relationship?

### **Resources**

The proposed program requires a large number of new courses. Although it is clear that program revenue will be used largely to pay for this teaching, has it been determined that the tenure-track faculty (who are proposed to do half the teaching) will have sufficient availability? Presumably they are already heavily involved in MBA and MMS teaching, their own research, etc.

There seems to be a classroom crunch, but completion of the Thomas Center renovation by early Spring 2017 would address the issue. Is the Thomas Center on track? Beyond classroom and teaching space, is there adequate space for students for a common area, project space etc? How about faculty and space sufficiency when the program has doubled in size to 100/year?

The proposal states that the program will be largely self-contained within Fuqua. Even so, the addition of 100 more master's students in the Duke community will have broader implications for university and local resources. Some of these needs are difficult to estimate, eg the availability of housing, while others are more tangible, like CAPS visits. Please assess the broader implications for Duke beyond Fuqua.

### **Students**

This is a very expensive program. Please comment on the nature and availability of financial aid and the criteria for aid?

Beyond the educational background of targeted applicant pool, the proposal makes little mention of the likely or preferred make-up of the class. There is a comment that more are likely to be international than in MMS. Please explain. There does not appear to be any mention of whether there will be efforts to achieve a diverse student body. If diversity is desirable in this program, will there be mechanisms to promote it (eg scholarships, recruiting, etc)?

### **Comments on the Text**

The proposal is well written, although it could use one more round of editing.

Use of color to distinguish program tracks in Figures 3 and 4 excludes about 8% of men, who are color blind. Also, the tables in Appendices 1 and 3 should be encoded with vector graphics. The current tables are bit maps: They are hard to read and do not become more readable when magnified.

Numbers in Appendix 3 do not always add up. For instance, the products of *enrollment:certificate* and *tuition:certificate* for years 2-5 are not equal to the figures reported. If there are reasons for these discrepancies, please explain.

## Response to Master’s Advisory Council Discussion Notes

We would like to thank the MAC for their excellent and timely review of the MQM proposal. We very much appreciate the thoughtful comments. We provide responses/elaborations of the issues raised below. Note: we have italicized and used red font to summarize the issue(s) raised by the MAC.

### General:

*Under the section of the summary labeled **Costs**, the MAC review noted that “No integration with other Duke master programs is envisioned, and courses may be shared only within Fuqua. No costs would be shared with other programs, either at Fuqua or elsewhere at Duke.”*

We assumed no integration and no cost sharing in order to construct a conservative budget purposes (i.e., overstate not understate costs). We believe there are potential ways that the MQM might integrate with other programs at Fuqua and at Duke. We think such synergies are best pursued once we have experience with the various operational aspects of the MQM program.

### **Comments and Questions:**

#### Relationship to Other Masters Programs at Duke

*The MAC asked for greater detail about other related masters programs at Duke University.*

We elaborate on our understanding of the relevant programs below. We believe the extended text descriptions below provide the best overall summary of the differences in foci across the programs.

- Master of Engineering Management (MEM), is offered by the Pratt School of Engineering is designed for engineering or science undergraduate majors. The curriculum is flexible, but largely involves students taking four management courses, four technical elective courses (typically in engineering but could be in other areas of Duke as well), and a final project and presentation. Within the technical electives, MEM offers several technology foci including one in “data and decisions” and another in “financial engineering”. In examining the courses listed as electives in these two areas (and where many but not all of the courses are taught by Fuqua), we believe we have a good understanding of their content. It is our sense that the MEM program does not currently have a focus on data-analytics, and certainly does not have a program that blends the data-analytic, functional and critical thinking skills in the way the MQM program envisions.
- Master of Science in Economics and Computation (MSEC), a joint degree offered by Economics and Computer Science. The curriculum of this program is more technical (in computer science) and more focused on econometrics and econometric modeling (in economics). According to the website, “The program is designed to train and develop programming skills linked to economics and related areas to prepare graduates for Ph.D. studies or related professions.” Our understanding of this program is that it reflects the more technical aspects of data science. The program does not have a business focus

(and so is less applied than MQM) and also does not have a significant communications element.

