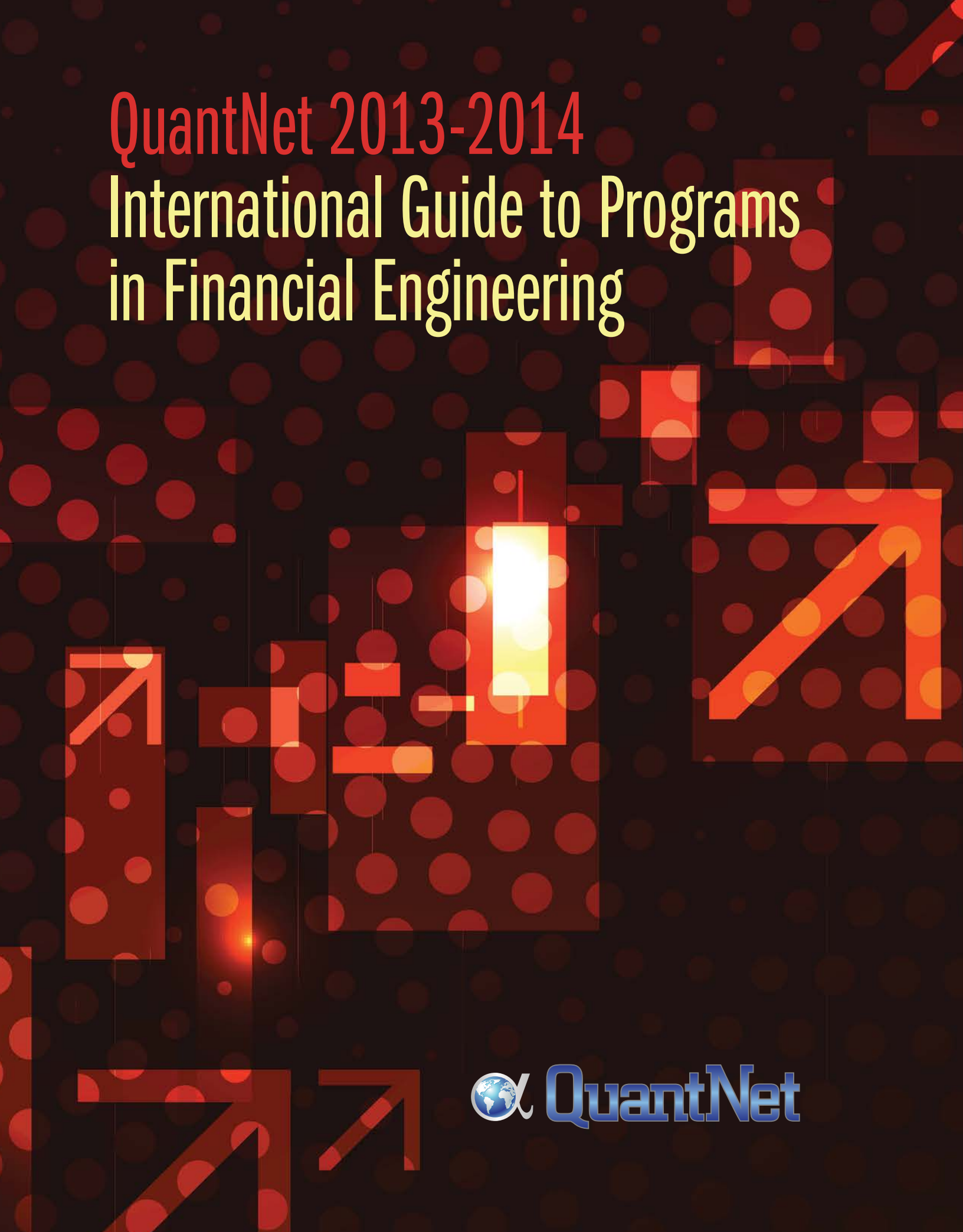
QuantNet 2013-2014
International Guide to Programs in Financial Engineering



QuantNet

Welcome

Welcome to the 2013-14 edition of the *QuantNet International Guide to Programs in Financial Engineering*.

