FOR CONFIRMATION   **PUBLIC**   **CLOSED SESSION**

TO:	Executive Committee
SPONSOR: **CONTACT INFO:**	Professor Cheryl Regehr, Vice-President and Provost 416-978-2122, cheryl.regehr@utoronto.ca
PRESENTER:	See above.
DATE:	January 30, 2017 for February 6, 2017
AGENDA ITEM:	4 (a.)

ITEM IDENTIFICATION:

Proposal for the Creation of a New Degree Program: Master of Management Analytics, Joseph L. Rotman School of Management

JURISDICTIONAL INFORMATION:

Proposals for new graduate programs and degrees may be approved by the Academic Board, subject to confirmation by the Executive Committee (Section 5.3.2(ii), Academic Board Terms of Reference.)

GOVERNANCE PATH:

1. Committee on Academic Policy and Programs [for recommendation] (January 10, 2017)
2. Academic Board [for approval] (January 26, 2017)
3. **Executive Committee [for confirmation] (February 6, 2017)**

PREVIOUS ACTION TAKEN:

The proposal for the Master of Management Analytics received approval from the Joseph L. Rotman School of Management on November 25, 2016 and from the Academic Board on January 26, 2017.

HIGHLIGHTS:

This is a proposal for a two session, full-time professional master's degree called Master of Management Analytics (M.M.A.). It will be offered by the Joseph L. Rotman School of Management. The program consists of twelve required courses (6.0 FCE) comprised of intensive course work aimed at students seeking expertise in business data analytics.

The fundamental framework of management analytics is the application of the scientific method using advanced data analytic tools to business decisions. These tools include statistical modeling, data mining, simulation, and optimization models. To be effective, analysts using these tools must also have strengths in modeling businesses, translating results into actions, and communicating with executives. Analytical support for managerial decisions is now the expectation for most firms. The goal of the M.M.A. program is to train professionals who are able to design and implement multi-faceted solutions that bring the right quantitative decision tools to bear on each business problem in various application contexts. It will also provide graduates with the skills to effectively communicate the results and insights arising from their analysis to both business executives and analytics professionals.

The program has a custom-designed curriculum and will leverage the skills and interests of Rotman faculty along with the Rotman approach to business education, which features an emphasis on business problem modeling and solutions with an emphasis on business application. The curriculum will provide graduates with the ability to use the tools of data analytics and to work in a broad set of industries and within professional organizations. The program delivery is divided into three sections: a 4 week introduction, a 13 week "Analytics Toolkit" section ending in December and a final "Analytics Practice" session from January to April. There will be an integrative capstone project completed in the last session wherein students have the opportunity to synthesize their knowledge gained through the research-informed coursework and apply it to new business contexts.

The degree nomenclature, Master of Management Analytics, is appropriate as it expresses the focus of the use of data analytics in the field of management and business administration. The courses taught in the program will all have specialized managerial data analytics learning outcomes and build on the students' pre-existing knowledge of mathematics, statistics, and computer science.

The proposal is the result of a highly consultative process. Across the University of Toronto consultation took place with the Faculty of Applied Science and Engineering, Faculty of Arts & Science, Dalla Lana School of Public Health, Faculty of Information, Faculty of Medicine, University of Toronto Mississauga, and University of Toronto Scarborough. The divisions were supportive of the proposed program and provided helpful feedback.

The program was subject to external appraisal on September 18 and 19, 2016 by Professor Harry Groenevelt, Simon Business School, University of Rochester and Professor Tim Huh, Sauder School of Business, University of British Columbia. The external reviewers made a number of suggestions, some of which resulted in small changes to the program as is reflected in the Dean's response to the appraisal report. The proposal received approval from the Joseph L. Rotman School of Management on November 25, 2016.

FINANCIAL IMPLICATIONS:

The new financial obligations resulting from this program will be met at the Faculty level.

RECOMMENDATION:

Be It Confirmed

THAT the proposed Master of Management Analytics, which will confer the new degree M.M.A., as described in the proposal from the Joseph L. Rotman School of Management dated November 3, 2016 be approved effective September 1, 2018.

DOCUMENTATION PROVIDED:

Proposal for the Creation of a New Degree Program: Master of Management Analytics, Joseph L. Rotman School of Management

University of Toronto
New Graduate Program Proposal

This template is for all proposals for new graduate programs. It will help to ensure that all evaluation criteria established by the Quality Council are addressed in bringing forward a proposal for a new program. Separate templates have been developed for other types of proposals.

Full Name of Proposed Program: *(i.e. Master of Arts in History; Master of Science in Sustainability Management)*	Master of Management Analytics
Degree Name and Short Form: *(i.e. Master of Arts, M.A.; Master of Science in Sustainability Management, M.Sc.S.M.)*	Master of Management Analytics, M.M.A.
Program Name: *(i.e. History; Sustainability Management)*	Management Analytics
Professional Program *(yes/no)*	Yes
Unit (if applicable) offering the program: (i.e., Site of academic authority. Where a program is housed elsewhere (in physical terms), this should also be indicated.)	Rotman School of Management
Faculty / Division:	Rotman School of Management
Dean's Office Contact:	Susan Christoffersen, Vice-Dean, Undergraduate & Pre-experience Programs
Proponent:	
Version Date: *(please change as you edit proposal)*	November 3, 2016

New Graduate Program Proposal

Master of Management Analytics
Rotman School of Management

Table of Contents

1 Summary

This proposal is for a Master of Management Analytics (M.M.A.) degree program at the Rotman School of Management. The proposed professional M.M.A. degree program will be offered as a full-time program that comprises two academic sessions (Fall, Winter) of intensive course work. The program is targeted at students with strong quantitative skills who have recently completed their undergraduate studies in mathematics, sciences, and engineering who have little or no work experience. The students will obtain both broad and in depth knowledge of the theory and application of managerial analytics and its role in organizations. They will learn how to translate business problems into data analytical models, obtain data to support decision making, analyze descriptive, predictive, and prescriptive models, formulate tactical and strategic solutions, and communicate the results of those models to executives within firms and other organizations. The research informed elements of the program and the intensity of the proposed coursework and the requirement of undergraduate training in a STEM or social science field justifies the designation as a Master's-level degree.

The initial size of the M.M.A. program will be about 40 students, with the expectation that it would grow to a cohort of 65 to 70 students; we note that the recent experience at Rotman with the new Master of Financial Risk Management program, as well as our preliminary market research indicates the initial target to be quite attainable. Our primary target audience is composed of the approximately 3,000-4,000 of University of Toronto graduates in math/science/engineering and related fields each year, and the graduates in similar fields from other Toronto-area universities. We expect that with growth the program will attract more wide-spread Canadian and international students as we intend to place students in positions globally.

Management analytics are a suite of tools and techniques useful in identifying and formulating strategies and policies to addressing problems in competitive environments. These tools include statistical modeling, data mining, simulation, and optimization models. To be effective, analysts using these tools must also have strengths in modeling businesses, translating results into actions, and communicating with executives. Analytical support for managerial decisions is now the expectation for most firms. The availability of data and the power of computers to process it has reached levels where managers can expect to gain insight to problems based on analysis of consumer, customer, competitor, and commercial data.

To provide effective analytics support for managerial decisions the analyst must be able to understand the managerial issues involved, identify the relevant data sources and analytical techniques, set up and perform the required analysis and then communicate the business implications of the findings to the managerial team. Thus a successful analyst must possess both hard skills (advanced analytical and data management) and soft skills (managerial and communication). Many indicators suggest that this combination remains rare. People with

highly developed hard skills often score poorly on business awareness and communication abilities, and, vice versa: effective business-oriented managers often do not possess strong technical skills in analytics.

This dearth of business analytics talent is projected to increase. McKinsey Global Institute estimates that by 2018, the US will have 190,000 fewer data scientists than it needs to meet demand. That's on top of the predicted shortage of 1.5 million managers and analysts who have the skills to effectively put to use the intelligence contained in all those numbers. Conversations with high-level managers in a variety of industries suggest that people possessing both hard analytics and soft business skills will be in very high demand.

In recent years, a number of schools, including our two main competitors in the Toronto market (Queen's and Schulich), have responded to this market demand by launching their own Master's programs in Analytics. These programs are growing rapidly, testifying to the strong market demand for graduates with the relevant skills.

Rotman's M.M.A. program has several features that differentiate it from both local and global competitors. The program has a custom-designed curriculum that combines analytical depth and a focus on business issues and applications. Many programs have combined a few new courses on data analytics with recycled M.B.A. courses. This program will leverage the skills and interests of Rotman faculty to provide a fully integrated, newly designed curriculum. Further, the Rotman approach to business education, featuring an emphasis on business problem modeling and solution, will provide the context for the M.M.A. program's emphasis on business application. The Rotman program will feature a capstone integrative project wherein students have the opportunity to synthesize their knowledge gained through the research-informed coursework and apply it to new business contexts to gain further understanding of how to integrate the analytic and managerial aspects of the program. It will also allow students to demonstrate their proficiency in the various analytical and data handling skills taught in the program to potential employers.

The proposed program will not have an adverse impact on the M.B.A. program. As noted the targeted student cohort for the M.M.A. program will be recent graduates with strong interest in the application of data analytics to businesses. The typical M.B.A. student has several years work experience and is considering working in managerial roles. While there is increasing need for data analytical skills at the M.B.A. level, data analytics is not the focus of their studies nor typically the main target of their job search. Thus, the proposed program should have minimal impact on Rotman's recruitment efforts for its M.B.A. programs and on the employment prospects of its M.B.A. graduates.

2 Effective Date

September, 2018

3 Program Rationale

Management Analytics encompasses the understanding and application of research techniques developed in the operations research and social science communities to problems faced by managers and business analysts. The fundamental framework of management analytics is the application of the scientific method using advanced data analytic tools to business decisions. Students in the program will learn to conduct research on management problems in this framework. They will learn how to

- identify valid research questions
- design experiments
- recognize natural experiments
- evaluate data and its sources
- gather, organize, and clean data
- analyze data using appropriate statistical techniques
- analyze data using appropriate algorithmic techniques commonly referred to under the title of `big-data' techniques
- qualify and justify underlying assumptions of the techniques
- summarize and discuss research findings

Faculty will teach the scientific method as applied to managerial problems through lectures and hands on problems, with examples drawn from their own research and from those found in journal articles. Students will apply these research techniques to the various projects assigned for the classes including the semester long integrative capstone project described below.

The goal of the M.M.A. program is to train professionals who are able to design and implement multi-faceted solutions that bring the right quantitative decision tools to bear on each business problem in various application contexts. It is also important that the graduates be able to effectively communicate the results and insights arising from their analysis to both business executives and analytics professionals. Therefore, the ideal graduate should:

- recognize business problems that call for analytics support
- know current analytics tools and techniques
- be familiar with the recent hardware and software tailored to business analytics
- have the ability to structure the business issue as a problem to which quantitative tools can be applied
- be able to critique alternate analytic approaches to problems faced
- evaluate modeling assumptions with respect to their appropriateness and application
- derive novel analytic models to address pertinent questions
- identify and organize the collection and processing of the necessary data
- identify and conduct the most suitable analytical analyses

- translate analytical results into managerial insights
- clearly and effectively communicate these insights

The program in its courses, hands-on projects, colloquia, and opportunities for self- and professional development is designed to foster the learning and professional objectives given above.

All courses in the M.M.A. program will be delivered at the St. George campus through a series of lectures and hands-on projects. The use of classroom time for most of the courses will vary between lectures, case discussions, and technical labs where students will work with faculty on development of projects. The lectures will develop theory on the material being taught, for example on statistical models or machine learning techniques. Students will engage with this technical material in the classroom under faculty supervision, using data examples to understand how and when to apply alternate models. Similarly, lectures will provide opportunities for professors to discuss common managerial models and link these to the technical models of analytics. Case studies will provide context for discussions and analyses. As the program is rooted in applications of the scientific method to managerial decision making, students will be trained in linking business problems to managerial questions, which in turn will be phrased as research questions that are then addressed by analytical models. Further, case studies will introduce students to open-ended conversations on translating analytical findings into firm decisions at operational and strategic levels. These will support the program's goal of developing the students' communications skills.

An important feature of the program will be training on state-of-the art analytical tools (ranging from analytical workhorse packages such as various SAS products, to the newer open-source tools such as R and Python) and the opportunity for students to obtain professional certification in several areas such as Predictive Modeling (SAS) and Analytics (INFORMS). These tools will be taught both in the classroom and through projects completed outside of class.

We include coursework on data collection and organization, data visualization, model validation, business modeling, and solution presentation. The most time-consuming and complex component of many real-life analytics projects is data collection and aggregation – to construct a meaningful data set on which insightful analysis can be performed often requires integrating data from different sources, both public and private, which, in turn, requires numerous data cleaning, aggregation, and normalization steps. Coursework and projects will feature such work. The curriculum will include techniques designed for situations where past data is not (and, in principle, cannot be) available, but certain probabilistic assumptions can be made – tools such as decision analysis techniques or Monte-Carlo Simulation. Moreover, data analytics is only useful if it generates managerial insights and actionable business plans. Any analytical model used for business decision-making must be validated. This may require additional experimental design, data collection, and modeling steps.

The curriculum will also feature opportunities for student self- and professional development. The program will begin with an orientation period where students will be coached on effective communication and effective workgroups. Throughout the courses students will be required to make in class presentations. For some of these presentations students will work with the Self-Development Lab at the Rotman School to learn how they can be more effective in their presentations. Students will also be coached in developing their resumés and interviewing skills. The analytics colloquia will include outside speakers presenting current topics on how data analytics is practiced in modern organizations.

Finally, the capstone integrative project will require students to interact in a professional environment with the sponsors of the projects. Capstone groups will be self-directed and require all members to show initiative and personal responsibility. Students will determine the relevant managerial questions and translate these into research questions. They will investigate relevant research techniques and analytic models to address the questions. They will gather, clean and organize data to support their analysis. They will then conduct appropriate analyses and derive interpretations of the findings. They will then develop presentations and reports based on these. Finally, the students will be required to evaluate their own models and present fair evaluations of them. The capstone integrative project will allow students to demonstrate the full range of professional and research techniques that are at the heart of the Rotman Master of Management Analytics.

Appropriateness of degree nomenclature and program name
The degree nomenclature, Master of Management Analytics, is appropriate as it expresses the focus of the use of data analytics in the field of management and business administration. The courses taught in the program will all have specialized managerial data analytics learning outcomes and build on the students' pre-existing knowledge of mathematics, statistics, and computer science. Similarly named programs exist at competitor schools in Canada and United States, with varying permutations of the terms "management", "business", "data", and "analytics". We are hesitant to call the program a "Master of Business Analytics" as the abbreviation M.B.A. would invite confusion.

Distinctiveness
Rotman's proposed M.M.A. Program will have several features that differentiate it from both local and global competitors. These include a custom-designed integrated curriculum, a focus on the use of analytics specifically to address managerial questions, and a target audience of recent graduates with strong science and technology backgrounds. The combination of these elements does not exist in our competitor programs.

The program has a custom-designed curriculum that combines analytical depth and a focus on business issues and applications. Many competitor programs that are based in business schools have combined a few new courses on data analytics with recycled M.B.A. courses. This program will leverage the skills and interests of Rotman faculty to provide a fully integrated, newly designed curriculum and be distinguished through its teaching of research skills in analytics by researchers active in the field. The strength of the Faculty and intuition

in the area is reflected in our international rankings. The Rotman School is listed as #3 in Research by the Financial Times rankings. Further, the M.M.A. program will be directed by faculty in the Operations Management and Statistics Area, and the Marketing Area of the Rotman School. These areas are ranked by research productivity by the University of Texas, Dallas, Business School rankings, as #4 and #12, respectively in their disciplines.

As we describe in Section 9, the program will consist of a short term introducing students to models, data, and management. Then there will be a set of courses teaching the tools and methods of managerial data analytics in the Fall session. This is followed by a Winter session focussed on the application of tools in various management disciplines. The courses in the Fall session will directly support the courses in the Winter session both in sessions of the tools and techniques needed. Our immediate business school competitors do not offer such a comprehensive, integrated curriculum.

The Rotman approach to business education features an emphasis on business problem modeling and solution. This approach provides the context for the M.M.A. program's emphasis on business application. We contrast this approach with that taken by programs at other universities given by their engineering, computer science, or information systems departments. These programs generally provide a deep look into the various data analytics techniques. However, they do not generally provide much of the business context, nor considerations of the data generation process or the consumption of the solutions by management. Thus, these programs while providing strong training in techniques, do little to address the need of businesses to have data analysts that understand the context and strategic implications of an analysis. The Rotman program is designed to provide the students with these skills.

