



The Academic Guide for Undergraduates
Entering the Department in 2011-2012

Class of 2014

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Important Contacts

Department Chair

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The Undergraduate Office

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Departmental Assistants

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Academic Advisors

Class of '12

Student	Advisor
A-J	Prof. Erhan Çinlar, Room 328, x8-0101, ecinlar@princeton.edu
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R-Z	Prof. Alain Kornhauser, Room 229, x8-4657, alaink@princeton.edu

Class of '13

Student	Advisor
A-K	Prof. Warren Powell, Room 230, x8-5373, powell@princeton.edu
J-Z	Prof. Philippe Rigollet, Room 201, x8-1044, rigollet@princeton.edu

Class of '14

Student	Advisor
A-J	Prof. John Mulvey, Room 328, x8-5423, mulvey@princeton.edu
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R-Z	Prof. Rene Carmona, Room 210, x8-2310, rcarmona@princeton.edu

Department Web Page

Additional information on the department can be found at our web site: orfe.princeton.edu

All ORFE department offices are located in Sherrerd Hall.

An Introduction to the Department

The Department of Operations Research and Financial Engineering combines emerging information technologies with powerful mathematical tools to study a variety of problems that arise in the study of human processes. These problems can be roughly divided into three broad categories:

- Physical – The management of physical resources, including people, natural resources (such as agricultural commodities and oil), equipment (such as aircraft, locomotives, trucks and cars) and products being sold to consumers. Application domains include transportation, logistics and manufacturing, as well as problems drawn from classical areas within engineering such as the design of structures or robots.
- Financial – The pricing of financial instruments, and the allocation of financial resources, with an emphasis on managing risk. Financial managers often face the problem of designing a portfolio of investments that might include stocks or the insurance of houses against earthquakes and hurricanes. The study of financial risk often takes us into the domain of the physical sciences, where we may study weather patterns, earthquakes or the economics of developing nations.
- Informational – The study, analysis and design of effective systems for storing and communicating information. This area spans the fundamentals of representing information engineering encompasses the representation of knowledge, and the study of the economics of different types of information and information technologies.

We approach these problem areas using three branches of mathematics:

- Statistics – This is the mathematics of working with data. It allows us to identify what is actually happening in a complex physical process from observations about this process. We might use temperature data to study the likelihood that a ski slope will have a bad winter or financial data to help determine the volatility of a financial instrument.
- Stochastics – Also known as probability theory, this is the mathematics of uncertainty, and we use these tools to model the possible behavior of a system in the future, where no data is available. For example, we might characterize the random behavior of interest rates, and use this to determine the price of a bond. Or we might want to estimate how many books an online bookseller should keep in stock to meet unpredictable demand.
- Optimization – This is the mathematics of making the best decision. Typically we study making decisions under uncertainty, balancing risks and making decisions that are likely to stand up under different outcomes. The computational problem of finding the best decision is large-scale and very complex in real applications. Such problems arise in transportation, the design of distribution networks, or the allocation of capital among competing investments.

What is Operations Research?

The field of operations research traces its foundations to World War II, although it includes dimensions that go as far back as the early days of the telephone at the beginning of the century. It embraces a set of mathematical disciplines (statistics, probability and stochastic processes, and optimization) which have been applied to a broad range of problems in business and management, finance, logistics and transportation. The most common theme that runs through these problems is the efficient management of resources, where resources may be natural resources, equipment, people, and/or physical facilities.

Students in operations research may follow a management track into business or consulting, or a more technical path into fundamental research or software development. There is a burgeoning marketplace for sophisticated software packages that schedule airlines and railroads or that optimize supply chains for large manufacturing enterprises. These activities build on a growing base of "enterprise resource planning (ERP)" software packages.

What is Financial Engineering?

Financial engineering is a field that draws on the same disciplines as operations research, but with an emphasis on financial resources. Financial engineers design innovative financial instruments and strategies to meet the specific needs of individuals and corporations. To this end, financial engineers analyze and ultimately manage risks within an integrated framework, as compared with traditional piecemeal approaches. Often, new instruments are constructed based on the specific requirements of the investor. The analytical methods consist of the following: applied mathematics including stochastic calculus, probability and statistics, stochastic processes, optimization, financial economics, and computation skills. Financial engineers are in great demand. They find jobs on Wall Street, with traditional financial companies, such as banks, insurance companies, mutual funds, and financial consulting companies, as well as in the CFO's office within mainline corporations.

Academic Program Planning

SEAS Requirements

MAT 103, 104; COS 126; CHM 201 or 203; PHY 103, 104; MAT 201, 202 or 203, 204

In addition to the engineering school requirements, there are three components to the curriculum:

1. The core requirements (six courses). These form the intellectual foundation of the field and cover statistics, probability, stochastic processes, and optimization, along with more advanced courses in mathematical modeling.
2. Departmental electives (eight or nine courses). These are courses that either extend and broaden the core, or expose the student to a significant problem area or application closely related to the core program.
3. Senior independent work. A one-semester project or a full-year thesis involving an application of the techniques in the program applied to a topic that the student chooses in consultation with a faculty advisor.