Our inaugural edition has been an extremely useful companion guide to the field of financial engineering for many students. It has been downloaded thousands of times since its debut one year ago.

Quantitative finance is ever-evolving due to unprecedented changes in technology, markets, and political forces. The biggest changes occurring in the last few years have been the diversity of employers who hire graduates from quant programs as well as the emergence of the Big Data movement.

Candidates with strong technical skills will be in high demand for the foreseeable future, but the required skills and domain knowledge are rapidly changing, especially so for the finance industry in the post-Dodd-Frank regulatory reform era.

The aim of this guide is to provide the information you need to prepare for your immediate goal, be it as a stronger applicant to the top graduate programs, a better job applicant, or a more successful professional.

Today, as the top website for quant education and career resources, we have served 2.5 million unique visitors since 2010. Our audience is made up entirely of MFE applicants, quantitative finance professionals, academics, and employers.

We hope that, having reading this guide, you'll learn more about the industry and make better-informed decisions on your education and career choices. Be sure to visit and join us on QuantNet to take advantage of our special tools and a community that helps you connect with employers and network with other professionals in the field.

With best wishes for your career,

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QuantNet

International Guide to Programs in Financial Engineering

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About Financial Engineering

Big Data in Finance

By Andrew Sheppard

Technology has always been a driver in finance. That was true when Nathan Rothschild (the eponymous founder of Rothschild Bank) used carrier pigeons to relay the news of Napoleon's defeat at Waterloo to London in 1815, something that was obviously going to move the London markets, and an innovation that, at the time, shortened the transmission of the outcome of the battle from days to hours. Technology as a driver in finance is also true today, perhaps even more so. And what's really driving finance today, from a technology perspective, is Big Data (and Big Compute and Machine Learning and Data Mining and the Cloud, as these oftentimes go hand-in-hand with Big Data).

Which raises the question: What should a modern day quant know about Big Data?

In many ways, this is related to the changing role of the quant. From my own experience of having been a quant for 20+ years, you have to reinvent yourself every three to five years or die. These days, the best quants I see are not just good at the quantitative stuff (math and the technical side of finance), but are also ace programmers, because the best and most useful type of quants build useful tools that can be used to make more money while better understanding and (we hope) managing risk. Now added to the mix is the role of Data Scientist. For a modern-day quant it's going to be difficult to avoid financial Big Data. Or, turning that statement around, if you are a modern-day quant and you aren't really rather good with Big Data, you are handicapping yourself. (I'd like to say "shooting yourself in the foot," but that may be a bit harsh, but not by much). Adapt and prosper, or die; it's your choice. Has life ever been any different for a quant?

So, what should the modern-day quant know about Big Data? I'll answer that by picking out the "peaks" of the Big Data landscape that are particularly relevant from a quant finance point of view.

However, before I do that, I would like to define what Big Data is and describe some characteristics of Big Data, which I hope will leave us in the position of knowing what we're talking about. Or, at the very least, for me to know what I am talking about!

I'm going to give not one, but two, definitions of Big Data in finance. The first is from an end-user perspective and leverages Microsoft Excel's role as the de facto, front-end-of-choice for trading desks, risk departments, and pretty much every layer of the financial organization from front-to-back office. If end users

"If end users have data that doesn't fit in Excel, or requires hours for Excel to process, you typically have a Big Data problem."