A distinct element of the Rotman program's focus on business problem modeling and solution is the inclusion of the capstone integrative project described above. While other programs have such projects, ours is based on the very successful capstone project required of first-year Rotman M.B.A. students. In that program, students use the range of skills they acquire in the first year M.B.A. to address a business problem. The M.B.A. capstone is distinguished by the access to data and knowledge of the context by which it was generated. In the M.M.A., the students will complete a similar capstone, but using the full range of statistical and analytic techniques taught in the M.M.A.; these are generally not known or used by the M.B.A. students.

Comparison to competitive programs
In preparing this proposal we examined a number of graduate programs in Analytics, both in Canada and in the United States. The greatest competition is likely to come from the locally-based programs at Queen's University (Smith School of Business), York University (Schulich School of Business), and Western University (Ivey Business School). We have also evaluated a number of U.S.-based programs. While a variety of programs are offered, including some at the top universities, only a few are offered through business schools, though this number is increasing. Of these, not all are focused on both managerial issues and technical skills in a program with courses designed directly for the program as does ours. Many programs offer

a few specialized courses in analytics and then ask the students to complete their curriculum by taking general M.B.A. course electives.

The key differentiation from the Master of Management Analytics program at Queen's Smith School of Business is the target audience (recent graduates vs. mid-career professionals) and the delivery mode (full-time vs. part-time). The average age in the Queen's program is 31 years with over 7 years of work experience and 2-3 years of management experience. Further, the program is aimed at working professionals, with classes scheduled over a 12 month period, with several residential modules and the balance of classes taking place in the evening and on weekends. While this provides a means of reaching this audience, it may not suit our target audience, recent graduates seeking in-depth training in data analytics applied to managerial problems. Further, we believe the Queen's program does not provide the in- and out-of-classroom time we consider necessary to train students in the research methods and skills needed for entry-level analytics positions. In part, the Queen's design reflects its target audience, professionals seeking to lead teams in analytics after working in the field for multiple years. However, recent graduates are less expected to lead teams (at least in their first few years out) while they are expected to have skills and training to contribute immediately to an analytics team. As part of our design we are trying to focus our admissions to recent graduates with strong science and technology skills who seek training in applications in management. We believe that the more uniform skill level of our entering students and the full-time nature of the program involving a significantly larger number of contact hours will allow us to better deliver on the promise of graduates with strong analytical and communication skills.

With regards to the Master of Business Analytics program at the Schulich School of Business, we believe that Rotman's proposed program provides much more analytical depth, covers a far wider range of techniques and application areas, and will impart many more practical skills. This is apparent from the comparison of course descriptions. Having custom-designed analytics-focused courses rather than recycling M.B.A. electives will be an important source of competitive advantage. Another key difference is the Rotman program's capstone integrative project. In comparison, the Schulich program features a co-op term. While there are many fine co-op experiences, there is a high potential for a co-op placement to be less than optimal, where students are not challenged and do not sufficiently learn to apply their skills within a work environment. We believe that the integrative project will place the students in a much more controlled environment, ensuring that the various analytical and data handling skills they have acquired are properly used and tested. This will afford the students the opportunity to demonstrate the research skills acquired – defining problems, translating research questions into models, seeking appropriate data, and analyzing it. Moreover, by forcing the students to consider unstructured and integrative business issues, we will ensure that the projects require the use of a combination of tools, rather than a single technique. Further, the design of the project will also force the students to develop their presentation skills before a board of judges. The projects will also allow us to scale the program as dictated by student demand and resource availability. The programmatic advantages described above, as well as the important reputational advantages of Rotman

and University of Toronto brands, will enable us to compete effectively both for the best applicants and the best placements for program graduates in the Toronto market.

The Master of Science, Business Analytics program at the Ivey Business School is a 16-month analytics program directed at recent graduates given as a stream of courses within the Masters of Science program at Ivey. There are four core courses developed just for the Business Analytics program, that are combined with three core courses common for all the M.Sc. students (Strategy, Statistics, and Global Management Practices) and a set of electives (that may include M.B.A. electives). The program is based on Ivey's case method of teaching. The Rotman program is distinct from this program as it will use a broad range of teaching tools, from lectures to data labs to colloquia to cases to deliver the program material. As noted above, it will also benefit from the distinct research strengths of the Rotman faculty.

Within the U.S., there are a number of programs in analytics. Many of these programs are housed in Engineering Schools (Harvard, Northwestern), Schools of Information Systems (UCBerkeley, Carnegie Mellon), and Departments of Computer Science (Columbia). These programs, true to their placement in technical departments focus on the technical aspects of data analytics. They do not appear to offer either the business focus or the emphasis on developing the communications and management skills we are addressing. Our program is most similar to those based in the business schools, including USC Marshall School of Business, North Carolina State, and University of Rochester (Simon School of Business). These three programs are trying to combine data analytics with business problem solving in integrated programs. NC State was the first school to develop such a program and has grown over eight years to 130 students. The programs at USC and Rochester are more recent, having started in the last two years. From discussions with the head of the Rochester program, they are expanding their program from the current 18 students. We believe that our programmatic offerings will be equal to or exceed those of these schools. To this end, a broad array of faculty members - from accounting, marketing, operations, and computer science - with diverse research interests, have offered to teach in the program.

We believe our position in Canada may provide some competitive advantage with respect to U.S. schools for non-Canadian applicants. First, our current tuition estimates are in line with those of these similar programs, though denominated in Canadian dollars so that currently there is a significant discount on the program. Second, our close relationship with our major financial and industrial partners should provide a sufficiently broad set of problems and opportunities for skill development that students should be able to market themselves upon completion of the program to non-Canadian firms. Third, Canadian immigration policies may provide benefits to students seeking to relocate to North America that may not be available to those attending U.S. schools.

Please see Appendix F for a table listing details of analytics programs in Canada and the U.S.

4 Fields/Concentrations

None

5 Need and Demand

The twin forces of exponential increases in both data availability and computational power are making advanced quantitative analysis more accessible than ever before. As a result, analytics support for managerial decisions is now the expectation, rather than the exception in many industries. To provide effective analytics support for managerial decisions the analyst must be able to understand the managerial issues involved, identify the relevant data sources and analytical techniques, set up and perform the required analysis, and then communicate the business implications of the findings to the managerial team. Thus a successful analyst must possess both "hard" (advanced analytical and data management) skills and "soft" (managerial and communication) skills. Many indicators suggest that this combination remains rare. People with highly developed hard skills often score poorly on business awareness and communication abilities, and, vice versa: effective business-oriented managers often do not possess strong technical skills in analytics.

This dearth of business analytics talent is projected to increase. McKinsey Global Institute estimates that by 2018 the US will have 190,000 fewer data scientists than it needs to meet demand. That is on top of the predicted shortage of 1.5 million managers and analysts who have the skills to effectively put to use the intelligence contained in all those numbers. Conversations with high-level managers in a variety of industries suggest that people possessing both hard analytics and soft business skills will be in very high demand.

We have conducted a series of in-depth interviews with 20 business executives working in the general area of analytics. The interviews were arranged through SAS Institute (an analytics support firm), personal contacts, and colleagues at Rotman. The interviewees came from a wide range of companies, from small firms to very large financial institutions, a variety of industries, and had different levels of seniority within their respective organizations. Each interview took 30-60 mins; most were conducted in person, with a few conducted by telephone. Interviews were conducted in 2015.

These interviews confirm the existence of strong market demand for graduates with strong analytics skills, particularly when coupled with effective communication skills. The interviewees were consulted on the design of the proposed program. While they were generally complimentary on the overall design, a number of suggestions for improvement were made; these have been incorporated in the current document. The interviewees agreed that given the reputational strength of Rotman and the University of Toronto brands, and based on the design of the proposed program, program graduates should attract strong interest from prospective employees in a variety of industries.

6 Enrolment

- *Please provide details regarding the anticipated in-take by year, reflecting the expected increases to reach steady-state. This table should reflect normal estimated program length. (Please adjust the table as necessary)*
- *Please provide an explanation of the numbers shown and their relation to the Faculty/Division's enrolment plan.*

The M.M.A. falls within the Rotman School of Management's academic priorities and enrolment plans. This program will capitalize on the Rotman school's strengths in business modeling and data analytics, especially in the areas of Marketing and Operations. We expect a steady state of 65-70 students by Year 4 of the program with a mix of domestic and international students, the majority being Canadian residents. In the current budget we are projecting 55 domestic students and 10 international students in steady state. The graduate enrolment spaces for this program are part of the Faculty's current enrolment plan.

Table 1: Graduate Enrolment Projections

Year of study	Academic year 2018-19	Academic year 2019-20	Academic year 2020-21	Academic year 2021-22	Academic year 2022-23
Year 1	40	50	60	65	65
Total	40	50	60	65	65

7 Admission Requirements

Admissions Process

Applicants will complete a standardized application form with written essays as well as provide official transcripts, reference letters, and a resumé. Additionally, all students will be required to provide a supplemental short video containing verbal response to several questions. The essay and video questions will help the admission team identify students with poor written or verbal communication skills. Applicants are expected to be "pre-experience" although may enter the program with some relevant work experience. Applicants will therefore be considered either immediately after completing their undergraduate education or a few years after graduation from a relevant undergraduate program. Applicants will be scored on each of the admission requirements and then ranked based on their overall score. The short-listed applicants may be invited for an interview (international applicants can be interviewed online through Skype or other means; local candidates will be interviewed in person). The Admissions Committee will then make decisions based on the overall weighted score, including the interview score. The main components of the weighted score will be:

overall academic strength, quantitative proficiency, computational (computer programming) proficiency, and communication skills.

Admissions Requirements
For students to be considered for acceptance into the M.M.A. program, they must meet the minimum admissions standards below.

1. **Appropriate four-year undergraduate degree:** For entry into the School of Graduate Studies of the University of Toronto, a four-year recognized undergraduate degree or equivalent is required. Given the nature of the M.M.A. program, degrees in Computer Science, Statistics, Mathematics, Engineering, Physical Science, Economics, and Commerce will be preferred, but degrees from any program where there is a significant quantitative and computational component will be considered.
2. **Grade Point Average:** Applicants must have achieved a minimum B average in the final year of their undergraduate degree.
3. **English language proficiency:** Applicants must demonstrate the ability to communicate in English in one of the following ways:
   - An undergraduate or graduate degree from a university at which the language of instruction and examination was English.
   - Satisfactory performance on a standardized English Language Test. Minimum TOEFL score of 100 is required. IELTS may be considered in special circumstances, and a minimum score of 7.0 will be required.
4. **Quantitative proficiency:** All successful applicants must demonstrate a high level of quantitative proficiency. This includes knowledge of Calculus, Linear Algebra and Statistics/Econometrics. For many applicants, this will be satisfied by having taken, and obtained a minimum B average, in the corresponding courses or courses covering a similar subject matter (e.g., Econometrics can be substituted for Statistics, etc.). In cases where evidence of quantitative proficiency is not obvious from the transcript, applicants will be required to provide supplemental evidence they have attained the required base of knowledge (ie. a course outline detailing material covered, research work demonstrating the required skills etc.).
5. **Computational proficiency:** All successful applicants must demonstrate proficiency in computer programming (in one or more of computer programming languages). This may be demonstrated through a minimum B average in one or more courses in Computer Science or in courses relying extensively on computer programming. In cases where evidence of computational proficiency is not obvious from the transcript, applicants will be required to provide supplemental evidence of their computational proficiency (ie. a course outline detailing the programming required in a course, a reference letter from a supervisor detailing computational skills and programming abilities, etc.).
6. **Communication skills:** All successful applicants are expected to demonstrate effective oral and written communication skills. These will be assessed through answers to essay-style and video questions, interviews, and relevant courses taken during prior study.

Explanation

Our primary target audience is composed of recent graduates in mathematics, sciences, and engineering at the Bachelor's and Master's levels. Students in the program will acquire skills in data analysis that are typically not found in undergraduate programs in math, science or engineering. These skills require significant mathematical maturity as well as a high degree of computer literacy. Thus we would require exposure to calculus, computational methods, linear algebra, and probability and statistics.

We may find that the program is attractive to students in the social sciences, such as economics and commerce. These students would also be viable applicants if they can demonstrate sufficient background and ability in the necessary quantitative and computational proficiencies based on prior coursework.

We are also sensitive to the concern that placing our graduates in roles where they can excel will require strong communication skills. As part of the admissions requirements, we require two essays, responses to video questions, and an interview in order to judge the written and oral communications skills of the applicant. In addition, the language proficiency scores are higher than the SGS minimum required. The program itself has set expectations on the development of communication skills of its participants. The admissions requirements are set to ensure that the students are able to acquire and enhance their skills to a level of expectation of the program and their future employers.

We believe that an undergraduate average at the B level in the final year and in courses that demonstrate quantitative and computational proficiency will be sufficiently high to ensure the students will be able to progress through the program with their peers. As the program is to be completed in lockstep with no electives (at least for the foreseeable future), any failure of a course would lead to a significant delay in completion of the course requirements. Depending on the views of the academic director and instructor, students who have failed a course may be allowed to write an examination counting towards 100% of the failed grade in place of retaking the course in the following year. This will be evaluated on a case-by-case basis depending on the circumstances of the failure. Students who need to withdraw from courses during the year due to unforeseen circumstances or need accommodation because of a disability would be accommodated on a case-by-case basis. If an equivalent course is available elsewhere in the University or at Rotman (as determined by the instructor and academic director), the student may be allowed to take this course as part of their degree requirements. Again this would only be granted on a case-by-case basis and would not be the intended pathway for the majority of students. Examples of accommodation may include scheduling additional make-up exams to complete course requirements or provide extra time to students with disabilities to complete exams or assignments. Students will have 2 years to complete their degree.

Locally, the University of Toronto produces approximately 1,500 graduates at the Bachelor's level in Mathematics and Physical Sciences and a similar number of graduates in Engineering and Applied Sciences each year. The corresponding numbers at the Master's level are 250

and 600, respectively. Many of these graduates will have acquired a high level of training in mathematics, statistics, and computer science, but will have little or no experience with the practical application of these skills to business problems, or, indeed, much knowledge of the functional areas of management and the typical issues that they deal with. Yet, many of these students have a strong interest in pursuing a career in analytics.

Thus we believe that our target audience (in the initial years) is composed of approximately 3,000-4,000 of University of Toronto graduates in math/science/engineering and related fields each year and the graduates in similar fields from other Toronto-area universities in similar fields. We expect that the program will attract great interest from students across Canada and internationally – many of whom have strong training in math-related fields; some will have work experience in analytics. We would work with the Rotman recruiting and admissions office to generate international interest in our program and increase the school's exposure globally. We are confident a broad recruiting approach domestically and internationally should attract a class of 40-50 students per year in the first few years of the program.

8 Program Requirements

For Proposed Calendar Copy, please see Appendix B.

Explanation of the Proposed Requirements
The M.M.A. degree program will be offered as a two session program. It will start in mid-August and finish in April using a cohort-based model. Within this two-session program, students must complete a structured sequence of 12 half courses on a full-time basis. Students will complete two HCE in an introductory period, and four HCE in each of two regular sessions. A one HCE colloquium course discussing special topics such student self-development, particular technologies, and industry structure will be scheduled over the course of the year. There is also a one HCE integrative project course in the second session for a total of six FCEs.

The courses are scheduled as follows:

Fall Session (18 weeks (including an exam week and orientation week))

Orientation (1 week, 2nd week of August)

Introductory term (4 weeks, 3rd week of August to 2nd week of-September)

- Strategic Uses of Analytics in Management (RSM 8X00H FCE 0.5) (new)
- Analytics, Models and Data (RSM8X01H FCE 0.5) (new)

Analytics Toolkit term (13 weeks (including an exam week), running from the 3rd week of September to December with a two-day break scheduled around a weekend in the semester)

- Structuring Data for Analytics (RSM8X11H FCE 0.5) (new)
- Predictive and Prescriptive Analytics (RSM8X12H FCE 0.5) (new)
- Big Data and Marketing Analytics (RSM8X13H FCE 0.5) (new)
- Decision Analysis and Spreadsheet Modeling (RSM8X14H FCE 0.5) (new)
- Management Analytics Colloquium (RSM8X15H FCE 0.5 –taught over two semesters) (new)

Winter Session (16 weeks (including an exam week), January – April)

Analytics Practice Term (16 weeks –including an exam week, running from January – April)

- Analytics in Consumer Marketing (RSM8X21H FCE 0.5) (new)
- Analytics in Data Driven Marketing (RSM8X22H FCE 0.5) (new)
- Analytics in Operations and Supply Chain Management (RSM8X23H FCE 0.5) (new)
- Applied Empirical Analysis in Accounting and Finance (RSM8X24H FCE 0.5) (new)
- Capstone Integrative Project (RSM8X30H FCE 0.5) (new)

As described below, the first session of the program is focused on the acquisition of the methods and tools central to the field of data analytics. The second semester provides coursework in a number of application areas where students will be able to learn to apply the tools acquired in the first semester in more in-depth projects. While programming tools are introduced early on in the program, the same programming requirements will be used throughout and applied to problems introduced in the second semester. Programming languages that we expect students to see throughout the program and to gain a strong understanding of while in the program include R, Python, and SAS.