Core Program (6 Courses)

ORF 245 Fundamentals of Engineering Statistics

A study of fundamentals of statistical methods and their applications in engineering. Basic concepts of probability, discrete and continuous distributions, sampling and quality control, statistical inference, empirical models, and least squares.

ORF 307 Optimization

Model formulation, analysis, and optimization of deterministic systems. Introduction to quantitative methods: linear programming, duality theory, large-scale mathematical programs, and network analysis. Emphasis will be on applications to problem areas such as allocation of resources, transportation systems, scheduling, capital budgeting, and network problems. Two 90-minute lectures. Prerequisite: MAT 202. It is strongly recommended that COS 126 or equivalent be taken prior to or concurrently with this course.

ORF 309 Probability and Stochastic Systems

An introduction to probability and its applications. Random variables, expectation, and independence. Poisson processes, Markov chains, Markov processes, and Brownian motion. Stochastic models of queues, communication systems, random signals, and reliability. Prerequisite: MAT 201, 203, 217, or instructor's permission.

ORF 335 Introduction to Financial Mathematics (also ECO 364)

Financial engineers design and analyze products that improve the efficiency of markets and create mechanisms for reducing risk. This course introduces the basics of financial engineering: the notions of arbitrage and risk-neutral probability measure are developed in the case of discrete models; Black-Scholes theory is introduced in continuous-time models, and interest rate derivatives and the term structure of interest rates are discussed. Prerequisites: ECO 100, MAT 104, ORF 309.

ORF 405 Regression and Applied Time Series

Regression analysis: least squares and robust alternatives, nonparametric techniques (splines, projection pursuit, and neural network). Time-series: trends, seasonal effects, clinical models, state space models. Includes a final project in the form of a realistic forecasting game involving portfolio management and economic time-series data. Prerequisites: 245 and Mathematics 202.

ORF 411 Operations and Information Engineering

The management of complex systems through the control of physical, financial, and informational resources. The course focuses on developing mathematical models for resource allocation, with an emphasis on capturing the role of information in decisions. The course seeks to integrate skills in statistics, stochastics, and optimization using applications drawn from problems in dynamic resource management. Students are organized into teams for a competitive game in resource management that tests modeling skills and teamwork. Prerequisites: ORF 245, ORF 307 and ORF 309, or equivalents.

Typical Course Schedule

FRESHMAN YEAR		SOPHOMORE YEAR	
FALL	SPRING	FALL	SPRING
1. CHM 201/203-General Chemistry 2. MAT 104 Calculus 3. PHY 103 General Physics 4. Writing Requirements 5.	1. COS 126 Gen. Comp. Sci. 2. MAT 201 Multivariate Calc 3. PHY 104 General Physics 2 4. 5.	1. ORF 245 Fund. of Eng. Stats 2. MAT 202 Linear Algebra Appl. 3. 4. 5.	1. ORF 307 Optimization 2. MAT 3XX (or MAE 305) 3. ECO 310 Microecon Theory 4. 5.
JUNIOR YEAR		SENIOR YEAR	
FALL	SPRING	FALL	SPRING
1. ORF 309 Probability/Stat Systems 2. Departmental Electives 3. Departmental Electives 4. 5.	1. ORF 335 Intro Fin. Mathematics. 2. Departmental Electives 3. Departmental Electives 4. 5.	1. ORF 478 Sr. Thesis (or Depart) 2. ORF 411 Oper & Info Eng. 3. ORF405 Regres/App.Time Series 4. 5.	1. ORF 478/479 Sr. Thesis 2. Departmental Electives 3. 4. 5.

Elective Checklist

DEPARTMENTAL ELECTIVES (8 or 9 courses - all graded)					
(If course is not from recommended list, provide explanation and obtain approval from Departmental Representative)					
Course	Check	Area (see below)	Course	Check	Area (see below)
300 Level Math (or MAE 305)					

HUMANITIES AND SOCIAL SCIENCE ELECTIVES (7 or more courses)					
Course	Check	Area (see below)	Course	Check	Area (see below)

The Undergraduate Academic Program

In addition to meeting the usual Engineering School requirements, students will complete courses in the following four groups:

- Departments core requirements (6 courses) – These form the intellectual foundation of our field, and cover statistics, probability, stochastic processes, and optimization, along with more advanced courses in mathematical modeling.
- Departmental electives (8 or 9 courses depending on senior thesis choice) - These are additional courses that either extend and broaden the core, or expose the student to a significant problem area or application closely related to the core program.
- Senior Thesis - ORF 478 - A full year effort that involves a major application of the techniques in the program applied to a topic that a student chooses in consultation with a faculty advisor. Students interested in a full-year senior thesis must be willing to spend the appropriate time during both the fall and the spring semesters. Students who are unable to make adequate progress can switch to ORF 479 and be required to take nine departmental electives. Students will enroll in the spring and will receive credit for two course grades given in the spring.
- Senior Independent Project - ORF 479 (Spring semester only) - A short progress report will be due in January, (Dean's Date) to make sure that the students have chosen a suitable topic and matched up with their advisor. The final outcome will be a report due at the end of the spring semester. The report will fully describe the research project and its results. Typically projects will take approximately 30 to 50 pages. Also, students who take the independent project will need nine departmental electives.
- Humanities and Social Science Electives (7 or more courses). B.S.E. students are required to include one course in at least *four* of the following six areas:
 - Epistemology and Cognition (EC)
 - Ethical Thought and Moral Values (EM)
 - Foreign Language at the 107/108 level or above (FL)
 - Historical Analysis (HA)
 - Literature and the Arts (LA)
 - Social Analysis (SA)

A student with no advanced standing will still have eight courses required to meet the engineering school requirement of 36 courses (more if the student places out of any of the SEAS requirements). Students are free to select these courses from any department, and are expected to design an academic program with his/her advisor that produces a balanced education. No course may count under more than one heading, under any circumstances.

Each student selects and schedules courses in consultation with his/her academic advisor and the Departmental Representative. While generally no exceptions in the core courses are allowed, students may design specialized programs through their choice of departmental electives. Specialized programs must be submitted for approval using the green Program Proposal Form, which must be signed by both the academic advisor and the Departmental Representative.

Department Electives (8 or 9 Courses)

The departmental electives represent courses that further develop a student's skills in mathematical modeling either by a more in-depth investigation of core methodologies, applying these skills in specific areas of application, or learning about closely related technologies. Students must choose eight courses from the following list, with the following constraints:

- There must be at least one 300 level math course (see list below).
- There must be at least two courses from ORFE
- There can be no more than three courses from any one department (excluding ORFE)

Courses which may be used to satisfy the MAT 3xx requirement:

- MAT 301/MAE 305 - Mathematics in Engineering I *or* MAT 303, *not both*
- MAT 302/MAE 306 - Mathematics in Engineering II
- MAT 303 - Ordinary Differential Equations
- MAT 304 - Introduction to partial differential equations
- MAT 306 - Introduction to Graph Theory
- MAT 307 - Combinatorial Mathematics
- MAT 308 - Theory of Games
- MAT 314 - Introduction to Real Analysis
- MAT 350/APC 350 - Methods in Partial Differential Equations
- MAT 390 - Probability Theory
- MAT 391 - Random Process

All Other departmental electives:

- ORF 311 - Optimization Under Uncertainty
- ORF 375 - Junior Independent Work
- ORF 376 - Junior Independent Work
- ORF 401 - Electronic Commerce
- ORF 406 - Statistical Design of Experiments
- ORF 407 - Fundamentals of Queueing
- ORF 409 - Introduction to Monte Carlo Simulation
- ORF 417 - Dynamic Programming
- ORF 418 - Optimal Learning
- ORF 435 - Financial Risk Management
- ORF 467 - Transportation
- ORF 474 - Special Topics in Operations Research and Financial Eng.
- ECO 310 - Microeconomic Theory: A Mathematical Approach
- ECO 317 - The Economics of Uncertainty
- ECO 341 - Public Finance
- ECO 342 - Money and Banking
- ECO 361 - Financial Accounting
- ECO 362 - Financial Investments
- ECO 363 - Corporate Finance and Financial Institutions
- ECO 414 - Introduction to Economic Dynamics

- ECO 418 - Strategy and Information
- ECO 462 - Portfolio Theory and Asset Management
- ECO 464 - Corporate Restructuring
- ECO 466 - Fixed Income: Models and Applications
- ECO 467 - Institutional Finance
- PSY 322 - Human-Machine Interaction
- COS 217 - Introduction to Programming Systems
- COS 226 - Algorithms and Data Structures
- COS 323 - Computing for the Physical and Social Sciences
- COS 340 - Reasoning about Computation
- COS 402 - Artificial Intelligence
- COS 423 - Theory of Algorithms
- COS 425 - Database and Information Management Systems
- ELE 485 - Signal Analysis and Communication Systems
- ELE 486 - Digital Communication and Networks
- MAE 433 - Automatic Control Systems
- CEE 303 - Introduction to Environmental Engineering
- CEE 460 - Risk Assessment and Management
- Students often wish to follow a theme in their selection of courses. Below are a few possible themes:
- Financial Engineering: ORF 435, 311; ECO 362, 363, 462
- Engineering systems: ORF 467; COS 226, 323, ELE 485 and MAE 433.
- Information systems: ORF 401, 467; COS 226; ELE 485, and 486.
- Applied mathematics: MAT 306, 308, 314, 391; COS 341, 423; MAE 306

Taking Courses at Other Schools

Students may take courses at other schools during the summer, during a semester off, or during a year abroad. The rules are slightly different depending on the activity. If you are considering taking a replacement course during the summer or a semester off, you need to obtain a form from West College where you describe the course that is being taken, and what course at Princeton is being replaced. This is particularly important if you want the course to count toward some requirement. Read the form carefully. It requires that you obtain the approval of the *home* department for the course. For example, if you wish to take a replacement course for MAE 305, you have to get the signature of the Departmental Representative from MAE. A replacement for an ORFE course requires the signature of the Departmental Representative of ORFE. It is a good idea to have a syllabus or at least a detailed description of the course before obtaining approval.