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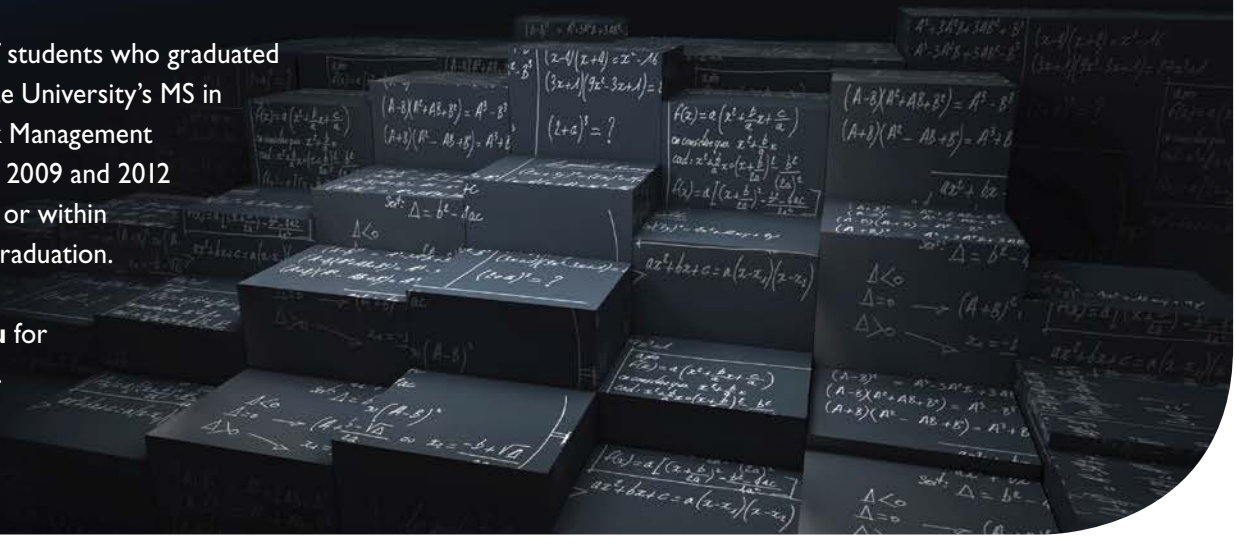

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have data that doesn't fit in Excel, or requires hours for Excel to process, you typically have a Big Data problem.

"There is also a characteristic of financial data that sets it apart from data in many other industries, and this is its relatively short 'half-life'."

The other perspective on Big Data is from an IT department's point of view, and it basically says that if you are looking at a data set and the first thing that comes to mind is "gosh, this belongs in Hadoop," then you have a Big Data problem. Note that in the second definition, it is only necessary to initially think the data belongs in Hadoop, not that it really does actually belong in Hadoop (and much financial doesn't, but more on that later); it's the sentiment that is at the core of the second definition. These are simple and practical working definitions for Big Data, and strangely enough, in more than a few years of working in financial Big Data, I've yet to hear someone disagree with them as useful working definitions.

Now that we know—or at least can broadly agree—on what Big Data is, it's time to explore the nature, or character, of data. Data, generally speaking, is characterized along four axes: volume, velocity, variety, and veracity—also known as the four V's for obvious reasons. Volume is the quantity of data. Velocity is the rate at which data is arriving. Variety is how structured or unstructured the data is (which, in short, is data complexity). And Veracity is the quality and reliability of the data. (Guess what, data that is clean and easily and unambiguously interpreted is better!) Data that is considered "Big" along any of these axes is, by definition, Big Data. This is our third, and perhaps, most generic definition of Big Data.

There is also a characteristic of financial data that sets it apart from data in many other industries, and this is its relatively short "half-life." The half-life of data is the time it takes for the economic value of the data to halve in value. To illustrate with a somewhat fatuous example, I'm going to give you the choice of two prices: 1) IBM's stock price for yesterday or 2) IBM's stock price for tomorrow. Any takers for yesterday's stock price? No, I thought not. And a show of hands for tomorrow's price? Yes, that's more like it! Clearly, stock prices, generally speaking, have a rather short half-life. What this means from a practical point of view is that for much financial data, if you can't use it within a small multiple of its half-life, you may as well throw it away. Its value can decay that quickly. There may be other reasons for storing the data, such as regulatory mandates, but you should always be mindful of the economic value of the data you are dealing with and deal with it accordingly.

What's driving Big Data? Financial markets across all times and all places are governed by two simple impulses: greed and fear. Or, opportunity and risk, to be more polite. The opportunity to make a dollar, and the chance to not

"Financial markets across all times and all places are governed by two simple impulses: greed and fear. Or, opportunity and risk, to be more polite."

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"In the case where you need to become expert in something very quickly, in the words of a former head trader I worked for: 'You have a week!'"

lose a dollar. Companies in finance see great value in Big Data, otherwise they would stop using the stuff in a heartbeat. They also see the chance to better manage their risks using more data. And, as mentioned before, the regulators are hard at work with new and far-reaching mandates that generate, and require the storage of, vast amounts of new data. What also drives data growth is technical capability, such as the price of disk storage; because if we could not store and process Big Data economically, again, we'd stop doing it.