Individuals working in business or managerial data analysis need to have skills in data acquisition, statistics, big data analytics, problem modeling, optimization, and decision making. The coursework (as outlined below and in the appendix) on models and data given in the Introductory term and the coursework in the remainder of the Fall session primarily concerned with the development of the breadth and depth of knowledge in the area of data analytics as well as the development of skills to pursue research and scholarship in analytics. Coursework will cover the latest research on topics being covered. In several courses, students will be required to present independent research in class. Students will be marked on the research and its presentation.

Graduates of the M.M.A. program also need to be able to apply their newly acquired skills in a business context. We view this as one of the innovative aspects of the program is taking the technical computing skills and applying to a business problem. These skills include knowledge of the language of business, organizational structure, and recognition of problems in business contexts. The introductory course in the strategic uses of analytics in management and the coursework in the Winter session are primarily aimed at the development of student skills in applying analytics in various business contexts such as consumer marketing, operations, accounting, and finance.

Graduates must have a basic knowledge of accounting – the language of business. This knowledge can be gained through pre-program material (such as an online course offered by Rotman). Students with prior course work in accounting at an undergraduate level with a minimum of B average would be able request a waiver from taking the pre-program material needed in accounting. Note the pre-program material would not be for credit but students would be incentivized to learn the material given it would be required for the accounting component of "Strategic Uses of Data in Analytics" as well as for the Accounting and Finance course taught in the second term.

Graduates should also have skills required for professional growth and autonomy. The management analytics colloquium will provide students with a course dedicated to their self-development and their understanding of current issues on analytics tools and the use of analytics in industry. Topics may include work on student self-development, presentations from industry leaders on current challenges in industry and expectations of how graduates integrate into their organizations, work on group dynamics and leadership, and special topics on developments in the data analytics industry. Finally, students are required to complete a group-based capstone integrative project that will allow them to demonstrate in full all of the aspects of the program from problem formulation through final presentation of results. This too should support the learning objectives associated with increasing professional capacity.

Based on these goals and program format, we are requiring all students to take the structured sequence of courses. The curriculum is designed for developing the students with regard to the learning objectives.

Please see Appendix A for a full list of the course numbers, titles, and brief descriptions.

9 Program Description

The M.M.A. will be a two session (mid-August to April) full-time program comprised of intensive course work aimed at students seeking expertise in business data analytics. The program will be cohort-based and consist of 12 half-courses (6.0 FCEs) given in an introductory session and two sessions. All 12 courses in the program are required. Classroom hours and expected workload will be coordinated in the program to ensure that students have sufficient time to learn course material and complete course assignments and projects. As stated in the admissions requirements, we expect to enroll students with a fairly consistent background with respect to mathematics, statistics, and computer literacy. Given the prerequisite courses that the applicants must have completed, the program length is appropriate for a professional Master's degree designed to develop expertise in a specialized field.

Curriculum Principles
Management analytics are a suite of tools and techniques useful in identifying and formulating strategies and policies to addressing problems in competitive environments. These tools include statistical modeling, data mining, simulation, and optimization models.

To be effective, analysts using these tools must also have strengths in modeling businesses, translating results into actions, and communicating with executives. Thus a successful analyst must possess both hard skills (advanced analytical and data management) and soft skills (managerial and communication). The 12 half-courses included in the program were determined to be essential for graduates of the program working in data analytics.

The first core principle of the program is that to be effective, our graduates must be fully capable in using the tools of data analytics. Through discussions with employers and those interested in working with Rotman in developing the M.M.A. program, it became clear that the wide variety of firms that depend on data analytics for success need team members with a broad set of analytical skills. Further, these skills must be at a level where our graduates could work with managers to formulate models, acquire data, and complete analyses. The firms seek talent capable of professional autonomy. The program is designed to get the students' hands dirty with data and models. This would provide immediate value to them and their firms. The Fall session is primarily dedicated to the development of the students' understanding of the various tools, focussing on data acquisition and organization, statistical data analysis, big data set analysis, and development of business models using simulation and optimization.

The second core principle of the program is that our graduates must be able to work in a broad set of industries and within professional organizations. Our discussions with potential employers indicate that technical capabilities are not sufficient for our graduates. They must be able to understand the context of the problems they address and the managerial issues involved. They must then be able to assist or lead the translation of the problems into analytical data questions. Further, they must be able to transform analysis into understanding and insights, which must be communicated effectively to others, particularly to co-workers who may have lower levels of technical skills but high level of business acumen. The Winter session is primarily dedicated to the development of these skills, focusing on application areas in marketing, operations, accounting and finance.

We next explain the elements of the program.

Program Structure
The program would start in the second week of August with a one-week orientation followed by a 4-week "Introduction" term and a subsequent 13-week "Analytics Toolkit" term. The four week "Introduction" term runs from the third week of August to the second week of September and features courses on the use of analytics in various functional areas as well as on data intensive business decision-making. It is followed by a 13-week "Analytics Toolkit" term starting in the third week of September and running through the second or third week of December (including a 2-day break scheduled around a weekend during the semester). This term is comprised of four courses and a bi-weekly colloquium which, collectively, develop the Analytics Toolkit as well as communication skills. The latter will be developed through: (a) targeted module(s) in the Colloquium course, (b) assignment and project presentations in all other courses, (c) close interaction with Rotman's Self Development Lab

(SDL) where video and written samples of each student's course work will be analyzed and focused coaching on improving communication effectiveness provided.

The Winter session starts shortly after New Year with a "Professional Certification Test" week allowing students to take a variety of professional certification exams offered by SAS Institute and INFORMS. While these are optional, it is anticipated that many students will take advantage of this opportunity. This will also feature career development activities (resume fine-tuning, etc.), preparing students for the job search. The 13-week "Analytics Practice" term (starting in the second week of January) consisting of four courses and a semester long project. The bi-weekly colloquium continues in the Winter session. This is followed by a two-week concluding period where students will complete the Capstone project and present their results. All required course work will be completed by the end of April to ensure grades can be submitted for graduation. Another round of optional Professional Certification tests will be scheduled in late April or early May after the required program material is complete. We note that effective communication skills will be more heavily emphasized in the second terms through a variety of industry-oriented course projects as well as the group presentation in the Capstone course. Once again, we expect that resources from the Self-Development Lab will be utilized throughout the program to develop students' business communication skills.

Fall Session
The fall session has three main components:

Week 1: **Orientation.**
- The program starts with a one week orientation period during which the students attend workshops on effective communication and effective workgroups. These are co-curricular activities and are not assessed.

- Some pre-program material needed in accounting and computing will be introduced during this orientation week. Computing boot camps introduce students to the main technical tools that will be used throughout the program and would include several different courses such as an SAS Foundation /SQL/ ETL course (to be offered by SAS), EXCEL and @RISK tutorial, and R/ Python introduction. These Boot Camps provide opportunities for students to be introduced to various software and programming languages that they may not have been exposed to before in preparation for their coursework. Similarly online material in accounting would help prepare students for material taught in the courses "Strategic Uses of Analytics in Management" and "Applied Empirical Analysis course in Accounting and Finance." These are co-curricular activities and students would be incentivized to learn the material since it would serve as the basic tools needed in some of their coursework.

Weeks 2-5: **Introductory Term.** This module has three main components:

- **RSM8X00H: Strategic Uses of Analytics in Management** The course will provide students with a general overview of the key functional areas of management and an introduction to business strategy.

- **RSM8X01H: Analytics, Models and Data** This course will introduce the students to some key ideas about data-intensive business decision-making.

- In parallel to these courses, the students will continue to attend ongoing **Boot Camps**, introducing them to the main technical and programming tools that will be used throughout the program.

Weeks 6-18 (with a two-day break planned around a weekend during the semester): **The Analytics Toolkit Term.** This module is comprised of courses whose primary objective is to introduce the key analytic methodologies.

- **RSM8X11H – 8X14H**: These four courses (**Structuring Data for Analytics, Predictive and Prescriptive Analytics, Big Data and Marketing Analytics, Decision Analysis and Spreadsheet Modeling**) present the main components of the analytical toolkit: data acquisition, preparation and transformation, predictive and causal statistical models, big data specific techniques such as segmentation and text mining, tools for spreadsheet modeling, simulation modelling and decision analysis. All four courses would include one or more group-based project-type assignments, with a presentation component to allow students to develop the key skill of effectively communicating analytical results.

- **RSM8X15H**: **Management Analytics Colloquia** The course will consist of a number of short modules or guest presentations. A typical module could run for two to three weeks and there could be several individual guest lectures, presentations, and modules scheduled each term. The course will run the full year. The Fall session will include modules focused on the development of effective presentation skills, as well as on introducing recent advances in analytical techniques and software. The Winter session will focus on the practical/applied issues, such as data governance or analytics in fraud detection. Throughout, speakers from inside and outside of Rotman will present in the course.

Winter Session
Week 1 will provide students with an opportunity to take the professional certification tests (there may be a one- to two-day prep workshop, followed by exams later in the week). These may include various SAS certifications exams (Predictive Modeling, EM, etc.) as well as INFORMS CAP-M certification. Students will be encouraged, but not required, to take a certification test in this period. Material presented in the courses taken during the Fall session and a workshop given during the week should prepare students for the certification test. It is expected that career development activities will also take place in this week.

Weeks 2-14: **The Analytics Practice Term.** This module is composed of courses whose primary objective is to introduce applications of analytics.

- **RSM8X21H-8X24H**: These four courses (**Analytics in Consumer Marketing**, **Analytics in Data Driven Marketing**, **Analytics in Operations and Supply Chain Management**, and **Applied Empirical Analysis in Accounting and Finance)** introduce the students to

some of the typical business problems that arise in various analytically-intensive practice areas. These areas will be selected from the industries where students are most likely to be employed upon graduation. The focus throughout the session will be on the business problem rather than analytical tools. The students will discuss the typical data requirements, where the data might reside within the organization, what analytical tools are most likely to be useful in each case, who the business primes are likely to be, and how the findings can be effectively communicated in the language of each application area.

- o All four courses would include one or more group-based project-type assignments with a presentation component to allow students to develop the key skill of effectively communicating analytical results.

- o In the future, as the program enrollment grows, we plan to add elective courses and/or specialization fields that will alloFw students to obtain additional expertise in the area of analytics and/or functional specialization area they have a particular interest in.

- o Students may also be able to take or audit courses from other specialized Master's programs such as the Master's in Financial Risk Management (MFRM) as appropriate for their intended application field.

- o These courses will also be open as appropriate to students in the M.F.R.M. and the M.B.A. programs at Rotman.

Weeks 1-16 (January-April):
- • **RSM8X30H Capstone Integrative Project** The student groups will be presented with an open-ended managerial problem and provided access to several potentially useful sources of data. Their task will be to structure the problem, construct an analytical data set (from the data sources provided, possibly supplemented by some additional data harvested from public sources), and develop analytical solutions.

  - o The project will begin at the start of the second semester, giving students time to develop their data sources and begin structuring their models. We anticipate classwork during the second semester will inform the students' approaches to the projects. The early start of the concluding project will also provide students with opportunities to interact with the sponsoring firms and the advisory board for the program early during the recruiting season.

  - o The final two weeks of the second session will be dedicated to the completion of the integrative projects. Students will present their solutions to a panel of judges, including members of the Advisory Board.

Note: rationale for an August-April timeframe
Note that the Fall session is actually composed of two terms: the "Introductory Term" (weeks 2-5) and the "Analytics Toolkit Term" (weeks 6-18). This sequence is essential: the students

are first provided with an overview of different functional areas of management, how analytics is used within each and how to structure data for answering managerial problems. This forms the foundation for the "Analytics Toolkit" term where various analytical techniques are introduced and illustrated in the context of specific managerial problems. In fact, the presence of the "Introductory" term is what (immediately) brings managerial focus to the proposed program and distinguishes it from the more general "data analytics" programs.

Teaching the "Introductory" and "Analytics Toolkit" courses concurrently would destroy the idea that Management Analytics should always be pegged to a specific managerial (not analytical) problem.

A later start (e.g. in September rather than August) is also not advisable: it would mean that the "Analytics Toolkit" term continues into January and the "Analytics Practice Term" does not start until February. Given the intensive nature of the program, the students would best be supported by faculty and staff if the "Analytics Toolkit" did not span over both the Fall and Winter terms when more scheduling issues are likely to arise with exams and teaching schedules. Starting in September would also delay completion of the degree by 1 month and postpone graduation.

Please note that under the proposed structure, no final grades for the Fall session, Introductory term courses would be assessed until the second week of September.

Completion of Program Requirements
By coordinating the coursework between the classes we expect that students will be able to complete all of the program requirements. As noted the introductory term (weeks 2-5) will be an intensive period with approximately 12.5 hours of class time per week in addition to the optional, co-curricular boot camps. We expect that assignments and preparatory reading will be limited to reflect this. For both 13-week sessions, it is intended that classes for courses RSM8X11H-8X14H and RSM8X21H-8X24H would be scheduled twice a week for each course for 1.25 hours (2.5 hours per week). This would allow students the afternoons and one day a week to work on class preparation and course projects. For most weeks the colloquium course would not require student preparation other than any assigned readings. Students would take turns presenting in groups. The final two weeks of the second session will ensure students have a dedicated time to complete the capstone integrative project.

Whereas the Province's Quality Assurance Framework requires that students complete a minimum of 2/3 courses at the graduate level, the University of Toronto requires graduate students to complete all of their course requirements from amongst graduate level courses. This proposed program complies with this requirement.

10 Degree Level Expectations, Program Learning Outcomes and Program Structure

Table 2: Master's DLEs

MASTER'S DEGREE LEVEL EXPECTATIONS (based on the Ontario Council of Academic Vice Presidents (OCAV) DLEs)	MASTER'S PROGRAM LEARNING OBJECTIVES AND OUTCOMES	HOW THE PROGRAM DESIGN AND REQUIREMENTS SUPPORT THE ATTAINMENT OF STUDENT LEARNING OUTCOMES
EXPECTATIONS: *This Master of Management Analytics is awarded to students who have demonstrated:*		

1. Depth and Breadth of Knowledge
 	
A systematic understanding of knowledge, and a critical awareness of current problems and/or new insights, much of which is at, or informed by, the forefront of the academic discipline, field of study, or area of professional practice.
	Depth and breadth of knowledge is defined in the Master of Management Analytics as the ability to demonstrate an understanding of the various quantitative tools of data analysis in order to analyze business problems in areas of marketing, operations, finance, and accounting, and apply the various quantitative tools of data analysis and the particular application of them to the solution of business problems in areas of marketing, operations, finance, and accounting.
	
	This is reflected in students who are able to:
	
	• recognize business problems that call for analytics support,
	
	• use current analytics tools and techniques,
	
	• evaluate novel techniques and compare and contrast them with alternatives
	
	• be familiar with the recent hardware and software tailored to business analytics
		The program design and requirements that ensure these student outcomes for depth and breadth of knowledge are:
		
		• Courses in each of the main tools of data analysis:
		
		  1. Structuring Data which will cover the means of data acquisition and organization which typically requires the greatest amount of time in any data analysis, and failure to do so efficiently can lead to delays in completion of projects.
		
		  2. Predictive Analytics which considers how data can be used to generate expectations of the behavior of the quantity or process under study.
		
		  3. Prescriptive Analytics which considers how data can be used to describe modal behavior of a quantity or process and be used to affect it.
		
		  4. Tools for Big Data which presents techniques aimed at identifying and quantifying various structures in very large data sets.