If you wish to take a semester or a year abroad, you need to obtain the signature of the Departmental Representative of ORFE, in addition to the approval of the course of study committee.

Departmental GPA, Graduation Requirement, Honors and Prizes

Departmental GPA: Prior to graduation, the department will calculate each student's *Departmental Grade Point Average* (GPA). The Departmental GPA is computed as the average of 10 grades. For students choosing the 2-semester Senior Thesis option (Orf 478) the 10 grades are: twice for Orf 478 plus the best 8 Princeton Graded (some courses may have been taken at other universities and are not eligible) 300-level and above courses from the set of {ORFE Core Courses (Orf 307,309,335, 405, 411, Math 300-level) and approved Departmental Electives (either from the published list or individually approved by the departmental representative)}. For students choosing the 1-semester Senior Independent Research option it is the Orf 479 grade plus the best 9 Princeton Graded 300-level and above courses from the set of {ORFE Core Courses and approved departmental electives}. Note, while two 200-level courses may be included among the Departmental Electives, no 200-level courses are counted in the departmental GPA.

A minimum 2.0 Departmental GPA is required for graduation, and as the major, not the sole, determinant of honors. The overall academic quality of the entire ORFE class and academic performance in individual classes is also taken into account in the faculty's decision in awarding honors.

Graduation Requirement: Core Courses and Departmental Electives **may not be taken on a PDF (Pass, D, Fail) basis**. Equivalent versions may be taken at other Universities but only prior formal written permission. A passing grade must be received in each ORFE Core Course and each Departmental Elective. To graduate, a student must satisfy the University's 36 course requirement, the SEAS requirements for Physics, Chemistry, Math and Computer Science, ORFE's Core and Departmental Elective requirement and achieve a Departmental GPA of 2.0 or greater.

Honors: Highest Honors, High Honors and Honors are awarded by the ORFE faculty to those graduating seniors who have demonstrated the highest levels of academic achievement. Departmental GPA is the major criterion; however, each student's overall academic record and overall quality of the entire class are also considered in the awarding of these honors.

Prizes: The ORFE faculty also awards a few individual prizes for specific superior achievement in a few defined categories.

Junior Independent Work

Students wishing to do Junior Independent Work should contact the Departmental Representative who will help the student identify a faculty mentor and a topic. The requirements for satisfactory completion of the study (such as reports, examinations, etc.) are set by the faculty mentor, not the Department, and the student should be clear about them when the work is begun. If a one-term project is being undertaken, the student registers for ORF 375 for the fall term and ORF 376 for the spring term.

Senior Thesis (ORF 478)

The senior thesis is a year long undertaking except there will be greater emphasis on the work accomplished during the first semester. Students interested in a full-year senior thesis must be willing to spend the appropriate time during both the fall and the spring semesters. Students who are unable to make adequate progress can switch to the Senior Independent Project (below) and be required to take nine departmental electives. Two course grades will be given in the spring.

A report on the background and research to date will be due at the end of the fall semester (roughly 30+ pages). This report should form a significant portion of the full senior thesis. The research results will be presented to faculty and students at the end of the spring semester.

In addition, there will be a selection process to insure that students will be able to conduct a two-semester research project. As with the independent project, there will be match of faculty and students based on the preferences of the students. A 3-5 page prospectus is expected for students who wish to pursue the senior thesis (due in September).

Senior Independent Project (ORF 479, Spring Semester Only)

Students will choose an advisor during the upcoming spring semester, based on the usual arrangement – attending presentations by the ORFE faculty, reading the shopping guide (which describes faculty interests and expertise), and meeting with individual faculty members. Students will select a broad topic, and rank faculty according to their preferences.

A short progress report will be due in January, (Dean's Date) to make sure that the students have chosen a suitable topic and matched up with their advisor. The final outcome will be a report due at the end of the spring semester. The report will fully describe the research project and its results. Typically projects will take approximately 30 to 50 pages. Also, students who take the independent project will need nine departmental electives rather than eight.

Certificates of Interest to ORFE Students

The following certificate programs complement well with ORFE and are thus popular with students:

- Applications of Computing
- Engineering Management Systems
- Environmental Studies
- Finance
- Program in Applied and Computational Mathematics
- Program in Robotics and Intelligent Systems
- The Woodrow Wilson School

Faculty and Their Research Interests

Sebastien Bubeck, Assistant Professor

Multi-armed bandits, online optimization, stochastic optimization, statistical learning theory, combinatorial hypothesis testing.