Also, I'll give a piece of advice to budding and existing quants. And it is this: build a portfolio of tools that people love to use. Not only will this endear you—beyond measure—to your existing employer and users, it will also prove to be an invaluable resource when it comes to finding your next employer and next group of users. If you are a budding quant without an employer, then build some demo tools or contribute to open-source projects in the finance space. There is a world of difference, a gulf that is tremendously wide, between just talking about something versus saying, "hey, look, if I can just flip open my laptop for a moment I can show you a real-time simulator I built for bank-wide CVA calculations that uses GPUs for compute acceleration" (or some other tool or technique that knocks their socks off). It's good advice, because I have successfully used it many times myself.

Now, back to the "peaks" of the Big Data landscape.

The perspective I want to give is a combination of techniques and tools that a practicing quant should ideally have at their fingertips. You don't have to be an expert in each, but you should know enough to know what techniques and tools to use in a given situation and to become expert when the need arises. In the case where you need to become expert in something very quickly, in the words of a former head trader I worked for: "You have a week!" On the trading desk I don't think it has ever been otherwise.

In terms of techniques, there are a number of areas of importance. Data gathering, cleaning (also called "scrubbing"), normalizing (putting everything on the same apples-to-apples basis), storing and management; all of which I will group together under "Data Programming". And "Data Insights" are ways of understanding the nature and character of the data you are dealing with; you need to understand your data before you can intelligently attack it with analysis. This "insights" step is often overlooked. "Fools rush in" is the expression that comes to mind when people do this. "Data Analysis" is extracting meaningful and actionable information from the data. This is the way I think when tackling Big Data problems; if you don't find it useful, feel free to create your own. But one way or another, design and build a Big Data tool chain that works for you, because an ad hoc set of tools that you throw together for each project will leave you in a world of pain.

Data Programming

In many ways, this is the plumbing that supports everything else you want to do with data. Like real-world plumbing, you want this to be tight, clean, and have the right capacity. No one wants to be dealing with an ugly mess on the floor, or have to metaphorically put their hand in

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the toilet bowl to unblock things! This is something you just have to get right, otherwise you won't get to the insights and analysis for your data. Also, something that is very often overlooked is that few (if any) data sets are static; data is a dynamic and living thing, so an automated mechanism for updating your data set is a must, and this mechanism must also be robust and scale as your data set gets bigger.

In terms of gathering, cleaning, and normalizing your data, scripting languages are very useful. Languages such as Python have a rich set of libraries that make data manipulation, if not simple, then at least easier. And don't be afraid to use older but still very useful and powerful tools such as Awk. You can use traditional languages such as C++, but that will be really productive only after you have built a data toolbox or developed a DSL (Domain Specific Language) for the purpose, in which case you have effectively created your own scripting language anyway.

So why not just use something like Python and save yourself the effort?

Also, since I've now mentioned DSLs, I would like to say a few more things about them. DSLs for Big Data are incredibly powerful. They are a way of getting things done very quickly and succinctly and at a level of abstraction that end users can understand; this way you can provide Big Data tools for end users to use. This is true not just for the data programming part of the data tool chain, but anywhere in the chain of tools you use for data insights and analysis. Start building DSLs for Big Data and make your life, and the lives of your users, easier. People will love you for it!

". . . there are plenty of good databases and tools. You should build your own only if doing so is a real competitive advantage (emphasis on 'real' here)."

For data storage and management, there are plenty of good databases and tools. You should build your own only if doing so is a real competitive advantage (emphasis on "real" here). There are plenty of in-memory databases and NoSQL databases and relational databases (yes, some Big Data really does belong under the relational model!) that you should find one where your data fits well. Just make sure that your choice here makes downstream activities—insights and analysis—simple and not hard.

In the area of data storage and management, one tool that I must mention specifically is Hadoop, which I will introduce through a story.