MASTER'S DEGREE LEVEL EXPECTATIONS (based on the Ontario Council of Academic Vice Presidents (OCAV) DLEs)	MASTER'S PROGRAM LEARNING OBJECTIVES AND OUTCOMES	HOW THE PROGRAM DESIGN AND REQUIREMENTS SUPPORT THE ATTAINMENT OF STUDENT LEARNING OUTCOMES
		5. Decision analysis and Spreadsheet Modeling which considers how to structure, analyze, and solve business decision problems using Excel spreadsheets. • Colloquia on the developing techniques and the hardware and software available.
2. Research and Scholarship A conceptual understanding and methodological competence that i) Enables a working comprehension of how established techniques of research and inquiry are used to create and interpret knowledge in the discipline; ii) Enables a critical evaluation of current research and advanced research and scholarship in the discipline or area of professional competence; and iii) Enables a treatment of complex issues and judgments based on established principles and techniques; and, on the basis of that competence, has shown at least one of the following: i) The development and support of a sustained argument in written form; or ii) Originality in the application of knowledge.	Research and Scholarship is defined in the Master of Management Analytics as the ability to conduct independent research on business problems, translating these into research questions, developing data sets, and critically evaluate the tools and techniques of data analytics as to their ability to provide insight and understanding into a business problem. The ability to create new means of data analysis and/or combine techniques to provide assurance of the robustness of an analysis is central to the demonstration of conceptual understanding and methodological competence. Developing and expanding these abilities are central to the research programs of the faculty in the program and inculcating them to the students constitutes the development of research and scholarship in analytics. This is reflected in students who are able to • formulate research questions and hypotheses based observations.	The program design and requirements that ensure these student outcomes for research and scholarship are: • The successful completion of a set of rigorous courses that will present the logical and mathematical underpinnings of data analytical techniques; • The presentation of multiple applications of data analysis in business environments through case studies in order to generate critical analyses of the use of techniques and the conclusions drawn from the analysis; • The participation in the integrative capstone project that will allow students to conduct independent and small group research on an unstructured problem. • The opportunity to construct new techniques or synthesize techniques to further the analysis of a data set. • The participation and presentation in colloquia on special topics and research findings.

MASTER'S DEGREE LEVEL EXPECTATIONS (based on the Ontario Council of Academic Vice Presidents (OCAV) DLEs)	MASTER'S PROGRAM LEARNING OBJECTIVES AND OUTCOMES	HOW THE PROGRAM DESIGN AND REQUIREMENTS SUPPORT THE ATTAINMENT OF STUDENT LEARNING OUTCOMES
	• develop data sources to test the hypotheses • describe the underlying assumptions of a proposed analytical technique; • critique data analysis conducted by others as to the appropriateness and validity of generated conclusions; • develop new means of data analysis and support these mathematically and logically.	
3. Application of Knowledge Competence in the research process by applying an existing body of knowledge in the critical analysis of a new question or of a specific problem or issue in a new setting.	Application of Knowledge is defined in the Master of Management Analytics as the ability to analyze a business problem and develop a prescriptive or predictive model that can be verified using available data. The application of knowledge is also based on the ability to understand the strengths and weaknesses of an application and critically analyze the implications of the study's results. This is reflected in students who are able to: • to structure the business issue as a problem to which quantitative tools can be applied • characterize the data source and generating process • evaluate the appropriateness of a technique to a data set. • identify and organize the collection and processing of the necessary data, • synthesize data analytic processes	The program design and requirements that ensure these student outcomes for application of knowledge are: • The inclusion of courses in each of the main application areas of data analytics: 1. Consumer and Data Driven Marketing which describe the business issues faced by marketing managers, what data is typically available, and the key areas where analytics is used 2. Operations and Supply Chain Management which consider how data can be used in inventory management, revenue management, and business process design and staffing 3. Accounting and Finance which will consider how firm level data may be used to perform accounting-based empirical analyses.

MASTER'S DEGREE LEVEL EXPECTATIONS (based on the Ontario Council of Academic Vice Presidents (OCAV) DLEs)	MASTER'S PROGRAM LEARNING OBJECTIVES AND OUTCOMES	HOW THE PROGRAM DESIGN AND REQUIREMENTS SUPPORT THE ATTAINMENT OF STUDENT LEARNING OUTCOMES
	• identify and conduct the most suitable analytical analyses,	• Presentation of concepts on the generation process of data and how these affect the conclusions that may be drawn from an application; • The capstone integrative project which will provide an open-ended project by which students will determine what data is required, what techniques to apply, how to prove the validity of the underlying assumptions of those techniques, and the potential development of novel means of data analysis and problem solution.
4. Professional Capacity/Autonomy a. The qualities and transferable skills necessary for employment requiring i) The exercise of initiative and of personal responsibility and accountability; and ii) Decision-making in complex situations; b. The intellectual independence required for continuing professional development; c. The ethical behavior consistent with academic integrity and the use of appropriate guidelines and procedures for responsible conduct of research; and d. The ability to appreciate the broader implications of applying knowledge to particular contexts.	Professional Capacity/Autonomy is defined in the Master of Management Analytics as the ability to translate the knowledge gained in the program to a professional setting, especially in regards to the ability to define and model business problems, seek out and organize data, analyze data, and present the results as a means of supporting the overall objectives of the organization. In addition, professional capacity and autonomy is defined as the ability to learn new techniques. Further, it depends on the ability of professionals to understand how the underlying assumptions may distort or bias results and the ability to clarify how and why these biases should be considered in drawing conclusions. This is reflected in students who are able to understand the structure of their organizations, their objectives, and their	The program design and requirements that ensure these student outcomes for professional capacity/autonomy are: • The capstone integrative project that will require students to interact in a professional environment with the sponsors of the projects. Students will need to work with stakeholders in the organizations to understand the challenges and the expectations. Capstone groups will be self-directed and require all members to show initiative and personal responsibility. Further, the students will be required to evaluate their own models and present fair evaluations of the concerns consumers of the models should have. Finally, students will need to evaluate the various recommendations generated by their analyses and prioritize these.

MASTER'S DEGREE LEVEL EXPECTATIONS (based on the Ontario Council of Academic Vice Presidents (OCAV) DLEs)	MASTER'S PROGRAM LEARNING OBJECTIVES AND OUTCOMES	HOW THE PROGRAM DESIGN AND REQUIREMENTS SUPPORT THE ATTAINMENT OF STUDENT LEARNING OUTCOMES
	governance. Students will understand how the projects they conduct fit in with and affect the various constituencies in their organizations. They will be able to learn new analytical techniques and evaluate their appropriateness for the problems they face. They will be able to assess the models they develop and consider how these might lead to incorrect conclusions, measuring carefully the potential for model error. The graduates must also have the ability to evaluate the impact of a specific business problem or analytical project using commonly-used accounting terminology (including the ability to pinpoint project's impact on business unit's balance sheet, evaluate long-term impact using concepts of discounting, etc.).	• The colloquia that will bring outside speakers in to discuss current topics on how data analytics is practiced in modern organizations. • The competency in accounting will be demonstrated through relevant prior course work and/or completion of Rotman's on-line accounting course in pre-program material. The relevant concepts will also be applied and reflected in various course material.
5. Communications Skills The ability to communicate ideas, issues and conclusions clearly.	Communications Skills is defined in the Master of Management Analytics as the ability to successfully convey data analytics results to managers, executives, and non-technical professionals so as to make clear recommendations and participate in the formulation of organizational strategies. This is reflected in students who are able to create reports, presentations, and data visualizations that simply and effectively communicate the results of their analyses.	The program design and requirements that ensure these student outcomes for communication skills are: • Presentations in class and written assignments, both of which will help to develop a student's communications skills. In several of the courses, students will be required to present in class and part of a student's grade will be based on the quality of that student's presentations. • There will be a presentation skills session at the outset and workshops on skills development throughout the program, all of which will help students to prepare for major presentations and interviews.

11 Assessment of Learning

In this course-based program, students will be assessed in a number of ways: mid-term exams, final exams, class participation, assignments, term papers, and projects. Fixed length assignments and exams are appropriate where specific skills, techniques, or subjects are taught. These will be the primary means of assessment for the first session courses introducing the analytic tool box. In addition, courses taught in the Fall session would include an assignment with a presentation component to allow students to demonstrate their deep understanding of the material.

Larger scale assignments, term papers, and projects will be used to assess learning and communication skills, primarily for the courses on the application of analytics to be given in the Winter session. For these courses, the student is required to demonstrate an understanding of the application of techniques to business problems. These courses would include several group-based project-type assignments with a presentation component to allow students to develop the key skill of effectively communicating analytical results.

For the Capstone Integrative Project, student groups will be presented with an open-ended managerial problem and provided access to several potentially useful sources of data. Their task will be to structure the problem, construct an analytical data set (from the data sources provided, possibly supplemented by some additional data harvested from public sources), and develop analytical solutions. The project will be assessed through milestone deliverables, mid-term presentations, and the delivery of a final document and presentation.

The Management Analytics Colloquium will be evaluated as a credit/ non-credit course where students are asked to present on current issues in data analytics and attendance and participation at the regular seminars will be evaluated.

Presentations will be graded and feedback on presentation performance will be offered. All assessment will be consistent with the University of Toronto's Grading Policy. Since the program is a professional program, a thesis will not be required.

Each course will contain a Rotman-specific student evaluation form to be completed by the students towards the end of each session. The course evaluation forms allow for course-specific questions designed by the course instructors. These questions can be used to assess the effectiveness of the course.

With regard to measuring success of the M.M.A. program, this will be done in a variety of ways. Surveys of students at the end of the first semester and upon completion will be undertaken, and the results shared with appropriate administration and faculty. These will ensure student expectations are being met and will identify needs and considerations moving forward. In addition, we will monitor employment progress through alumni outreach in the form of surveys and informal discussions. We will also maintain contact, both formal and informal, with major industry employers to ask their input on the progress of graduates and changing skills and expertise desired for business data analysts.

M.M.A. alumni will be invited to annual events where Rotman faculty will present their current research and where alumni will be able to network with current students and faculty members. Alumni will be solicited for information on how to improve the program, in part through an Alumni advisory group. These types of events and initiatives are already being organized for other Rotman alumni.

12 Consultation

- *Describe the expected impact of what is being proposed on the nature and quality of other programs delivered by the unit/division*
- *Describe the expected impact of what is being proposed on programs being offered by other units/divisions*
- *Describe any consultation with the Deans of Faculties/Divisions that will be implicated or affected by the creation of the proposed program*

We have consulted widely with colleagues at Rotman, with other UofT programs, with industry, and with potential students.

The M.M.A. will complement the existing offerings of Rotman and the University of Toronto. We anticipate minimal impact on Rotman's M.B.A. program. First, M.B.A. students have an average four years of work experience compared with the pre-work experience audience the M.M.A. is targeting. Second, the primary goal of the M.B.A. programs is to train business leaders, rather than analytics professionals. While in recent years Rotman's M.B.A. program has taken steps to improve the level of analytical skills of its graduates, the training is more in line with developing consumers of analytics. And while there certainly are M.B.A. students with exceptional analytical skills, a typical M.B.A. student has neither the interest nor the requisite background and skills to consider a position as an analytics professional. Our interviews with potential industry partners and graduate employers confirm that M.B.A. graduates are rarely hired for the analytics positions M.M.A. students would consider. Thus, the proposed program should have minimal impact on Rotman's recruitment efforts for its M.B.A. programs and on the employment prospects of its M.B.A. graduates.

In addition to the M.B.A. program, Rotman has several Master's programs. The Rotman Master of Finance degree program offers experienced working professionals with a minimum of two years of finance-related experience a Master's level degree focused on depth and breadth in finance generally. The Master of Financial Risk Management program is a pre-experience program focusing on the way in which financial institutions manage risks and regulatory requirements. The Master of Financial Economics is a joint program between Rotman and the Department of Economics in the Faculty of Arts and Sciences, targeted at recent graduates with degrees in Economics considering employment in Finance. All of these programs are targeted at students considering positions in finance, not business analytics, which as described considers applications primarily in marketing and operations. We do not anticipate any impact on these programs.

Extensive consultation of the program occurred across the University of Toronto. In particular we asked for feedback on this proposal to six different representatives in the university.

- University of Toronto, Mississauga, Vice-Dean Robert Reisz, Department Chair Mihkel Tombak, Director of Master of Management of Innovation, Alberto Galasso
- University of Toronto, Scarborough, Dean Bill Gough and Department Chair David Zweig
- Faculty of Medicine, Vice-Dean Allan Kaplan
- Dalla Lana School of Public Health, Dean Howard Hu
- Faculty of Engineering, Vice-Dean Markus Bussmann and Professor Timothy Chan
- iSchool, Dean Wendy Duff and Professor Periklis Andritsos
- Faculty of Arts & Science, Vice-Dean Joshua Baker and Computer Science Chair, Ravin Balakrishnan, Statistical Sciences Chair Jamie Stafford, and Mathematics Chair Professor Murty

In general, all faculty responses were positive and supportive of the proposals and did not foresee overlap with their existing programs. Detailed comments were provided by the representatives at the iSchool and we responded and have incorporated clarifications into this document to address questions raised.

The Vice-Dean of the Faculty of Arts & Science was positively supportive of the program and asked us to discuss the proposal directly with chairs of statistical sciences, computer science, and mathematics. All were supportive and helpful given their expertise in this field. In Statistical Sciences, we learned that there are discussions about introducing a data science stream at the undergraduate level which we view as complementary to our proposed graduate program in management analytics as it is a potential source of talented qualified students. In Computer Science, possibilities for future collaborations were also discussed.

The University of Toronto produces approximately 1,500 graduates at the Bachelor's level in Mathematics and Physical Sciences and a similar number of graduates in Engineering and Applied Sciences each year. The corresponding numbers at the Master's level are 250 and 600, respectively. Many of these graduates will have acquired a high level of training in mathematics, statistics, and computer science, but will have little or no experience with the practical application of these skills to business problems, or, indeed, much knowledge of the functional areas of management and the typical issues that they deal with. Yet, many of these students have a strong interest in pursuing a career in analytics. This program will fill that gap.

13 Resources

- *Please be specific where this may impact significant enrolment agreements with the Faculty/Provost's Office.*
- *Indicate if the new program will affect any existing agreements with other institutions, or will require the creation of a new agreement to facilitate the new program (e.g.*

There are no projected impacts on existing enrolment agreements with the Provost's office. The enrolment targets for the program are already part of the existing budget plans for Rotman. There would be no needed amendments to existing agreements as this is a new program. All courses are expected to be taught by existing faculty at Rotman. While we have the full-time faculty in place to teach in the program, we are projecting to grow the Faculty complement to accommodate any redistribution of teaching assignments in existing programs when the new program starts. The co-curricular SAS boot camp offered during the introductory period will be taught by representatives from SAS. Informal relationships with SAS exist and SAS has expressed interest in teaching in some capacity within the program. Other elements of the co-curricular boot camps may require teaching by non-Rotman faculty members. Staffing for these elements will be obtained following H.R. guidance.

13.1 Faculty Complement

- *Complete Table 4 below*
- *Provide a brief commentary on:*
  - o *the adequacy of the number and quality of Graduate faculty who will teach/supervise in the program*
  - o *evidence that faculty have the recent research or professional/clinical expertise needed to sustain the program, promote innovation and foster an appropriate intellectual climate*
- *Provide the CVs of all faculty, as evidence substantiating the above. The Appendix should form a separate document with a table of contents and all CVs in alphabetical order. CVs should be submitted in a standardized format relevant to the proposed program field*

The Rotman School's faculty has a strong commitment to business analytics as demonstrated through their research and teaching. The M.M.A. program is backed mainly by the faculty areas of Marketing and Operations Management, collectively representing 35 professors, with some support from other areas of the school like accounting and/or finance. Numerous faculty members at Rotman from various areas of the school will teach in the M.M.A. program, expressing the broad support the school is giving to the program. These faculty members' research and clinical practice include widely cited work in financial services, retail and online marketing, and service and supply chain operations. Together, Rotman has a complement of full-time faculty with research interests and clinical practice that will ensure the continued intellectual growth of the program.

Rotman is committed to investing the needed faculty resources to make this a leading program and, as is evident in the list of professors below, we currently have all the full-time faculty in place who are interested and can teach as experts in this program. To offset potential teaching demands in our existing programs, we have budgeted for increases to our current faculty complement. Over the next five years, our budget includes 6 new tenure-stream hires and 7 new teaching-stream hires. Of these, 2 tenure-stream and 4 teaching-

stream faculty positions have already been approved in the 2016-17 budget and we are currently engaging in recruiting for these new positions. We intend to have new hires in place to cover off any required redistribution of teaching in existing programs when the new program starts.

The program will be led by Professors Dmitry Krass, Joseph Milner, and David Soberman.

Dmitry Krass is Professor of Operations Management and Statistics at the Rotman School of Management. He holds a PhD in Operations Research from Johns Hopkins University. His research interests include facility location and transportation, humanitarian logistics, development and application of optimization models for marketing mix management, stochastic dynamic programming focusing on problems with constraints, and problems with non-standard payoff criteria. He teaches courses in Statistics, Predictive Analytics, and Decision Analysis and Spreadsheet Modeling.

Joseph Milner is Professor of Operations Management at the Rotman School. He holds a PhD (Operations Research) and S.M. from MIT. His research interests include service operations modeling, revenue management, and applications to healthcare operations. He uses data driven approaches including studying large-scale inventory and wait time data to improve retail operations and outpatient services. His publications appear in *Management Science*, *Operations Research*, *Manufacturing & Service Operations Management* and *Production and Operations Management*, and he serves on their editorial boards. He teaches courses on operations management, operations strategy, and service operation at the M.B.A. and Executive M.B.A. levels.