Rene A. Carmona, Professor

Research interests center on stochastic analysis and its applications to problems in financial mathematics: pricing in incomplete markets, credit and energy derivatives and modeling of the emissions markets. Other topics of interest include stochastic partial differential equations, stochastic control and stochastic games, filtering, and the statistical analysis of financial data.

Patrick Cheridito, Professor

Stochastic modeling, optimal control, finance, insurance, risk management.

Erhan Çinlar, Professor

Stochastic models of random phenomena in engineering, finance, and operations research. Control and optimization of stochastic systems. Theories of queues, inventories, reliability, and replacement. Point processes, Markov processes, stochastic differential equations.

Jianqing Fan, Professor

Research interest focus on statistical analysis and its applications in finance, biological science and health sciences. They include Financial Econometrics, Computational biology, high-dimensional statistical learning, nonparametric modeling, non-linear time series, and other statistical theory and methods.

Alain L. Kornhauser, Professor

Development and application of operations research techniques in the design of decision systems related to transportation, energy transmission systems and navigation-based commerce (nCommerce). Special interest in route optimization in stochastic networks, image processing as related to optimal control of vehicles and human-machine interactions and real-time dynamic pricing and consumption dynamics in the energy grid.

William A. Massey, Professor

Dynamical queueing systems, applied probability, dynamic optimization, stochastic networks. Applications to communication systems and services.

John M. Mulvey, Professor

Expert on optimization under uncertainty, with emphasis on financial planning applications. Develops strategic planning systems for financial organizations, such as American Express, Towers Perrin - Tillinghast, Merrill Lynch and Siemens. Interested in the optimization of large organizations by means of decentralized optimization methods. Current research involves optimizing multi-strategy hedge funds.

Warren B. Powell, Professor

Stochastic optimization and optimal learning, primarily in the contextual domain of energy systems analysis. I am interested in a wide range of problems in energy and environmental systems where we need to learn how to design and control these systems to improve the efficiency of how we use our natural resources in the presence of different forms of uncertainty. Applications include topics such as dynamic pricing of electricity, the impact of electric vehicles on the power grid, managing the use of energy from wind and the sun in the presence of different forms of storage, understanding and exploiting flexibility in demand, endogenous learning in climate change, developing efficient trading strategies for electricity in the presence of heavy-tailed spot prices, and understanding auctions and markets for energy assets. For more information, please see <http://energysystems.princeton.edu>.

Birgit Rudloff, Assistant Professor

Hedging, superreplication, price bounds and risk measurement in markets with transaction costs. Convex and coherent risk measures. Risk minimal hedging in incomplete markets. Utility maximization with risk constraints. Convex Analysis applied to Finance.

Ronnie Sircar, Professor

Financial mathematics; stochastic models, especially for market volatility; optimal investment and hedging strategies; analysis of financial data; credit risk; employee stock options; dynamic game theory; energy markets.

Robert J. Vanderbei, Professor

Algorithms and software for nonlinear optimization. Application of nonlinear optimization to various optical designs related to the NASA Terrestrial Planet Finder space telescope. Minimizing the action-functional to find new stable solutions to the n-body problem. Using the parametric simplex method to generate confidence intervals in quantile regression.

Ramon van Handel, Assistant Professor

Research interests focus on probability theory and stochastic processes, motivated by applications in engineering and science. Specific interests include Markov and hidden Markov processes, ergodic theory, stochastic calculus and stochastic analysis, nonlinear filtering and prediction, information theory, stochastic control, and empirical processes.

Research and Teaching Studios

Students in the department often participate in the research interests of the faculty, and may take advantage of the facilities used for this work. This includes:

- CASTLE Lab works on problems in dynamic resource management, with ongoing projects in chemical distribution, railroads, trucking and the airlift mobility command. Students regularly participate in the analysis of research questions arising in these projects, and have access to both data and specialized tools developed in the studio to help with their work. To learn more about CASTLE Lab, see its web page: <http://www.castlelab.princeton.edu>.
- The Financial Engineering Studio provides students with access to financial data support research into methods for managing risk. Research topics include the development of advanced financial instruments which can be used by insurance companies, major manufacturing companies and investment houses to control risk exposure.
- The Financial Econometrics Studio works on a variety of quantitative problems from finance using statistical techniques and financial economic theory. These include valuation of financial derivatives, optimal portfolio allocation, risk modeling and management, volatility estimation, modeling and analysis of financial data, and simulation of financial system. The studio also studies financial econometrics theory and provides various fundamental insights into the statistical inference problems from financial markets.
- The Statistics Studio is interested in statistical methods in financial econometrics and risk managements, computational biology, biostatistics, high-dimensional statistical learning, data-analytic modeling, longitudinal and functional data analysis, nonlinear time series and justifying statistical methods that are used to solve problems from the frontiers of scientific research. This is expanded into other disciplines where the statistics discipline is useful.
- Princeton Autonomous Vehicle Engineering (PAVE) is a student-led research group. The group consists primarily of undergraduates but is assisted by a diverse group of graduate students and talented faculty advisors. The primary research is focused on producing an autonomous vehicle that will complete the DARPA Urban Challenge within the six hour time limit.