- Master of Science in Statistical & Economic Modeling (MSEM), a joint degree offered by Economics and Statistics. As compared to the MQM program, this program is more focused on statistical and economic theory. According to the website, “The focus is on theory and methods of statistical science and economics, computational statistics, Bayesian statistics, and interdisciplinary applications.” Our analysis of this program is similar to that of MSEC above: this program takes a more technical focus relative to the business application focus of the MQM on data analytics.
- Master of Science in Financial Economics (MSFE), is a degree approved for offering by the Economics department. It is our understanding that while this degree was approved in 2014, the Economics department has not admitted students because of a shortage of faculty to teach relevant courses. It is difficult for us to evaluate the similarities between the MQM and this program other than to note the MQM has distinct data analytic, business application, and communication components; in contrast and at least at its inception, the MSFE focused on deeper econometric and forecasting training with application in business and finance. It is possible there may be some similarities in finance training offered by the MQM finance track and the MSFE; however, it is difficult for us to judge that overlap at this time given that the MSFE program has not been offered.

Overall, the MQM fills a gap in Duke’s offerings by providing a very applied masters in data analytics. It is our sense that the other master’s programs currently being offered at Duke are more technical in nature. We note that we see an opportunity for Duke to think about the impact of these programs collectively -- to market and brand Duke as a place where students could pursue either deep technical expertise (MSEC, MSEM, MDS and MEM) or applied expertise (MQM), or both.

*The MAC also asked for more detail about Fuqua’s MMS program, including whether it drew from the same or different applicant pool, and whether MQM could be conceived as a track within the current MMS program.*

The Masters of Management Science (MMS) program at Fuqua is a 10-month program, aimed at attracting a variety of undergraduate majors, including liberal arts majors, with 0-3 years work experience. The program has a fixed curriculum that covers all business disciplines (accounting, decision sciences, economics, finance, management, marketing, operations, strategy). Relative to our MBA degree, the curriculum in the MMS program is more technical than management focused; that is, it is geared to helping students acquire technical business skills that are necessary in entry level analyst positions in consulting, finance, marketing, and other areas. Relative to the MQM program, the MMS program has no data-analytic courses, a smaller communications and critical thinking component, and the business courses are arguably less quantitative in their topics and instruction than envisioned for the MQM program. The MMS program provides a broader business education than MQM, and is geared to a student who does not have significant prior coursework in a STEM discipline. Given these numerous differences, we do not believe the MQM program could be implemented as a track or set of tracks within the MMS program.

We have a large applicant pool for the MMS program – roughly 1000+ students for the 120-130 spots in each class. Some of these students would have the necessary backgrounds to apply to the MQM program instead of, or in addition to, the MMS program. Most would either not have the background to pursue the MQM or prefer the data-analytic based career path offered by the MQM. Please also refer to our response to “The MQM as an Alternative to Related Programs Elsewhere”

### The MQM as an Alternate to Related Programs Elsewhere

*The MAC review asked why applicants would choose MQM over many similar master’s programs, and particularly those (such as) with a lower tuition. There is also a question as to the size of the market demand for such a program.*

It is worth emphasizing that master of data analytics programs differ greatly as to whether they are more technical in nature versus more applied in nature. Both types of master’s degrees have considerable demand. Applied programs, such as the MQM, are generally but not exclusively offered by business schools. There is increasing demand and supply for both technical and applied master’s programs, and perhaps especially so for applied programs – many of which have only recently started. In this regard, we believe Fuqua’s MQM program: (a) is a relatively early, not late, entrant into the applied side of this degree market; (b) has a distinctive, balanced curriculum relative to competitors, and that is desired by recruiters; and (c) would be the only one housed in a top-ranked business school. We believe Fuqua’s MQM would be viewed very strongly and enthusiastically by prospective students and prospective recruiters of these students.

Fuqua competes all of the time with local universities in the MBA degree market. Both NC State and UNC offer MBA degrees at lower tuitions than Duke. Students select Fuqua because of the combination of reputation, curriculum, faculty, and network. With regards to NC State University’s Master of Science in Data Analytics program, it is technical in nature, and therefore, not a direct competitor to the MQM program. Were any local universities to develop a direct (applied-focus) competitor for MQM, we would compete with it on the same dimensions as we do for our MBA programs.