David Soberman, P.Eng, is the Canadian National Chair in Strategic Management and Professor of Marketing at the Rotman School. He holds a PhD (Management) from the University of Toronto and an M.B.A. and a B.Sc. in Chemical Engineering from Queen's University in Kingston. Professor Soberman's research has appeared in *Marketing Science*, *Management Science*, the *Journal of Marketing Research*, the *Journal of Marketing* and the *California Management Review*. Professor Soberman has received awards for his research including the *International Journal of Research in Marketing* 2006 Best Paper Award and the INFORMS 2000 John DC Little Best Paper Award. He is an area editor for the *International Journal of Research in Marketing* and a member of the *Marketing Science* editorial board. Prior to academia, Professor Soberman held a number of positions in marketing management, sales, and engineering with Molson Breweries, Nabisco Brands Ltd., and Imperial Oil Ltd.

Other faculty who are affiliated with the program include Professors Philipp Afèche, Opher Baron, Francesco Bova, Andrew Ching, Scott Liao, Nitin Mehta, Sridhar Moorthy, Matthew Osborne, Mengze Shi, and Dilip Soman.

Philipp Afèche is Associate Professor of Operations Management at Rotman. He holds a PhD (Operations, Information and Technology) from Stanford. His research studies revenue and operations and supply chain management issues, focusing on pricing, service design, and response time management problems. Professor Afèche publishes in premier journals such

as *Management Science*, *Manufacturing & Service Operations Management*, and *Operations Research*. He teaches courses on Operations Management, Supply Chain Management, and Statistics.

Opher Baron is Professor of Operations Management at the Rotman School of Management. He holds a PhD (Operations Management) from M.I.T. Professor Baron is especially proud of the M.B.A. elective "The Art of Modeling with Spreadsheet" he introduced and teaches at Rotman. His research interests include queuing, applied probability, facility location, service operations (such as healthcare and call centers), inventory planning, and revenue management. Professor Baron has published in leading journals such as *Operations Research* and *Manufacturing & Service Operations Management*, and serves on several editorial boards. He has won several research awards and grants and is active in the operations research having chaired several conferences, clusters, and sessions.

Francesco Bova is Associate Professor of Accounting at The Rotman School whose field of research expertise is employee ownership research. He has been awarded numerous fellowships to conduct research on employee ownership including the Louis O. Kelso Fellowship and most recently, the Joseph Cabral Distinguished Scholar and Fellow Award. His work on employee ownership has been featured in several top management journals.

Andrew Ching is Associate Professor of Marketing at Rotman. He is a winner of the Young Economist Award from the European Economic Association in 2003, and received Honorable Mention for the Dick Wittink Prize Award in 2011. His research is focused on developing new empirical models and estimation methods to understand choices of consumers, firms, and managers. His papers are published in *Econometrica*, *Management Science*, *Journal of Applied Econometrics*, *International Economic Review*, *International Journal of Industrial Organization*, *Quantitative Marketing and Economics*, and *Journal of Banking and Finance*.

Scott Liao is an Associate Professor of Accounting at Rotman. He earned his PhD from the Ohio State University in 2008. His research interests include the agency problems in debt markets, banking regulation, and economic consequences of financial reporting and disclosure. He has published his papers in several premium journals including the Journal of Accounting and Economics, The Accounting Review and Contemporary Accounting Research. His teaching is focused on financial accounting.

Azarakhsh Malekian is an Assistant Professor of Operations Management and Statistics at Rotman. Previously, she was a post-doctoral fellow at the Massachusetts Institute of Technology. She holds a PhD in Computer Science from the University of Maryland, College Park and her research and teaching interests include network economics, mechanism design and algorithmic game theory as well as optimization.

Nitin Mehta is an Associate Professor of Marketing at Rotman. His research focuses on structural models on consumer search behaviour; structural models on cross-category choices; structural models on memory, learning and forgetting; and structural models on

product line design. Professor Mehta teaches courses in Marketing Management and Econometric Methods in Marketing.

Sridhar Moorthy holds the Manny Rotman Chair in Marketing, and is also a Senior Consultant at CRA (Charles River Associates). His expertise is in bringing economic perspectives to bear on marketing problems. Moorthy's research focuses on strategic issues in advertising, branding, product differentiation, retailing, including the impact of the Internet on marketing practice. He is an Associate Editor (and past Co-Editor) of Quantitative Marketing and Economics, Associate Editor of Management Science, member of the editorial board of Journal of Marketing Research, and coauthor of the textbook Marketing Models (Prentice Hall). Moorthy has served as a Vice President (Education) of the INFORMS Society for Marketing Science, and provided expert testimony in a number of legal cases.

Matthew Osborne is Assistant Professor of Marketing in the Department of Management at the University of Toronto Mississauga, with a cross-appointment to Rotman. Professor Osborne's research interests include the development of modelling techniques to help understand consumer choices and firm behaviour. His research has focused on areas such as consumer choice of wireless carriers, consumer learning about new products, and how firms price in markets where transport costs are important.

Mengze Shi is Associate Professor of Marketing at Rotman. Professor Shi's research is focused on incentives, specifically how people respond to incentives and how companies should design incentive programs. He has investigated a wide range of consumer incentive programs, including loyalty rewards, sweepstakes, group buying, discounts, and direct mails, as well as incentives for sales agents such as commissions and sales contests. His work has covered such industries as airlines, wireless communications, gasoline retailing, and mailing catalogues.

Dilip Soman is a Professor at the Rotman School of Management and the co-director of the university's *Behavioural Economics in Action* research cluster. He holds a PhD in Behavioral Sciences from the University of Chicago. He conducts research on interesting human behaviours and applications to choice architecture, consumer welfare, health behaviours, policy, and financial well-being. He is the author of over 50 research papers and several books, including the recently published **The Last Mile** (University of Toronto Press). Professor Soman works with several governments, businesses, and NGO's in the area of behavioural insights and their implication for value creation and delivery. He is presently at the Innovation Hub at the Privy Council Office in Ottawa. He worked in sales and advertising, consulted for several organizations, and taught at the University of Colorado, the Hong Kong University of Science and Technology and been a distinguished visiting scholar at the National University of Singapore and the University of Chicago.

Table 3: Faculty Complement (please list alphabetically)

Name	Home Department / Unit *(who holds primary budgetary appointment)*	University Rank	Graduate Faculty Membership Status *(e.g., Associate/ Full privileges)*	Commitment to other programs *(please list other programs in which the person routinely teaches / supervises)*	Nature of contribution to this program *Course Instructor (CI), Thesis Supervision (TS), Clinical or practice supervisor (C/PS).*
Tenured					
Philipp Afèche	Operations Management, RSM	Associate	Full	M.B.A.	CI
Opher Baron	Operations Management, RSM	Full	Full	M.B.A., PhD	CI
Francesco Bova	Accounting, RSM	Associate	Full	BComm, M.B.A., E.M.B.A.	CI
Andrew Ching	Marketing, RSM	Associate	Full	BComm, M.B.A.	CI
Dmitry Krass	Operations Management, RSM	Full	Full	M.B.A., PhD	CI
Scott Liao	Accounting, RSM	Associate	Full		CI
Nitin Mehta	Marketing, RSM	Associate	Full		CI
Joseph Milner	Operations Management, RSM	Full	Full	M.B.A., E.M.B.A.	CI
Sridhar Moorthy	Marketing, RSM	Full	Full		CI
Mengze Shi	Marketing, RSM	Associate	Full		CI
David Soberman	Marketing, RSM	Full	Full	M.B.A.	CI
Dilip Soman	Marketing, RSM	Full	Full	M.B.A., E.M.B.A.	CI
Tenure-Stream					
Azarakhsh Malekian	Operations, RSM	Assistant	Associate	BComm	CI
Matthew Osborne	Marketing, UTM + RSM	Assistant	Associate		CI

Name	Home Department / Unit *(who holds primary budgetary appointment)*	University Rank	Graduate Faculty Membership Status *(e.g., Associate/ Full privileges)*	Commitment to other programs *(please list other programs in which the person routinely teaches / supervises)*	Nature of contribut-ion to this program *Course Instructor (CI), Thesis Supervision (TS), Clinical or practice supervisor (C/PS).*
Non-Tenure Stream (i.e., CLTA)					
n/a					
Teaching Stream					
n/a					
Sessional Lecturer					
n/a					
Others **(please specify – i.e., Adjunct, status only, clinical faculty, visiting or other as per U of T definitions)**					
n/a					

13.2 Learning Resources

Please see the following Appendices

Appendix C: Library statement confirming the adequacy of library holdings and support for student learning

Appendix D: Standard statement concerning student support services

13.3 Financial Support for Graduate Students

As is the case with all professional Master's programs at the University of Toronto, there is no funding package.

The Rotman School of Management supports student accessibility to its programs through a Professional Loan Program currently offered by the Bank of Montreal (BMO) and Royal Bank

(RBC) to assist Rotman students in financing their degree. These banks lend as much as the full tuition amount of the student's degree program (depending on the individual student circumstance). International students currently require either a Standby Letter of Credit from their home bank or a Canadian co-signer to access this financing. In addition, the Rotman School will pay the interest on these loans for the duration of the degree program plus two months post- graduation. After that, students can make interest-only payments on the loan for 12 months, and are then required to start repayment of the loan principle.

Rotman also provides an interest subsidy on loans accessed through any other financial institution that students use to finance their tuition for their Rotman degree. The interest payment is not a loan – students do not pay back the interest subsidy to Rotman. As a result, the student does not pay any interest on the loan for the duration of the program. Domestic students may also be eligible for government assistance and for loans from other financial institutions.

Rotman plans to apply for government funding for the program which, if successful, would provide domestic applicants access to OSAP (Ontario Student Assistance Program) funding.

13.4 Space/Infrastructure

- *Address any unique space/infrastructure requirements including renovations to existing space, new space, information technology, laboratories, or equipment etc. and how these will be accommodated*

The M.M.A. degree program will be offered in the Rotman School at 105 St. George Street. The Rotman School has a new building, completed in 2013. Classroom facilities, group study space, and administrative support will be shared with the existing professional Master-level degree programs at the School. No other space implications are anticipated. In addition, The BMO Financial Group Finance Research and Trading Lab will be available to provide state of art facilities for particular coursework that would benefit from the facility. Other existing resources required to operate the new M.M.A. degree program (administrative staff, IT resources, program services, etc.) either currently exist or are planned to grow at Rotman to accommodate the needs of the program.

14 Quality and Other Indicators

- *Please describe the appropriateness of the faculty's collective expertise and how it contributes substantively to the proposed program and refer to specific areas of faculty strengths, innovation, and scholarly record that will contribute to the quality of the program and student experience*

The Rotman School is Canada's premier business school and is listed as #4 in Research by the Financial Times rankings. Further, the M.M.A. program will be directed by faculty in the Operations Management and Statistics Area, and the Marketing Area of the Rotman School.

These areas are ranked by research productivity by the University of Texas, Dallas, Business School rankings, as #4 and #12, respectively in their disciplines.

The program will be distinguished through its teaching of research skills in analytics by researchers active in the field. There is no school in Canada whose collective expertise compares with Rotman's in the area of business modeling through data analytics. The faculty members associated with the M.M.A. program are at the forefront of research on the tools and application of data. They conduct research using statistical and big data models, and apply the research in the varied areas of pricing, marketing, healthcare, retailing, queueing, customer loyalty and incentives programs, consumer choice, product line design, and many others.

In addition, faculty across the University of Toronto work within the area of data analytics. These include researchers in the Departments of Statistics, Computer Science, Mechanical and Industrial Engineering, the Faculty of Information, and the Faculty of Medicine. We anticipate that the M.M.A. program will benefit from the broad research program in analytics across the University.

15 Governance Process:

	Levels of Approval Required
Consultation with Provost	
Decanal and Provostial Sign-Off	
	Faculty/Divisional Governance
Submission to Provost's Office	
	AP&P
	Academic Board
	Executive Committee of Governing Council
Program may begin advertising as long as any material includes the clear statement that "No offer of admissions will be made to the program pending final approval by the Quality Council and the Ministry of Colleges Training and University (where the latter is required)."	
	Ontario Quality Council
	Submitted to MTCU (in case of new graduate degrees and programs, new diplomas)

Appendix A: Courses

The M.M.A. program will start in August of each year and continue until April the following year. The required courses will be as follows:

RSM8X00H Strategic Uses of Analytics in Management*
This introductory course will ideally serve several functions:
- provide students with a general overview of the key functional areas of management and the main decisions they face
- provide an introduction to business strategy and the overall approach for making strategic decisions
- introduce students to case analysis and afford an opportunity to start forming effective workgroups
- provide an overview various uses of analytics in managerial decision problems; students should understand how data analytical approaches can be combined with contextual decision analysis to arrive at effective decision recommendations
- The course should culminate with students forming a managerial decision map, an understanding where the various analytical approaches might be used in different functional areas of the firm. This map will serve as a reference point for the subsequent courses.

The course will be delivered in four mini-modules. Each module will be taught by a different faculty member from the following functional area: Accounting, Finance, Marketing, and Operations.

Delivery: three-hour class sessions, meeting three times a week, for four weeks (M/W/F), for a total of 30 contact hours.

RSM8X01H Analytics, Models and Data*
The goal of this course is to introduce the students to some key ideas about data-intensive business decision-making. Some of the key ideas are
- the difference between what the data say and what the data mean
- understanding and measuring randomness and its implications; different sources of randomness (inherently random outcomes vs measurement errors)
- the importance of mapping out data generation process; using decision trees as a key tool to represent a data generating process; mapping out alternative processes, using these to generate hypothesis and using the data to test which alternative is more plausible; the idea of the counterfactual
- understanding various biases in the data and their implications on the analysis
- the value of the experiments; designed versus natural experiments
- difference between different modeling types (prescriptive, causal, predictive, etc.)

The course will review many of the basic probabilistic concepts already familiar to the students (distributions, measures of variability and co-variability, standard errors and statistical hypothesis), emphasizing how these van be used to facilitate robust data-driven decision-making.

Delivery: three hour class sessions, meeting twice a week, for four weeks (Tu/Th), for a total of 24 contact hours.

RSM8X11H Structuring Data for Analytics*
The main goal of this course is to introduce the basic data manipulation and processing tools, as well as the idea and creation of an Analytical Data View, i.e. a data structure (usually in the form of a flat table) that is amenable to analysis by the tools covered in RSM8X12/RSM8X13.

It is well known that over 90% of the time, effort and cost in any real-life analytics project is concerned with gathering, normalizing, formatting and validating the data. Most valuable insights often come from datasets that are formed by combining several different data sources. However, forming such combined data sets present many challenges.

In this course, the basic issues related to forming an analytical dataset will be discussed. The concept of the Analytical Data View will be introduced. Students will learn how to create it using original, and often very diverse, data sources. The course will develop data programming techniques in SQL, as well as introduce newer tools such as NoSQL, and Python-based Web Spiders. It will also cover the structure and management of Data Warehouses.

Delivery: 1.25 hour class sessions, meeting twice a week, for 12 weeks (total of 30 contact hours). Classes will meet either M/Th or Tu/F during either AM or PM time slots.

RSM8X12H Predictive and Prescriptive Analytics for Business Decisions*
This course will introduce the workhorses of Predictive and Prescriptive Analytics (PPA) – a set of models and analysis tools commonly employed in industrial applications, including Customer Relationship Management (Customer Acquisition and Customer Retention), Target Promotion, Risk Scoring, etc. This course will follow a consulting approach to help students appreciate the value of PPA in business decision-making process.

Predictive and Prescriptive Analytics (PPA) considers how firms can measure the causal effects of various business decisions and predict the outcomes of interest. Examples include understanding how customers decide to adopt a new product or service, identifying the best target audience for this product, and predicting the outcome of a specific marketing campaign for the product based on some historical data (e.g. a history of customer activity and prior communications with the customer). Specific topics covered will include (1) Index models, (2) Regression models, (3) Discrete choice models, (4) Dynamic models, (5) Model evaluation and validation, and (6) Experimental design and hypothesis testing.

Delivery: 1.25 hour class sessions, meeting twice a week, for 12 weeks (total of 30 contact hours). Classes will meet either M/Th or Tu/F during either am or pm time slots.

RSM8X13H Big Data and Marketing Analytics*
Thanks to the advance of computer and information technology in the past two decades, a number of different large-scale data sources have become available to aid companies to make sound marketing and, more generally, data-drive decisions. Some examples of these databases include scanner panel data that keeps track of individual customer's purchase histories, prices and promotion-mix at retail stores, time-series product level data that keeps track of market shares, prices and advertising efforts for different product categories, company's loyalty programs data that keeps track of what their customers bought from them under different promotional environment, and direct-marketing data that keeps track of contact and transaction histories for potential clients. In order to take full advantage of these databases, analytics professionals need to go beyond the traditional toolbox and employ specially adopted "big data" statistical models designed to analyze actual customer behavior data and evaluate the effectiveness of their past marketing-mix.