Career Paths

Updates from Recent ORFE Graduates

I'm working as a transportation engineer in the transportation planning department at Parsons Brinckerhoff (Princeton, NJ office). I became interested in this field after taking Prof. Kornhauser's transportation course and doing senior thesis research on the traffic woes of the Route 1 Corridor. Rarely a day goes by that I don't rely on something I learned during my thesis research or ORFE courses, be it traffic condition analysis, general research skills, MS Excel work, or NJ transportation history. A real bonus about being in this field with an ORFE degree is having a solid background in economics. Many of the exciting transportation innovations are market-based solutions and my ORFE studies have uniquely positioned me to work on these innovations with a different approach from my civil engineer and urban planner colleagues.



Meghan Fehlig, '02

I am an Analyst in the Corporate Finance group at The Walt Disney Company in Burbank, California. I play an active role in a number of ongoing transactions focusing mostly on film financing working closely with production finance executives in Walt Disney Pictures and Television and Miramax, as well as Corporate Legal and Tax, to structure financings that reduce the negative cost of a film without restricting the Studio's creative control. These financings are typically one-off tax-advantaged deals, but we are constantly analyzing true risk-sharing slate financings. My duties in Corporate Finance require a great deal of analytical analysis, a skill I developed as a student in ORFE. We use EXCEL based models extensively. I am frequently asked to review bank simulation models that use At Risk software. My strong understanding of the financial and mathematical concepts that underlie even the most complicated of deals allows me to make intelligent and poignant comments. Thanks to my ORFE education.



Daniel Nash, '03

I am working on a doctorate at Harvard in the field of Information Technology & Management (ITM). My program is jointly sponsored by the Harvard Business School and Harvard's Computer Science division, and it aims to produce scholars who will conduct research on questions related to business and technology. I hope to write a dissertation related to E-Commerce. My background in ORFE has proved invaluable to me in the ITM program. I started ahead of other doctoral students in statistics, economics and computer science, and as a result of my undergraduate thesis, I already had a sound understanding of research methodologies. What I learned in Professor Çinlar's Probability Theory course, Professor Carmona's Regression and Applied Time Series course, and Professor Powell's Operations and Information Engineering course whenever I read papers in my field.



Katherine Milkman, '04

I am an Investment Associate at Bridgewater Associates, an institutional hedge fund manager in Westport, CT. We deal with large institutions - pension funds, college endowments, central banks. Most of my work revolves around solving problems that deal with portfolio structuring. I use a lot of the concepts I learned in ORFE in my day-to-day work. I use a lot of the portfolio math I learned in ORF 435 to figure out a portfolio's risk and return characteristics. We also have a tool that calculates a client's optimal portfolio using a Monte Carlo simulation process. I've even used some of the ideas I developed in my senior thesis, which used implied volatility in currency options to estimate the chance of a currency crisis, in my job, since Bridgewater manages currencies and options as part of its investment strategy. In my opinion an ORFE degree is the most flexible major to have at Princeton because it teaches a wide array of skills to apply basically anywhere after college.



Kimberly Mattson, '05

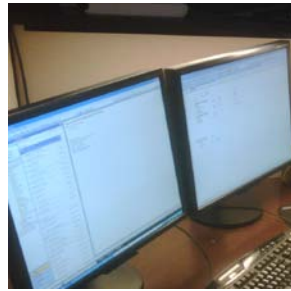
Since graduating in 2006, I have been working on the US Government Bond Trading Desk in Morgan Stanley's Fixed Income Division. My main responsibilities are to make markets for customer trades in the long end of the US Treasury market (i.e. US Government bonds with 10-30 years to maturity) and zero-coupon bonds, as well as to come up with proprietary trades based on either my Macroeconomic views or a relative value views on the Treasury market. Although I am based out of the NY office, my job also led me to an eight-month stint in London where I learned about the European Government Bond market.

In a nutshell, my post-graduate allowed me to draw upon the skills I learned as an ORF major. I first became interested in fixed income after taking Professor Sircar's ORF 335 (Introduction to Financial Mathematics) course, which taught me about various fixed income products and pricing models. My current job requires me to use these types of pricing models on a day-to-day basis, as well as come up with trade ideas based on probability models, statistics and historical regressions. Being an ORF prepared me well for my role as a Bond Trader because it taught me how to think both quantitatively and creatively.



Jacqueline Ng, '06

I am working as an investment banking analyst in Morgan Stanley's Mergers & Acquisitions Group. I am responsible for building financial models in Excel and creating presentations for our senior bankers to present to the Firm's clients. I have been part of some really interesting transactions, including the recent \$46 billion merger of Merck and Schering-Plough, two large pharmaceutical companies. I frequently use a lot of the math skills I learned as an ORFE major and the rigorous foundation has definitely given me a leg up on other young people at the Firm. In particular, a lot of the programming skills I acquired at Princeton have been incredibly useful. I am still unsure about where my career is headed but I am eager to further immerse myself in the financial world.