The MAC review asked for an explanation for the expected strong demand for the MQM program (up to 100 students per year). We believe the MQM program will have very strong demand for several reasons; these are summarized in the main report and elaborated on here. First, corporate recruiter survey reports (prepared by the Graduate Management Admissions Council, GMAC) indicate that over 50% of surveyed companies will hire graduates to fill data-analytic roles in 2015, this reflects an increase from 44% in 2014. Second, numerous studies and surveys indicate that the demand for people with a deep understanding of data and how to analyze large amounts of data is large and growing. For example, a 2011 survey by McKinsey & Company estimated that by 2018, the US would need 140,000-190,000 more employees with deep-analytic skills and another 1.5 million data-literate managers. Third, the MQM is distinctive and innovative: it reflects the needs of many recruiters for candidates who have a strong quantitative understanding of data issues, but also understand how to put that data to business-use and how to articulate key issues to less data-literate management.

## Certificate in Research

*The MAC asked for greater development of the ideas presented in the report concerning the Certificate of Research.*

An additional Fall term (consisting of Both Fall 1 and Fall 2) is proposed for students who wish to pursue a Certificate of Research. In order to pursue the Certificate in Research, interested students must apply by the end of the Spring 1. Note that students pursuing the certificate would not graduate in May, but defer their graduation until completion of the Certificate in Research, in December.

This Certificate and additional term provides flexibility for two types of students. First, students who may be interested in pursuing a PhD degree in business. These students could be identified and matched with one or more faculty members to work on research over the Summer. In the Fall term(s), these students would work on guided research (Independent Study supervised by one or more faculty members), and enroll in 1-2 relevant PhD seminars. The independent study would be done at the individual student level, under the supervision of a faculty member, and would focus on developing the student's research skills. Students would also enroll in 1-2 advanced MBA classes in each of the Fall terms. The selection of those courses would depend on the functional area the student was planning to pursue for doctoral studies (e.g., finance, accounting, marketing, etc.). Including the summer and fall periods together, this group of students would gain about eight months of research experience which we believe will dramatically improve their preparedness for a PhD program, as well as their success in admissions to PhD programs.

The second type of student is one where a formal internship is advantageous (or possibly required) by their chosen career path or employer. Internship experiences would be identified and developed by Fuqua's career management center. These students could engage in the internship in the summer following their coursework, then return to Fuqua for Fall 1 and Fall 2 to deepen their professional skills. The primary objective here is to provide flexibility for some career paths where an internship may be viewed (by employers) as essential to the overall professional development of the student. The Fall 1 and Fall 2 curriculum for these students would include an Independent Study and extended communication courses customized to the needs of the students, as well as enrolling in 1-2 advanced MBA electives relevant to the career path. We anticipate that the Independent Study would be done at the individual student level and would be supervised by a faculty member. The focus of the Independent Study would be a project that deepened the student's data-analytic skills in the functional track being pursued. In addition, these students would work closely with the career management center in pursuing employment opportunities.

For both types of students, we plan to make available work-study opportunities as research assistants and teaching assistants. While we expect both the prospective PhD group and the internship group to be small, it would be beneficial to have a formal mechanism, such as the Certificate in Research, available to accommodate these distinct needs, should or when they arise. For purposes of the financial projections, we have assumed that 5% of the prior year class would seek the certificate in the following year.

## Resources

### *1. The MAC asked about the availability of TT faculty for supporting the MQM program.*

There is sufficient existing TT faculty capacity and interest at Fuqua to meet the needs of the MQM program for the initial 1-3 years of the program; additional NTT hiring is expected. Sufficient capacity is available for several reasons: we have several programs, and thus have flexibility for faculty to move across programs; our current fraction of TT faculty teaching in our programs is very high (over 90%) relative to our peers (less than 60-70% in most cases), this providing some flexibility for staffing in other programs; demand across our programs is uneven, meaning that shifts across programs also derive from changes in demand. Fuqua is opposed to immediate TT faculty hiring for the MQM program. Rather, we believe that the MQM program should demonstrate success in its curriculum, in recruiting students to the program, and in identifying career paths for students, before any long term and costly commitment is made to changes in TT faculty size or composition linked to this program.

### *2. The MAC asked about the expected completion of the Thomas Center, as well as other spaces issues within the Fuqua School.*

Our targeted date for the start of the MQM program is July 2017. The Thomas Center renovation is expected to be completed by January-February, 2017. We have confirmed the opening date is on target. Other shared spaces at Fuqua include the library and Fox Center. Our assessment of the physical space indicates that the MQM program (in initial and later years) can be accommodated by our space. It is straightforward, for example, to revise the timing of classes for the MQM or other programs to avoid busy food service times at the Fox Center.