This course will introduce the students to the diverse uses of "big data" techniques. These techniques are often aimed at identifying and quantifying various structures in the data (e.g. What are the key similarities between certain business units with respect to customer satisfaction? What are the characteristics of important customer segments?). Model validation and effective communication of model-based results will be stressed.

Particular topics covered will include
•   nested logit models
•   text mining
•   regression trees
•   machine learning / adaptive Bayesian models
•   Classification and clustering
•   techniques for working with unstructured data

Delivery: 1.25 hour class sessions, meeting twice a week, for 12 weeks (total of 30 contact hours). Classes will meet either M/Th or Tu/F during either AM or PM time slots.

RSM8X14H Decision Analysis and Spreadsheet Modeling*
In this course students will learn how to structure, analyze, and solve business decision problems using Excel spreadsheets. We will focus on problems involving decision-making and risk analysis. The emphasis of the course will be on systematic, logical thinking and problem solving using spreadsheets as our primary tool. We will start with the basic techniques of good spreadsheet modeling and organization, and proceed to introduce a variety of decision modeling techniques and approaches, including optimization modeling, sequential decision models, and Monte-Carlo simulations. These tools are particularly appropriate when (a) a decision has to be made based on incomplete or unavailable data (e.g. new product introduction, one-off decisions), and/or (b) as a follow-up to statistical data analysis.

The modeling tools we introduce will be illustrated by building and analyzing problems in finance, marketing, and operations. While the underlying concepts, models, and methods of this course are mathematical in nature, we will develop them on the more intuitive and user-friendly platform of spreadsheets, always focusing on the ideas and insights, rather than the underlying mathematical details. The spreadsheet approach to problem solving is more accessible to managers, as they often find spreadsheets a natural medium for organizing information and performing "what if" analyses. We will study how to use Excel and various add-ins to perform such analyses and interpret them.

Delivery: 1.25 hour class sessions, meeting twice a week, for 12 weeks (total of 30 contact hours). Classes will meet either M/Th or Tu/F during either AM or PM time slots.

RSM8X15H Analytics Colloquia*
This course will consist of a set of short (two-week or three week) modules interspersed with appearances by guest speakers, as well as short (one day) team-building events such as analytics competitions. The modules will be focused on the new analytics tools and important issues related to the practice and application of analytics.
These are anticipated to include:
- effective communication of analytical findings
- data visualization tools (Tableau, etc.)
- Hadoop and other distributed data access systems
- tools for mining unstructured data
- data governance and data security
- analytics for money laundering and fraud detection
- effective management of analytics projects
- career counseling and career path for an analytics professional

These modules are expected to involve less intensive course-work compared to other courses. The main goal is to expose students to the most current issues faced by analytics professionals. Each module may involve a short assignment or require students to research and present on the topic. The course will be marked on a Pass/Fail basis.

Delivery: Two hour class sessions, meeting bi-weekly on Wednesdays over the course of the year (maximum total of 30 contact hours).

RSM8X21H Analytics in Consumer Marketing*
Marketing is one of the main application areas of analytical techniques. The forces and dynamics of today's market are making the marketing task more complex and competitive. In this context, a successful marketing plan involves complementing the basic elements of marketing mixed with analyzed data and appropriate models and simulations incorporated in a consistent and professional way. Marketing is not only an art, but also a science. In this course students will learn about the conceptual and the science sides of marketing by studying

multiple models used by companies and consulting firms in the different steps of the marketing process. The marketing analytics approach of this course provides a deeper understanding of the process that supports the marketing management decisions.

The focus will be on the business issues faced by marketing managers, what data is typically available, and the key areas where analytics is used. At the end of this course the student learn to apply modeling techniques (discrete choice modeling, cluster analysis, factor analysis) to a variety of business problems, as well as how to communicate their findings effectively to business managers.

Delivery: 1.25 hour class sessions, meeting twice a week, for 12 weeks (total of 30 contact hours). Classes will meet either M/Th or Tu/F during either AM or PM time slots.

RSM8X22H Analytics in Data Driven Marketing*
The world of marketing has been undergoing a transformational change with the advent of cutting edge technology, innovative methods to capture data, minimal costs for data storage, and superior analytical tools. Previously marketing campaigns would take as long as six months to execute and their ROI was difficult to calculate. However, with the advent of digital advertising, marketing campaign launches take significantly less time. This shift in marketing has resulted in two major challenges:
- *analysis of this data*
- *translation of the key data insights into business decisions*

Using data-driven cases, students will learn how to conduct data analysis to support modern marketing campaigns. Students will learn how to apply data acquisition tools to structured, semi-structured, and unstructured data sources. Students will apply data analysis tools learned in the Fall session to generate insights into the problems faced. Students will learn to use data visualization tools to provide clarity to their understanding. Cases will cover topics such as A/B testing, media intelligence, digital marketing, and web analytics.

Most organizations now realize the need to have a dedicated analytics team to enable them to address these challenges. This course will equip the students with the necessary business context, analytical rigor, and soft skills essential for uncovering and presenting key data insights in an easily digestible and business-relevant manner.

Delivery: 1.25 hour class sessions, meeting twice a week, for 12 weeks (total of 30 contact hours). Classes will meet either M/Th or Tu/F during either AM or PM time slots.

RSM8X23H Analytics in Operations and Supply Chain Management*
Operations management, particularly in the area of logistics and supply chain management, is another heavy analytics user in a number of industries, including retail, airlines, hotels, and financial services. This course will focus on the application of analytics to decision problems that are prevalent in supply chain operations, including inventory management, revenue management, and business process design and staffing.

The required analytical toolbox in this areas includes statistical tools as well as optimization and dynamic simulation techniques. The latter will be introduced as needed. The focus of the course will be on business issues, rather than tools: structuring a business problem as an analytics problem, identifying and gathering the required data, developing model-based solution, and effectively communicating the results to business leads. Standard of Proof and typical Key Performance Indicators used in various areas will be discussed.

Delivery: 1.25 hour class sessions, meeting twice a week, for 12 weeks (total of 30 contact hours). Classes will meet either M/Th or Tu/F during either am or pm time slots.

RSM8X24H Applied Empirical Analysis in Accounting and Finance*
This course has three broad aims. At the end of the course students will: (1) better understand and appropriately use accounting and other financial data, (2) more confidently conduct empirical modelling to make decisions and solve the problem at hand, and (3), appreciate the strengths and limitations of empirical analysis.

This course will build on the tools, skills, and concepts developed in the first half of the program. As an applied course, students will be expected to, on a weekly basis, perform accounting-based empirical analysis. Students must first practice their ability to formulate appropriate empirical research questions in the context of the business problem or opportunity. Our emphasis will be on analyses at the firm level, which corresponds well with the study of B2B transactions. At the firm level, we have an abundance of financial accounting data. It also allows students to incorporate a wide variety of structured and unstructured publicly-available data about firms into their analyses. In addition to modelling the data, students will practice acquiring data, converting unstructured data to structured data, as well as cleaning and merging data. Lastly, and extremely importantly, students will practice communicating their analyses. This will include written reports as well as oral presentations. Motivating the analyses, explaining methods, and appropriately interpreting results are invaluable skills.

Delivery: 1.25 hour class sessions, meeting twice a week, for 12 weeks (total of 30 contact hours). Classes will meet either M/Th or Tu/F during either AM or PM time slots.

RSM8X30H Capstone Integrative Project
In the capstone project for the program, students will apply the skills learned to a real-life decision problem. Projects will be completed in groups of four to six students. Each group will have access to a faculty coach who will guide the students in their analyses. The projects will be drawn from different industries and application areas, allowing students to focus on the most relevant areas of interest. We will rely on our partnering firms and advisory board for access to their companies and data. Similar projects are currently being undertaken by M.B.A. students at Rotman.

Students will be expected to formulate problems, identify required data, and assemble their own data from the proprietary data sources and from publically available information. They will then need to formulate hypotheses, conduct appropriate analyses, and draw conclusions. They will then be expected to create both visual presentations and documents to support the decisions and policies they proscribe.   Finally, the projects will be presented to a panel of judges and awards will be given for the best projects.

Professional Certifications (Optional)
The program will enable students to obtain several professional certifications in analytics. The option of pursuing these certification (as well as the decision of which specific certifications to pursue) will be left up to the student. It is anticipated that many students will take advantage of this option because of the increasing weight attached to the professional certifications in the business world. It has been the experience at some competing programs; for example, at Queen's M.M.A. program, over 70% of students in recent years have selected to write a SAS certification exam.

While the majority of the material required for achieving these certifications will be covered in the required courses within the program, intensive one-day pre-exam workshops may be required prior to certification exams. Initially, the following certification options will be offered (more may be added later):
- SAS Predictive Modeling Certification
- INFORMS Certified Analytics Professional (CAP) Certification

Appendix B: Graduate Calendar Copy

Overview

The professional Master of Management Analytics (M.M.A.) degree program offers a curriculum that combines analytical depth and a focus on business issues and applications. Analytic depth is provided by courses on business models and data generation, acquiring and structuring data, predictive and prescriptive analytics, big data methods, decision analysis, and spreadsheet modeling. Course applying analytics to business feature the use of analytics in marketing, operations and supply chain management, and accounting and finance.

The M.M.A. degree program will be offered over two sessions using a cohort-based model. Within this two-session program, students must complete a structured sequence of 12 courses (6.0 FCE with 3.0 in each session) on a full-time basis. The M.M.A. is designed for pre-experience graduates.

Contact and Address

Web: general http://www.rotman.utoronto.ca

Telephone: 416-946-3377

Degree Programs

Master of Management Analytics

Minimum Admissions Requirements

Applicants must meet the following requirements:

1. **Appropriate four-year undergraduate degree:** For entry into the School of Graduate Studies of the University of Toronto, a four-year recognized undergraduate degree or equivalent is required. Given the nature of the M.M.A. program, degrees in Computer Science, Statistics, Mathematics, Engineering, Physical Science, Economics, and Commerce will be preferred, but degrees from any program where there is a significant quantitative and computational component will be considered.
2. **Grade Point Average:** Applicants must have achieved a minimum B average in the final year of their undergraduate degree.
3. **English language proficiency:** Applicants must demonstrate the ability to communicate in English in one of the following ways:
   - An undergraduate or graduate degree from a university at which the language of instruction and examination was English
   - Satisfactory performance on a standardized English Language Test. Minimum TOEFL score of 100 is required. IELTS may be considered in special circumstances, and a minimum score of 7.0 will be required.

4. **Quantitative proficiency:** All successful applicants must demonstrate a high level of quantitative proficiency. This includes knowledge of Calculus, Linear Algebra and Statistics/Econometrics. For many applicants, this will be satisfied by having taken, and obtained a minimum B average, in the corresponding courses or courses covering a similar subject matter (e.g., Econometrics can be substituted for Statistics, etc.). In cases where evidence of quantitative proficiency is not obvious from the transcript, applicants will be required to provide supplemental evidence they have attained the required base of knowledge (ie. a course outline detailing material covered, research work demonstrating the required skills etc.).

5. **Computational proficiency:** All successful applicants must demonstrate proficiency in computer programming (in one or more of computer programming languages). This may be demonstrated through a minimum B average in one or more courses in Computer Science or in courses relying extensively on computer programming. In cases where evidence of computational proficiency is not obvious from the transcript, applicants will be required to provide supplemental evidence of their computational proficiency (ie. a course outline detailing the programming required in a course, a reference letter from a supervisor detailing computational skills and programming abilities, etc.).

6. **Communication skills:** All successful applicants are expected to demonstrate effective oral and written communication skills. These will be assessed through answers to essay-style and video questions, interviews, and relevant courses taken during prior study.

Applicants who meet all the criteria will be assessed on the basis of their application essays (addressing writing ability, critical thinking, and applying business knowledge), answers to the video question, undergraduate GPA, references (academic references are acceptable), and the supplemental material submitted as part of the application by the admissions committee. Short-listed applicants may be invited for an in-person admission interview (out-of-town short-listed applicants may be interviewed via video). The interview will assess, among other areas, communication skills, professionalism and expectations.

Undergraduate GPA, evidence of quantitative skills/pre-courses satisfied, application essays, answers to video questions, references, and the interview performance will be scored in a similar manner to all of our existing degree programs and applicants assessed and chosen based on that analysis.

Program Requirements

- Within this 2-session program, students complete 6.0 full-course equivalents (FCE) as follows:
    - Fall Session (3.0 FCE):
        - Courses that start mid-August: RSM 8X00H (0.5 FCE) and RSM 8X01H (0.5 FCE)

- - Courses that start mid-September: RSM 8X11H (0.5 FCE), RSM 8X12H (0.5 FCE), RSM 8X13H (0.5 FCE), RSM 8X14H (0.5 FCE), and RSM 8X15H (0.5 FCE offered in Fall and Winter)
  - Winter Session (3.0 FCE):
    - All courses begin in January: RSM 8X21H (0.5 FC), RSM 8X22H (0.5 FCE), RSM 8X23H (0.5 FCE), RSM 8X24 (0.5 FCE), and RSM 8X30H (0.5 FCE)
    - Note RSM8X15H will spread across the Fall and Winter sessions

Program Length

2 sessions

Time Limit

3 years

Required Courses

RSM 8X00H	Strategic Uses of Analytics in Management
RSM 8X01H	Analytics, Models and Data
RSM 8X11H	Structuring Data for Analytics
RSM 8X12H	Predictive and Prescriptive Analytics
RSM 8X13H	Big Data and Marketing Analytics
RSM 8X14H	Decision Analysis and Spreadsheet Modeling
RSM 8X15H	Management Analytics Colloquium
RSM 8X21H	Analytics in Consumer Marketing
RSM 8X22H	Analytics in Data Driven Marketing
RSM 8X23H	Analytics in Operations and Supply Chain Management
RSM 8X24H	Applied Empirical Analysis in Accounting and Finance
RSM 8X30H	Capstone Integrative Project

Appendix C: Faculty CVs

See separate document entitled *CVs_MMA proposal* for a complete package of instructors' resumés.

Appendix D: Library Statement

University of Toronto Libraries Report for
Master of Management Analytics, Rotman School of Management, 2016

Context: The University of Toronto Library (UTL) system is the largest academic library in Canada and is currently ranked third among academic research libraries in North America, behind Harvard and Yale.[1] The research and special collections, together with the campus and college libraries comprise over 12 million print volumes, 5.6 million microform volumes, more than 17,000 journal subscriptions, in addition to a rich collection of manuscripts, films, and cartographic materials. The system provides access to more than 1.9 million electronic books, journals, and primary source materials and increasingly supports access via personal handheld devices.[2] There are numerous collection strengths in a wide range of disciplines reflecting the breadth of research and instructional programs at the University. The University of Toronto Library system has an annual acquisition budget of $31 million. The strong collections, facilities and staff expertise attract unique donations of books and manuscripts from around the world, which in turn draw scholars for research and graduate work.

Major North American Research Libraries[3]					
	2009-10	**2010-11**	**2011-12**	**2012-2013**	**2013-2014**
ARL RANK	**UNIVERSITY**	**UNIVERSITY**	**UNIVERSITY**	**UNIVERSITY**	**UNIVERSITY**
1	Harvard	Harvard	Harvard	Harvard	Harvard
2	Yale	Yale	Yale	Yale	Yale
3	**Toronto (3rd)**	**Toronto (3rd)**	**Toronto (3rd)**	**Toronto (3rd)**	**Toronto (3rd)**
4	Columbia	Michigan	Columbia	Columbia	Columbia
5	Michigan	Columbia	Michigan	Michigan	Michigan

Top 5 Canadian Universities in the ARL Ranking of Major North American Research Libraries				
2009-10	**2010-11**	**2011-12**	**2012-2013**	**2013-2014**
RANK/ UNIVERSITY	**RANK/ UNIVERSITY**	**RANK/UNIVERSITY**	**RANK/UNIVERSITY**	**RANK/UNIVERSITY**
3/Toronto	**3/Toronto**	**3/Toronto**	**3/Toronto**	**3/Toronto**
11/Alberta	11/Alberta	10/British Columbia	18/Alberta	22/British Columbia

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[1] Chronicle of Higher Education, "Library Investment Index at University Research Libraries, 2013 – 2014." In the Almanac of Higher Education, 2015. http://chronicle.com/article/Spending-by-University/232279
[2] Figures as of 2014 taken from UTL's 2015 Annual Report and 2013-2014 annual statistics.
https://onesearch.library.utoronto.ca/sites/default/files/annual_reports/annualreport-2015.pdf and
https://onesearch.library.utoronto.ca/annual-statistics/2013-2014
[3] Association of Research Libraries Statistics, 2013-14 http://www.arlstatistics.org/analytics

24/British Columbia	16/British Columbia	15/Alberta	24/British Columbia	26/Alberta
31/Montreal	32/Montreal	18/McGill	30/McGill	35/McGill
37/McGill	38/McGill	32/Montreal	35/Montreal	36/Montreal

Space and Access Services: The Library system provides a variety of individual and group study spaces for both undergraduates and graduates in the 14 central and 30 divisional libraries on the St. George, Mississauga, Scarborough and Downsview campuses. During the academic year, study space and computer facilities are available twenty four hours, five days per week at one location, Robarts Library. Web-based services and electronic materials are accessible at all times from campus or remote locations, through the U of T based Scholars Portal and other leading edge digital services.