Zachary Kurz, '08

I am an analyst in the Technology, Media, and Telecommunications (TMT) group in Investment Banking at Goldman Sachs. We advise companies in the TMT space on mergers, acquisitions, IPOs, and other financing transactions. I have worked on some very interesting deals in my first year, including the \$4.4 billion sale of Brazilian telecom operator GVT to Vivendi, the \$336 million sale of a minority interest in Chilean telecom operator VTR to CorpGroup, and Time Warner Cable's \$2 billion unsecured notes offering. Through my work, I have had the chance to travel to across North and South America to work with management teams on a variety of transactions. My ORFE education definitely gave me a great foundation in financial modeling and has been a huge advantage as I work through the finer theoretical aspects of valuation, cost of capital, and the financial impacts of potential transactions.



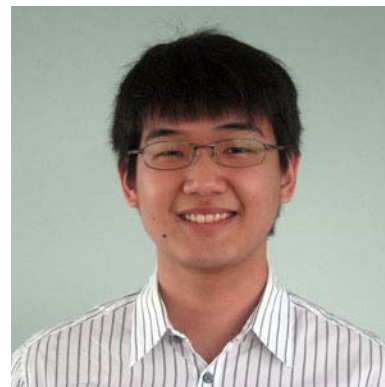
Jonathan Lange, '09

I am a quant analyst in Hedge Fund Credit Risk Management (within the larger Global Credit Risk function) at JPMorgan. My job entails applying many of the techniques I learned as an ORFE in order to first assess the different layers of market risk the bank is exposed to through its hedge fund counterparties and then properly margin (or, in the trader's slang, apply a "haircut" to) client trades based upon these assessments. Over 5000+ clients are covered, with strategies ranging from long/short equity to mortgage arbitrage. This has allowed me to see the daily trading flow (from fairly vanilla to highly exotic) of entities with several billion in assets under management. Given that the goal of the job is to ensure that no key risks posed by the products traded go unnoticed, it is necessary to understand each product almost inside out. As such, a strong background in probability theory, financial math, stochastic calculus, and optimization goes a long way. In this regard, the skill set provided by the ORFE department is wonderful. With the knowledge I gained through ORF 307, 309, 405, 435, and 474, the learning curve is far less steep than it could have turned out to be. I thank the professors I had the pleasure of studying under for this.



Hosham Eltahir, '10

I am an analyst at the New York office of Cornerstone Research, an economic and litigation consulting firm. We provide attorneys with analytical support in all phases of commercial litigation and regulatory proceedings, from identifying relevant issues and developing case strategy to engaging expert witnesses, conducting research, and preparing effective testimony. . In my first year, I have been working on a complex case involving highly specialized credit and interest rates derivatives. The analysis I've done so far include market liquidity analysis, valuation of these derivatives, and netting analysis under a variety of frameworks and assumptions. Graduating from the ORFE department gave me a great foundation in financial modeling and a high comfort level with the quantitative aspect of the work we do, giving me a great advantage as I work through progressively advanced assignments. A lot



Teck Hsien Ho '10

of the programming skills picked up during my time in the ORFE department have also helped greatly.

During the year following graduation, I am working as a Princeton ReachOut56-81 International Fellow with Wellbody Alliance (formerly Global Action Foundation), a global health NGO focusing on sustainable community-based health interventions in the rural diamond-mining district of Sierra Leone. I have been working on projects such as an HIV home-based care program, reproductive health peer education program, palm kernel micro-agriculture farm and oil processing plant, HIV validation studies, amputee health, and more. In addition, I have been able to learn what it takes to run a startup in this field and gain experience about the challenges and complexities of navigating in a developing environment with different cultural and professional norms. While I have not been directly applying many of the skills taught in ORFE core courses on a daily basis, my engineering education is omnipresent in managing my day-to-day operations, shaping a unique approach to problem-solving, and providing the quantitative background necessary to understand and explore evidence-based research on the field. This has been invaluable, as quantitatively rigorous research is limited in the developing world. ORFE teaches students to model real-world situations and make optimal and efficient decisions under uncertainty or with limited information - these tools are necessary in virtually any field, particularly in healthcare/global health. I intend to go to medical school, and have found that my ORFE degree and unusual academic and extracurricular background has been an asset in finding employment and academic opportunities in the interim years. I encourage students to consider using their ORFE education to pursue unconventional careers, as it may open doors to greater responsibility and intellectual creativity, and am happy to connect any students interested in the healthcare or international service world.