### *3. The MAC asked for an assessment of broader implications of the MQM's program use of Duke resources.*

As noted in the MQM proposal, our financial plan assumes that, similar to its other master's degree programs, Fuqua will manage, conduct and pay for the incremental costs of admissions, student life, career management, IT, library services (at Fuqua), marketing and communications, and administration of the new program. We expect that MQM students will live off campus (and we will assist them in identifying rental housing). We expect MQM students to pay for University health services – hence, incremental health costs that accrue to the University (such as use of CAPS), are borne by the student via the University-determined healthcare fee. In addition, we have budgeted for the expected cost of University shared resources, at the rate of 15% of direct costs. We expect this share of University costs would be used to cover incremental costs that Fuqua does not bear directly; for example, use of Duke buses by MQM students, use of broader Duke University library services by MQM students, etc. Our Career Management Center (CMC) currently works with the University career services office on mutually beneficial arrangements for our MMS students. Should such opportunities arise in the future with regard to MQM students, we would work with University career services to identify a mutually agreeable arrangement.

## Students

*The MAC asked for elaboration on the nature and availability of financial aid, as well as the targeted composition of the MQM class.*

As noted in the proposal, merit scholarship assistance (of roughly 15% of total tuition revenues) is budgeted. As with our other programs, we anticipate using scholarships to attract students that would otherwise be under-represented in the program; including URMs, women, and possibly domestic students. We would like to attract a diverse body of students in the MQM program. Our research indicates, however, that the preponderance of students pursuing STEM degrees lies outside of the United States. We will recruit globally, to attract as diverse a set of students as we can, using financial aid to incentivize the diversity component.

## Comments on the Text

Thank you; we have reviewed the document and attempted to remove typos and other errors.

We regret that 8% of men are not able to distinguish the color coded program tracks. We do not know of a simple way to represent the curriculum to a large number of diverse individuals who will read and review this proposal, in a pdf format. We could remove the colors, but this would not improve understanding of the 8% and would surely worsen the understanding for the remaining men and women who will read the report. If you have a different, simple way to help visualize this, please let us know.

We have redone the tables in Appendices 1 and 3 to make the information more readable. We have updated the budget and removed discrepancies. (The issue involved not using an integer formula for forecasting certificate of research students; we now use the integer formula to make calculations clearer.)

## Additional Letters of Support

Thomas Nechyba, Director SSRI



January 22, 2016

Dear Review Committee,

I am writing to express my enthusiastic support for the proposal to create a Master of Quantitative Management (MQM) degree at Fuqua. As you know, we are in the process of proposing an MS in Data Science (MSDS) (joint with the Initiative in Information at Duke (iiD)). As I read the MQM proposal, I was immediately struck by the many connections and areas of collaboration I can see emerge as these proposed programs seem highly complementary. Indeed, Jennifer Francis and I have already discussed several ways we can collaborate. Together these programs can quickly help Duke catch up in the area of data science education.

While the MQM program has a narrower business-related focus than the broader interdisciplinary approach taken by the MSDS, both recognize the importance of communication of data science as opposed to the mere "doing" of data science. We think the MSDS could benefit greatly from the experience that Fuqua has in this area and the practical ways the MQM will bring that experience to this new Masters degree. Our MSDS program has at its core a Data Science Seminar that brings graduate students with interests in data science from around the university together with practitioners and faculty to explore new projects and collaborations. The pilot version of this seminar, known as Data Dialogues, is already highly successful, and we think MQM students will find it a welcoming community. The proposed MDS is similarly planning a number of exciting electives that we hope some of our MSDS students will find attractive.

I look forward to seeing these programs jointly grow and flourish while providing an exciting platform on which the larger data science community at Duke can grow and connect more deeply.

Sincerely,

A handwritten signature in black ink, appearing to read "Thomas Nechyba".

Thomas Nechyba  
Professor of Economics and Public Policy Studies  
Director, SSRI

A.Craig Burnside, Chair of Economics



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1/26/16

To: the Curriculum Committee

Colleagues:

We are writing in support of The Fuqua School of Business's proposed Master of Quantitative Management Program. The proposed degree provides a new graduate education choice for our graduating economics majors interested in furthering their study of big data in a business functional context. We hope that the program will also provide potential for new interdisciplinary education and research opportunities between Master's students in Fuqua and the Economics department, that build on the strengths of our faculty and lead to new collaborative opportunities.

Sincerely,

A handwritten signature in black ink, appearing to read "A.C. Burnside".

A. Craig Burnside  
Professor and Chair of Economics  
Duke University