The Library offers a specialized data support facility, the Map & Data Library (MDL). The MDL has a computer lab available to all students, with statistical software including R, SPSS, SAS, Stata, ArcGIS, and Tableau Public. MDL staff include data and GIS specialists who can support students in accessing and analyzing data.

Instruction & Research Support: Libraries play an important role in the linking of teaching and research in the University. To this end, information literacy instruction will be offered to assist in meeting the Master of Management Analytics degree level expectations in the ability to gather, evaluate and interpret information. These services are aligned with the Association of College and Research Libraries (ACRL) Framework for Information Literacy for Higher Education[4].

Program Specific Instruction: Instruction can occur at a variety of levels for Master of Management Analytics students and will be provided by the faculty liaison librarian for Management. The Rotman Business Information Centre facilitates formal instruction integrated into the class schedule and hands-on tutorials related to course assignments. Additional instruction in data-related topics is available from librarians in the Map & Data Library through online tutorials and in-person instruction. The Library also offers a GPS course on Data Visualization using Tableau Public. The Library, through its liaison librarians, customizes feeds of library resources which appear prominently in Portal/Blackboard course pages.

Collections: Many college and campus libraries collect materials in support of Master of Management Analytics; the largest collection of materials is centrally located in Robarts Library. Collections are purchased in all formats to meet the variety of preferences and styles of our current students and faculty. The University of Toronto Library is committed to collecting both print and electronic materials in support of Master of Management Analytics at the University of Toronto.

Journals: The Library subscribes to 24 of the top 25 journals listed in Journal Citation Reports (JCR) in Finance; to 24 of the top 25 journals listed in JCR in Management; and to 23 of the top 25 journals listed in (JCR)[5] in Business. All journals are available electronically to faculty and students.

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[4] Association of College & Research Libraries. Framework for Information Literacy for Higher Education. ACRL, 2016. http://www.ala.org/acrl/sites/ala.org.acrl/files/content/issues/infolit/Framework_ILHE.pdf
[5]2015 Journal Citation Reports® (Thomson Reuters, 2015)

Monographs: The University of Toronto Library maintains comprehensive book approval plans with 53 book dealers and vendors worldwide. These plans ensure that the Library receives academic monographs from publishers all over the world in an efficient manner. In support of Management Analytics, we specifically receive books through plans with YBP for books published in the US and UK. In addition to these plans individual librarian selectors select unique and interesting scholarly material overlooked by standard approval plans. Books supporting this program typically class in the "HD" call number range. In this call number range the Library received 510 unique titles in 2015. Some monographs supporting this program are classed in "HF". In this call number range we received 183 unique titles in 2015. Of interest to researchers in Management Analytics are the e-book packages that the Library licenses from Wiley, Springer, Palgrave, Oxford University Press, Cambridge University Press, major US University presses and Canadian University presses.

Preservation, Digitization, and Open Access: The University of Toronto Library supports open access to scholarly communication through its institutional research repository (known as T-Space), its open journal services, and subscriptions to open access publications. In addition to acquiring materials in support of the Master of Management Analytics, the Library, in cooperation with the Internet Archive, has digitized its monograph holdings published before 1923. These books are available without charge to anyone with access to the Internet through the Scholar's Portal e-Book platform.

Key Databases: Key financial and social science databases such as *Compustat, Capital IQ, Bloomberg, SimplyMap* and *CHASS*.

Prepared by: Dan D 'Agostino, Social Sciences Selector; Holly Inglis, Public Services Librarian; Leanne Trimble, Data & Statistics Librarian. July 21, 2016.

Submitted by: Larry Alford, Chief Librarian, University of Toronto Libraries, August 16, 2016.
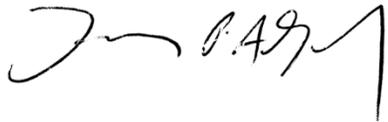
Appendix E: Student Support Services

Student service information for Quality Assurance Framework
[St. George Campus]

All University of Toronto undergraduate and graduate students have access to student services on all three campuses, Mississauga, St. George (downtown Toronto), and Scarborough, regardless of their 'home campus'. The services and co-curricular educational opportunities provide a complement to the formal curriculum by engaging and challenging students to reach their full potential as learners, leaders and citizens. At the University of Toronto (St. George Campus) these services are organized by Student Life Programs and Services, and the academic division registrar offices, which support the success of our students from the time they are admitted through degree completion and beyond.

Students have access to comprehensive **physical and mental health care** on campus including a medical clinic, travel medicine services, immunization, contraception and sexual health education. Counselling and treatment options for psychological and emotional concerns include psychotherapy, group therapy and pharmacotherapy, as well as specialized assault counseling services.

Housing needs, including off-campus housing listings and resources for students living independently, are met through the Student Housing Service.

Coaching and education in the development of key **learning skills** – from time management to overcoming exam anxiety – is provided through the Academic Success Centre. The ASC also partners with faculty to integrate success strategies and support into the curriculum.

Students' career exploration and employment services are provided through a **Career Centre** offering resume and interview coaching, workshops, career resources, on and off-campus employment and volunteer listings, job shadowing, and career counseling.

Specialized services are provided for **international students** (orientation, advising, cross-cultural counselling), students with **disabilities** (academic accommodations, advising), students with **children or other family responsibilities** (advising, resources, subsidized child care), **aboriginal students** (academic support, financial counselling) and **lesbian, gay, bisexual and transgender** students (counselling, referrals, equity outreach and engagement).

Participation in **campus life** and **experiential learning** are facilitated through Hart House (clubs, committees, events), the Centre for Community Partnerships (service learning), the Multifaith Centre (interfaith dialogue, events), and the Office of Student Life (leadership development, orientation, recognition and support for student groups, activities.) **Sport and recreational facilities and programs** are provided to all students through both Hart House and the Faculty of Kinesiology and Physical Education.

Appendix F: Canadian and U.S. Analytics Programs

School	Program Name	Admission Requirements / Positioning	Duration / Structure	Tuition	Current Enrollment
Queen's University, School of Business	Master of Management Analytics	Mid-career analytics professionals with strong quant background Admission: undergrad degree in Math/Sci with strong math performance	One-year (11 months), part-time, alternating residential modules (Kingston) and 10 classes in Toronto (Wed eve. and Sat.)	$40000 domestic $61000 international	120-140 (just added a full section; may add another section next year)
York University, Schulich School of Business	Master of Business Analytics	Undergrads with math/quant background; "B+" average + GMAT required. Work experience is not required.	Two academic sessions (8 classes) in Fall/Winter + "major research project" (12 weeks in summer, internship-style)	$47000 domestic $ 57500 international	40 (up from 25 last year)
New York University, Center for Data Science	MS in Data Science	Undergrads with strong math background; specific mathematical competencies listed	2 years (4 semesters) with a 3-semseter option. Standard program is 3 courses per session	Approx. $58,000 US	N/A

North Carolina State, Institute for Advanced Analytics	Master of Science in Analytics	Residential program aimed at recent graduates with median 3 yrs experience	10 months	Approx. $40,200 US	130
Northwestern University, McCormick School of Engineering	Master of Science in Analytics	Residential program, Recent graduates (<2 yrs experience) Engineering/ Math/ Econ majors	15 months consisting of coursework, industry practicum, internship, capstone	$64832	32
University of California, Berkeley School of Information	Master of Information and Data Science	On-line program with a small on-site requirement. Appears aimed at working professionals with strong quantitative skills	20 months (5 semesters) with 2 courses per semester	Approx. $61,000 US	100+
University of Rochester, Simon School of Business	Master's of Science in Business Analytics	Residential program. Business/ Math/ Engineering undergrads 2-3 yrs work experience	11 month/12 course program with an optional, 5-month internship.	$63,000 US	18
University of Southern California, Marshall School of Business	Master of Science in Business Analytics	Residential program. 1.5 year work experience	18 month/10 course.	$51,300 US	N/A

Other programs:

The following programs are less comparable to our proposed program. They either are differently focused (less business / more computing focused, or specialized in a particular field of business) or are unlikely to attract students with a similar background to the students we aim to attract.

Bentley University: Masters in Marketing Analytics. This is a 1-year program consisting of 10 courses. The coursework is very marketing focused. It appears to be more managerially oriented than other programs with what appears to be a significant re-use of general marketing courses. The placement rate for the program is high (92%) with a median salary of US$75,000.

Carnegie Mellon University: Master in Information Systems Management with concentration in Business Intelligence and Data Analytics. This program is offered by the Heinz School (Public Policy and Information Systems). The 16 month program costs US$70,000 and has 24 courses. It is a program focused heavily on computer programming and database management with some statistical analysis training and some text analysis training. It appears to provide little managerial context for decision making. It has a 95% job placement rate with a median salary of US$93,000.

Columbia University: Masters of Science in Computer Science, concentration in Machine Learning (School of Engineering and Applied Science). The 1-year program consists of 10 courses focused on machine learning. There are electives in multiple computer science areas and some in data analytics, optimization, and statistics. There appears to be no coursework in managerial decision making. As such it is much more of a technical degree than a business analytics degree.

DePaul University: Master of Science in Predictive Analytics (College of Computing and Digital Media). This is a 2-year program consisting of 18 courses. It is very tools oriented with limited managerial content. It has some statistical coursework but not much on anything but statistical modeling techniques. There is a capstone project. The program costs US$41,600.

Drexel University: Master of Science in Business Analytics (LeBow College of Business). This is a 1.5 year, 15 course program. The program is similar to the model we propose consisting of coursework on managerial decision making, statistics, database management, and a capstone project. Electives can be undertaken in a concentration in statistics, modeling (operations research and economics), or information systems. The program costs US$48,825. As a regional university based in Philadelphia we would not expect to be in competition for students with Drexel's program.

Harvard University: Master of Science in Computational Science and Engineering (School of Engineering and Applied Sciences) This is a 1-year, 8 course program with core courses in numerical methods, computational science, data analysis, inference, optimization, and systems development. Additional coursework is available in applied

computation, statistical methods, and computer science (data structures, algorithms, and machine learning). There are stated goals of framing real-world programs, choosing and implementing appropriate approaches, collaborating in teams, and development of software. There is a capstone project course. There is little managerial coursework or emphasis on business analytics. The program appears to have been developed with industry sponsors including national research laboratories.

Rensselaer Polytechnic Institute: M.S. in Business Analytics (Lally School of Management)

The program is a 9-month program consisting of 10 courses. These include courses in statistics, accounting and finance, information systems, technology for analytics, predictive analytics, data management, quantitative methods and a capstone project. While the program is similar in scope, it does not seem to provide the full depth of project-based curriculum that we are proposing. Current enrollment is 26 students. Tuition is US$48,100. 86% of the students found employment with an average salary of US$71,000.

Rutgers: Master's of Business and Science Degree in Analytics

The program is a 43-credit (14 course program) that combines an introduction to business (finance & accounting/marketing/leadership/ethics/electives) with eight courses on analytics. These include programming, statistics, database systems, and big data computing courses. The program is aimed at early career professionals and is given in evening and online formats. The program does not seem to provide the training in contextual decision making that our second semester is direct at. It also does not seem to provide a unified curriculum where the business and analytics courses reinforce one another. Current tuition is US$40,500 in-state, US$49,500 out-of-state.

University of Texas at Austin: Master Science in Business Analytics

The is a 36 credit/ 3 semester / 10 month program. The summer and fall courses are focused on a number of tools similar to our courses. The spring semester consists of a couple of technical courses and a capstone along with a few electives in analytics or business. There does not seem to be a focus on making decisions in a business context. Current tuition is US$36,000 in-state, US$44,000 out-of-state.

New Program Proposal Appraisal Report
September 23, 2016

Harry Groenevelt

Simon Business School

University of Rochester

Tim Huh

Sauder School of Business

University of British Columbia

Background

The University of Toronto is proposing to offer a new graduate program called the Master of Management Analytics (M.M.A.) administered by the Rotman School of Management. We have been asked by Susan Christoffersen, Vice-Dean, Undergraduate and Pre-experience Programs, to serve as external evaluators for the proposed program.

We have received and read the following documents:
- New Graduate Program Proposal for Master of Management Analytics
- Curriculum Vitae of faculty members involved in the program

We also visited Rotman School of Management building at 105 St. George Street in Toronto, and met with several faculty members and others on September 18 and 19, 2016. The list of names that we have consulted are listed below:
- Tiff Macklem, Dean
- Susan Christoffersen, Vice-Dean, Undergraduate & Pre-Experience Programs
- Dmitry Krass, Professor, Operations Management
- Joseph Milner, Professor, Operations Management
- Leanne Pollard, Managing Director, Professional MBA & Specialized Programs
- Eva Hughes, Director, Recruitment and Admissions, Professional MBA & Specialized Programs
- Mark Morreale, Academic Program Manager, SAS
- Levent Timur, MBA student
- Catherine MacDonald, MBA student
- Mengze Shi, Associate Professor, Marketing and scheduled to teach in the program
- Philipp Afèche, Associate Professor, Operations Management and scheduled to teach in the program
- Fiona Duley, Recruitment and Admissions Officer, Master of Finance, Morning MBA and Evening MBA
- Ken Corts, Vice-Dean, Faculty & Research
- Mary Lyne, Chief Administrative Officer
- David Soberman, Professor, Marketing and scheduled to teach in the program

In this document, we report our findings and comments about the newly proposed program. Overall, we find that this program has been carefully prepared and designed, and there is ample evidence that the program will be academically rigorous, and practically relevant, preparing students for the emerging analytics marketplace both in Canada and abroad. We also note a strong sense of support from the administration and staff, and the faculty members are also highly qualified and committed to the success of the program. We expect this program to be one of the highest-quality analytics programs in the world.

The rest of this document is organized by eight evaluation criteria.

1 Objectives

The proposed M.M.A program is consistent with the University of Toronto's mission and the Rotman School of Business' academic plans. From our experience with industry as well as from various other forecasts, we agree with the proposal that there will be a large demand for data scientists in the immediate and medium-term future, and professionals who are fluent in both analytics and management skills will especially be in demand. The proposal clearly states the program's requirements and expected learning outcomes, and they are appropriate for a graduate degree level.

In terms of the degree nomenclature, we feel the expression "business analytics" may be more appropriate than "management analytics" as business analytics is more commonly used than the latter. The proposal acknowledges this and explains that why *management* analytics is chosen instead to avoid possible confusion with Master of Business Administration which is abbreviated as M.B.A. We understand the rationale for calling the program the Master in Management Analytics (M.M.A), and we feel that this nomenclature is also acceptable. Given that the business school at the University of Toronto is called the Rotman School of Management, the use of management in the title of the program is appropriate.

2 Admission requirements

The admission to the M.M.A program is based on multiple criteria. In addition to the academic performance in the applicant's undergraduate program, the applicants provide written statements and a video recording. This supplementary information can be used to evaluate the applicant's written and oral communication skills as well as other soft skills. In addition, select students will be invited for an in-person or skype-based interview. We believe that all of these screening methods can be useful to evaluate the candidate's aptitude for business analytics. We have been told that approximately twice as many applicants as expected for enrolment will be invited to the interview, and each interview will last approximately half-an-hour, conducted by the academic director. While we agree that the best person to interview applicants is the academic director, especially in the early years following the program launch, we are slightly concerned that this would involve a substantial amount of time for the academic director.

The transcripts of applicants would primarily be evaluated using the grade point average (GPA), with the quality and difficulty of undergraduate programs considered in an ad-hoc fashion. This may be a quick and convenient way of comparing transcripts, but we are concerned that this might inadvertently penalize good applicants who have attempted difficult courses or programs. This concern is particularly pronounced in evaluating transcripts from international institutions that Rotman may not be as familiar with.

The proposed program does not require any standardized tests such as GRE or GMAT. We understand the rationale of not creating barriers in applying to this program. We think it may be appropriate not to require such a standard score for students with an undergraduate degree from the University of Toronto (and possibly a select set of additional universities). For international students, however, we feel that requiring a standardized test score will reduce the variability in quality among incoming students, and such a test is not likely to act as a barrier to apply since most international students apply to multiple programs and thus would have taken such a test. Standardized scores can also be used to track the quality of the incoming class over the years.