Kate Hsieh '10



Class of 2010 Senior Thesis Titles

Wheeling Paratransit through the 21st Century: Expansion of GPS Technology in Flexible Route Transportation

Epidemiology of the H1N1 Pandemic Influenza

From Smart Grid Vision to Reality: Agent-Based Modeling of the Smart Grid

Building a Spot-Price Model for Natural Gas From Supply and Demand Fundamentals

The Impacts of High-Frequency Trading

An Investigation of Factors Affecting Real Estate Price in China

Estimating the Risk and Return of Private Equity Investments

Using Learning Curves to Optimize Government Subsidies for Photovoltaic Technology

The Non-Default Component: The Influence of Liquidity Factors on Corporate Bond Spreads

Updating of Entropy Pooling Approach

View Confidence Levels Objectively via Model Averaging

Simulation and Analysis of an Energy Portfolio Problem Using a Deterministic Linear Program

Real-Time Dynamic Congestion Value Pricing, Express Toll Lane Design and Bus Lane Throughput Improvements for the New York-New Jersey Lincoln Tunnel

The Impact of Emissions Leakage on Greenhouse Gas Regulation

Excessively Conservative Attitudes to Financial Instruments and Low-Risk Hedging: A Contextual Model Proposed for the National Budget of Trinidad and Tobago

Improving the Efficiency of the Major League Baseball Rule IV Draft: An Application of Machine Learning

Navigation based Services: Request, Organization, Delivery and Consumption

Language Processing Techniques for Text Classification with Applications to the Analysis of Financial News Leading to Trading Strategies

Regime Identification in Stock Markets and its Applications in Stochastic Portfolio Optimization

Optimal Dosing Applied to Glycemic Control for Type 2 Diabetes

Greening the Grid: Optimal Tax Policy for Wind and Solar Technology

Characterization and Modeling of Shipping Pick-Up and Delivery Operations

Transportation Shocks: Analyzing Transportation Networks for Increased Traffic Flow During the Olympic Games

Sovereign Wealth Funds: Their Performance in Global Financial Markets and its Implications for Regulatory Controls

Modeling Locational Spreads of Natural Gas Spot Prices: Impact of Pipeline Capacity, Gas Flow, Temperature, & Storage Level

Personal Rapid Transit: Qualitative and Quantitative Tools for Analysis

Gray Market: Building a Secondary Market for Private Company Equity

Towards Optimizing a PRT Network

Stochastic Games: The Analysis of Campaign Funds on the 2008 Presidential Race

Wind and Pumped-Hydro Power Storage: Determining Optimal Commitment Policies with Knowledge Gradient Non-Parametric Estimation

The Valuation of Natural Gas Storage: A Knowledge Gradient Approach with Non-Parametric Estimation

Batteries: Storing Wind

Utility Pricing of Collateralized Debt Obligations

The Promise of Grid Storage: Applications, Regulation, and Revenue-Maximizing Policies for Energy Arbitrage

Over the Counter Markets

Powering America: Optimizing Electricity Generation for the United States Until 2030

Cuba after Castro: Modeling the Transformation from Collectivism to Capitalism

Option-Implied Market Sentiment

Stochastic Analysis of Number Games with Jackpots & Sales Forecasting Models for Lottery Operators

Optimal Levels of Hourly Wind Generation Commitment and Reserve Portfolio Usage

Utility Indifference Pricing Under Prospect Theory

Relative Pricing of Options and Defaultable Bonds under Stochastic Volatility

Returns and Risks of the Chinese stock market -a Discrete State Hidden Markov Model Approach

Network Failure Localization Using Noisy Search Techniques

Game of Numbers: A Statistical Analysis of Rotisserie Fantasy Baseball

Optimal Information Collection and Intervention Strategy for an Infectious Disease Outbreak at Princeton University: A Partially Observable Markov Decision Process

20% Wind Generation and the Energy Markets A Model and Simulation of the Effect of Wind on the Optimal Energy Portfolio

Class of 2010 Post Graduate Plans

Company	Position/Type of Work
Boston Red Sox	Baseball Operations/Player Development
Bates White	Economic Consulting
Cornerstone Research	Economic Consulting
Analytics Operations Engineering	Engineering
AMR Capital	Finance
Bank of America Merrill Lynch	Finance
Bank of America Merrill Lynch Asia Pacific	Finance
Citigroup Private Bank	Finance
Cushman and Wakefield	Finance
Deutsche Bank (2)	Finance
Goldman Sachs (3)	Finance
Goldman Sachs, Sales & Trading Division	Finance
G.X. Clarke & Co.	Finance
J.P. Morgan (6)	Finance
Jefferies & Company	Finance
Morgan Stanley (3)	Finance
Nomura London	Finance
Prudential Financial	Finance
Sophrosyne Capital	Finance
Spark Management L.P.	Finance
Trillium Trading	Finance
Two Sigma Investments	Finance
Wells Fargo (3)	Finance
Reach Out 56-81 Fellowship	Global Health Work in Sierra Leone
Bain and Company	Management Consulting

Dean & Company	Management Consulting
Princeton University	Master in Finance
Stanford University	PhD Fellowship
Microsoft	Programmer
Hot Potato	Technology Startup