3 Structure

The program is structured such that students take technical and methodological courses before the end of December, and application-based courses starting from January. We believe this is an appropriate structure for this program. We also find it innovative and valuable to set aside the first week of January for students to acquire analytics related professional certification during that time. As such, certification can be useful to build CV's for students who are expected to have very limited professional work experience before the start of the program.

We are slightly concerned that the students will be engaged in intense course work from the beginning of their program in mid August to mid-December without any break. The program is designed to be quite demanding to students, and fatigue may set in towards the latter half of the first semester. A one-week break after the first four weeks of the program, or in the middle of October (around Canadian Thanksgiving) can be helpful to alleviate some of the student's stress. This could be accommodated by starting the program a week earlier in August. We understand that program designers considered this but that, regrettably, this idea was abandoned for logistical/systems reasons.

The overall length of the program is appropriate and it is in line with similar graduate programs in analytics. We expect most students to complete the program in the normal duration of the program. The structure of the program is appropriate and well designed to achieve program learning outcomes.

We feel that the estimate of the class size is quite conservative. We expect that there will be many qualified applicants applying to the program, and the steady state class size could be much higher than 60 students, if desired. The program director and administrators will soon be faced with the decision of whether or not to increase the class size. We also expect that the proportion of international students will be much higher than 20%.

4 Program Content

The first half of the program focuses on methodology while the second half focuses on applications. This sequence of program delivery is appropriate for the students who come from a quantitative undergraduate background as they start with course content that is more traditional and probably similar to their previous training. Then the courses in the second half of the program move to applications. The emphasis on applications through various operations and marketing areas will be highly helpful to students with limited prior professional experience. The set of courses in the latter half of the program is less conventional than other analytics programs, and we expect that this innovative, problem oriented approach will suitably prepare students for the job market.

We find that the year-long colloquium course provides a flexible way to introduce students to emerging topics in both the tools and applications of analytics. This will enable the program to provide tutorials on the latest tools as well as to invite practitioners to present analytics applications. This program is a lock-step program with no electives, and it is appropriate for students with a common professional goal. This ensures students to be exposed to all the important tools and major application domains so that they can be prepared to fill any type of analytics position. This will also enhance the student's experience as they take classes as a single cohort, which is advantageous since the program is less than one year in length.

We understand that the proposed time span imposes a limit on how many courses can be included in the program, and a decision has to be made regarding what courses to include. Given that the program will attract students with

technical backgrounds, that many of the courses will be quantitative in nature, and that graduates from the program are expected to play a mediating role between more technically oriented and more business oriented employees at their future jobs, it would be important to ensure that students become well versed in various soft skills such as writing, presentations, professionalism, leadership, teamwork, project management, change management and conflict resolution. While such programs can be taught by various extra-curricular means such as Rotman's existing self-development lab, students will take such essential skills more seriously if it is a part of the required curricular work with grading. Not only will soft skills help students' career trajectory in the business environment, it will also ensure Rotman's reputation and protect its brand in businesses. We recommend that a way is found to attach some credit to these planned activities.

5 Mode of Delivery

The mode of delivery is traditional in the sense that students are expected to be on campus on a full-time basis, and instruction is primarily given in a face-to-face format. We consider this the most effective method since the complexity of analytics and applications is not well suited for an online or part-time format. The instructor is expected to interact closely with students, and as students will be working together in groups, it is essential that they are located in the same place. Students will develop teamwork and project management skills on campus. The colloquium course, capstone integrated project and other events allow students to meet and interact with business leaders.

6 Assessment of Teaching and Learning

We find that the assessment of teaching and learning through tests, projects, assignments, case studies, presentation and participation is appropriate to ensure that students have grasped concepts and tools taught in the courses and use them in various application contexts. The capstone project both provides students with valuable experience and is appropriate to assess that the students have mastered analytics tools and apply them appropriately. Students are expected to perform well and maintain a 3.0 GPA, and they will be on academic probation or expelled if they do not maintain the required GPA or fail a course. We do not expect that such an adverse outcome for students to be frequent given the careful admission screening process.

Since the business or soft skills aspects are an important part of preparing students in a professional environment, it would be advantageous to think ahead and plan how the assessment in these areas would be conducted. A formal course in soft skills can be one way to assess student outcomes in this area.

We agree with the proposal that survey, alumni feedback, industry employees and other engagement events can be useful to indicate the success of the program over the years. On a more short term basis, direct and immediate feedback from recruiters and potential employers following student job interviews can be helpful to assess how the students are being prepared for the marketplace.

7 Resources

We have talked to several administrators and we feel confident adequate resources would be provided for this program. There is sufficient space for all learning activities in the current Rotman building, and students in the M.M.A. will be able to access most of its resources, similar to what is currently available to the M.B.A. and other Masters' students. Should there be any issues with space, the administration is committed to find sufficient space.

The faculty members committed to the program have both academic and professional knowledge and expertise to teach the course content and support other students' learning activities. They are world-class leaders in various aspects of analytics. Furthermore, most faculty members are tenured, and therefore we expect little impact of this program on tenure promotion outcomes.

As this program is a professional program where students are likely to be employed in an attractive career position upon graduation, we expect that any student loan that a student has accumulated during the course of the program would be paid off in a reasonably short number years upon graduation. The proposal states that the students in the program would be able to benefit from an interest-free loan. In addition, we were informed during our meetings that the program plans to award some scholarships to attract the best applicants.

The tuition revenue from the program is expected to immediately cover the ongoing costs of three additional staff members, while the start-up costs are expected to be recovered within a few years. We expect these staff members dedicated to the analytics program will be instrumental in attracting applicants, managing student programs and facilitating student placement.

We have been told that the faculty members will be involved on an overload basis during the first few years of the program, and some incentives will be provided for course development and delivery. The extra load on faculty may be undesirable, and the overload might not be the ideal way to staff instructors for the courses in the M.M.A. program since these staff members are involved in the preparation of new courses. We would like to suggest the possibility of reducing the dependence on overload teaching by possibly hiring additional sessional (or adjunct) instructors for teaching in other established programs.

8 Quality and Other Indicators

The quality of the faculty involved in this program and other operations and marketing faculty at the Rotman School is excellent and these groups maintain a strong reputation for academic research and scholarly leadership. They are also connected with the business world around the Greater Toronto Area. They will bring their research and intellectual rigour to the classroom, enabling them to be creative and innovative in the course and program design. The courses proposed for the program are unique and not standard, but designed with the particular students the program is expected to attract in mind. These courses will be technically demanding, much more than typical undergraduate or Masters level courses, perhaps closer to doctoral level courses. The school is geographically located in the centre of Canada's largest financial and business hub. We can think of no school that could design and deliver a better program for the targeted market.

November 3, 2016

Vice-Provost Sioban Nelson
Simcoe Hall, Room 224
27 King's College Circle
Toronto, ON M5S 1A1

Re: External Appraiser Report, Master of Management Analytics Proposal

Dear Vice-Provost Nelson:

I am writing in response to the report by external appraisers Professors Harry Groenevelt and Tim Huh, concerning the Rotman School's proposed Master of Management Analytics (MMA) degree program. We are deeply appreciative of Professors Groenevelt and Huh for their valuable time and careful review during their visit on September 18 and 19, 2016. We are thankful for their thoughtful views and expressed support for the proposed program. As experts in the field of business analytics, their endorsement reinforces our view that this program will be of great value and interest to students, the university, and future employers.

The report raises several issues that we address in this response and through changes we have made to the proposal.

Admission requirements
The report questions the amount of time required for applicant interviews to be conducted by the academic director. As noted in the proposal, the program will require applicants to submit responses to questions in written and video formats. We intend to require video submissions as this provides a better way to sort students based on their communication skills and ability to respond to technical questions. The director of admissions, rather than the academic director, would be responsible for reviewing all the video interviews so using this as an initial sort will help to identify quality while not requiring the involvement of the academic director. We recognize that both the time and logistics involved in

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interviewing a large number of applicants are burdensome. At the same time, we continue to believe in the value of learning about an applicant's communication skills and fit for the program based on these interviews. Currently, our academic directors in both the Master of Finance (MFin) and Master of Financial Risk Management (MFRM) spend a considerable amount of time interviewing a short-list of candidates and both find that the involvement in the interview process is tremendously valuable in selecting students for the program.

For the initial cohort of students, we would want to be particularly careful in our selection process and would want the academic director heavily involved in this initial selection, and in particular for the subset of students where our admissions officer is uncertain about the candidate's qualifications. However, on an ongoing basis, the admissions team may become comfortable using the video interviews and applications to select the highest quality students and as a consequence, focus their interviews on a subset of more marginal candidates. The proposal now indicates that applicants being considered for admission *may be* invited for an interview to provide some flexibility as to whether the program director needs to interview all or just some candidates.

The report questions the reliance on a minimum grade point average for admission because of differing grading criteria among schools, especially international schools. We are obligated by SGS guidelines to require a minimum B average in the last year of an undergraduate degree, so we need to retain this requirement. We also require a minimum B average in Calculus, Linear Algebra, Computer Programming, and Statistics/Econometrics to demonstrate quantitative and technical proficiency. Based on our extensive experience with evaluating transcripts for admission to graduate programs, we believe that for the vast majority of undergraduate programs, a B average provides sufficient leeway for a student taking a difficult program to demonstrate their ability and serves as a minimum standard we should aim to attain. Our hope is that our selected students will have GPAs that exceed this minimum.

The evaluators encouraged us to consider adding an admission requirement of a standardized test such as the GRE or GMAT. Given this is a specialized program with a heavy reliance on computer programming, statistics and mathematics, we do not believe these generalized tests will be as informative about a student's success in the program since they do not test the key criteria we will be focusing on in our admissions process. In cases where we are unclear about the material covered in a course, we have indicated that the admissions team would request supplemental information from candidates to ensure that the courses we are assessing are comparable. Already our admissions team is confident in comparing many different undergraduate program across Canada and internationally and this ability to compare across programs will only improve over time. In terms of tracking the quality of the students coming into the program over time, we believe that tracking job placement will be a better indicator of our success and substitutes for the need to rely on incoming standardized test scores to track program success.

Program Structure
Given the rigor of the program, the evaluators encouraged us to schedule a break in the Fall term. We agree that a respite from classes would be appreciated by students at some point in the middle of the term. Currently, the proposal indicates that students should start their orientation in the third week of August and we have now moved this back a week so orientation begins in the second week of August. While a break of one week is not possible given the volume of material of the first session, a two-day break coinciding with a weekend is now built into the schedule. We have looked at a number of future years and can confirm that by starting the orientation program in the second week of August, the proposed fall program of courses can be completed, including an exam week in December, prior to the winter break.

The evaluators believe we have been very conservative with our long-term target of 65 students (20% international), as the external evaluators seem optimistic this is a program which will attract a large number of applicants. With regard to the demand, we certainly hope to grow the program but also believe we need to

conservatively build the brand and ensure all students are successful at gaining employment after graduation. Given the physical constraints of our classrooms, we can only accommodate a cohort of 70 students before needing to split the class into two sections, and our sense is this is something we can reevaluate once we have more experience with the program. We continue to believe that there is sufficient interest from Ontario and other Canadian students to ensure most of the places in the program will be filled domestically. Should this program look to garner more interest from international students than the projected 20%, we will make the adjustments in our budget after the first year, but do not feel we want to adjust now until we observe more during our first admission cycle.

Program Content
The report recognizes that the graduates of the program are likely to play a mediating role between more technically-oriented and more business-oriented employees in their organizations. As such, the development of various soft skills such as writing, presenting, professionalism, and leadership are going to be important. The appraisers ask if more training in these skills could be included as part of the for-credit program as opposed to planned co-curricular activities. We agree with their assessment. We intend that the for-credit program colloquium will require students to take part in professional development and team activities. Further, in current Master's courses, we have found that for technical subjects such as Statistics, it is important to challenge the students on their models while they are presenting them. In doing so, they gain both presentation skills and deeper knowledge of the material. To support this, we intend that most of the second semester courses that apply the analytic tools will require students to present and defend their models within the classroom. We expect significant parts of course projects will be marked based on these presentations.

It is also the case that some of the co-curricular planning can be integrated into the for-credit coursework. For instance, if students are learning how to build an argument in a co-curricular class or getting feedback on presentation style from the Self-Development Lab, then they could be using the time and concepts taught in the co-curricular session to help in preparing a presentation needed for their

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coursework. This provides the correct incentives for students to participate in the co-curricular activities since it is helping them prepare presentations needed in classrooms. The tight link between the co-curricular planning and classroom deliverables has been very effective in our MFRM program and we suspect the same will be true for the MMA program.

Resources
The appraisal recognizes the commitment the school has made to the program through promises of classroom space and additional staff. Currently, our budget has allocated four additional staff members who would need to be hired to manage the admissions, careers, and program planning for this program. We have also reviewed the space needs in the building alongside our other programs and believe that there is appropriate space both to accommodate the additional staff and the additional classroom demand.

There is some clarification needed regarding the reviewers' comments on overload teaching. We consider this new program as part of our complete complement of programs and teaching demands and are committed to investing the resources necessary to make it a leading program. We currently have all the full-time faculty in place who are interested and can teach as experts in this program (please refer to the list of faculty in the proposal). However, to offset potential teaching demands in our existing programs, we have budgeted for increases to our current faculty complement. Over the next five years, our budget includes 6 new tenure-stream hires and 7 new teaching-stream hires. Of these, 2 tenure-stream and 4 teaching-stream faculty positions have already been approved in the 2016-17 budget and we are currently engaging in recruiting for these new positions. We intend to have new hires in place to cover off any required redistribution of teaching in existing programs when the new program starts. We are not requiring or relying on instructors to teach on overload as the additional teaching demands are already included in our budget projections.

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My colleagues and I are truly appreciative of the significant time and effort that Professors Groenevelt and Huh invested in evaluating the proposed MMA program. The program will benefit from the constructive feedback we received from them and their report.

Sincerely,

Tiff Macklem, Dean
Rotman School of Management

Email: susan.christoffersen@rotman.utoronto.ca
Website: www.rotman.utoronto.ca/schristoffersen

December 14, 2016

Tiff Macklem
Dean
Joseph S. Rotman School of Management
University of Toronto

Re: Appraisal Report, Proposed new Master of Management Analytics

Dear Tiff,

I am very pleased to receive the appraisal of the proposed Master of Management Analytics. Your administrative response to the appraisal nicely summarizes the report and highlights the specific suggestions made by the reviewers.

I note that the reviewers commented positively on the program's academic content, but felt the first session would be challenging for students and therefore they recommended a formal scheduled break from classes. You have responded by moving the program's start date one week earlier in August and scheduling a short break into the first session. You agreed with the reviewers' comments on the importance of soft skills in preparing students for a professional environment, and you have provided comments to clarify the strong links between for-credit activities in the program and these skills. The reviewers suggested that the admissions process, which includes evaluating written and video responses to questions, would be a burden on the academic program director. Your response affirms that the admissions process is intensive but you feel the Faculty has expertise and experience to manage it and you indicated that the academic director will not be solely responsible for vetting applications. The reviewers suggested that standardized tests like the GMAT or GRE be part of the admission requirements for applicants without University of Toronto degrees for evaluation purposes. You believe that, for this specialized master's program, standardized tests will not provide sufficient information about applicants' background in the particular areas needed to support success. I note that the refined admission requirements in the proposal reflect your commitment to and expertise in effective selection of candidates. Finally, the reviewers suggested that the Faculty hire sessional instructors to teach in other programs to alleviate any need for existing faculty to teach on overload when the new program starts. Your response clarifies that the faculty who would teach in the proposed program are currently in place and no further faculty appointments are needed to deliver the proposed program. I note that Rotman has an approved plan to increase its faculty complement and this is reflected in the budget. The new faculty will teach in the existing programs, which will allow faculty associated with the proposed program to participate without the need for overload teaching.

The reviewers were very impressed with the program proposal and stated they expect it to be one of the highest-quality analytics programs in the world. I will be very pleased to recommend

this new professional master's program to governance for approval, following approval at the Divisional level.

Sincerely,

Sioban Nelson
Vice-Provost, Academic Programs

cc.
      Jackie Monahan, Assistant to the Dean, Rotman School of Management
      Professor Susan Christoffersen, Vice Dean Undergraduate and Pre-Experience Programs
      Daniella Mallinick, Director, Academic Programs, Planning and Quality Assurance, Office of the Vice-Provost, Academic Programs
      Jennifer Francisco, Coordinator, Academic Change, Office of the Vice-Provost, Academic Programs
      Locke Rowe, Dean, Graduate Studies and Vice-Provost, Graduate Research and Education, SGS
      Elizabeth Smyth, Vice Dean, Programs, SGS