Some years ago I was working on Big Data on Wall Street and I would often ask "Have you looked at Hadoop?" to which the response was nearly always "What's Hadoop?" Fast-forward from that point by six months, and I would ask people "Are you working on Big Data?"—often to the same people as before—and the answer would be "Yes, we have a Hadoop project!" In six months people had gone from not knowing what Hadoop is to Hadoop being synonymous with Big Data! Gosh, things move fast in finance.

Hadoop is not just a tool for storing and managing Big Data, it is in reality an ecosystem of tools that includes such things as machine learning (Mahout). Hadoop is simply a must-have skill for a quant these days; start learning it today.

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Data Insights

Know your data.

That seems a sensible idea, but it's amazing how many people jump into analysis without even the most basic knowledge of what they are dealing with. Before doing analysis on your data, and certainly before you start making important decisions with your data, you should have an intimate knowledge of all aspects and characteristics of your data. Think of it like this: if you were going to attack an enemy on a hilltop over open ground, wouldn't you want to do some reconnaissance first? Data reconnaissance, if we can call it that, will give you a good picture of the battlefield before you advance.

Tools I find useful here are, again, the scripting languages and tools used for data programming. In addition, data visualization is a very powerful technique for having a sense of what your data is about. Whereas a large data set presented as a table of numbers is largely incomprehensible to a human, the same data creatively displayed as a graphic—ideally one that is interactive and which allows the user to zoom in and out, flip, and rotate—can convey meaning at all scales, large and small. Tools that are useful for this type of exploratory work include MATLAB, Mathematica, and R, the latter being free and open-source. These same tools are very good at extracting statistical and other summary measures from your data. You should also keep an eye out for new and useful tools that may make you more productive; this is general advice for the whole data tool chain. The data language Julia is one such tool that comes to mind and is worth keeping an eye on.

"You should also keep an eye out for new and useful tools that may make you more productive; this is general advice for the whole data tool chain."

I'll close the discussion on data insights with a word of caution. Data sets are so large these days that there is a danger of seeing patterns in the data that simply aren't there. The term for this is apophenia. If you have ever looked at a cloud and seen a ship, a car, or a face that looks like your grandmother, you have experienced apophenia. The cloud has so many countless water particles that almost any pattern can be fitted to them just by altering your point of view. Make sure this doesn't happen with you and your financial data. Apophenia in financial data is particularly prevalent when looking for profitable strategies from the data.

" . . . if you build tools that give easy access to Big Data to your end users (eliminating you as the bottleneck at each stage of the data tool chain), people will love you for it."

Data Analysis

This, frankly, is the purpose of Big Data. Data programming and data insights were just a way to get you here in an orderly fashion. Now it's time to extract

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value from the data. The data tool chain all the way up to this point has been expense, now it's time for profit!

When you chose how to store and manage your Big Data (the data programming step), you will have chosen a tool that makes the analysis easier. Here's where the ecosystem of tools around something such as Hadoop pays big dividends. Not only does Hadoop provide good out-of-the-box tools for analysis, it also provides tools to build your own analysis tools.

Hadoop is particularly strong in this area, but other NoSQL and relational tools are coming along very nicely too and definitely worth looking at.

It's also the case that Excel and R have become rather good front-ends to Big Data; Excel in particular is a comfortable and easy-to-use front-end for end users. And I will repeat a common theme throughout this article: if you build tools that give easy access to Big Data to your end users (eliminating you as the bottleneck at each stage of the data tool chain), people will love you for it.

Lastly, and this is again something all too often overlooked, analysis is also a source of Big Data. Data feeds on data, and more Big Data is often the byproduct of Big Data. Indeed, sometimes your analysis may generate data sets that are larger than your original Big Data. Just make sure that extra size is reflected in the added value they bring.

So, where are we today? Big Data is now a reality in finance and pervades every nook and cranny of financial institutions. IBM has determined that 90% of the world's data was created in the past two years alone, and there seems no end in sight to data growth. From this quant's perspective, you had better get your Big Data skills up to snuff—and quickly.

To echo again the words of my former head trader boss, "You have a week!", so you'd better get started soon.

Andrew Sheppard started his career in finance as a quant at Bankers Trust working in London, then Tokyo, and finally in New York. Andrew has since worked as a consultant, chief quant, and CTO at various European and U.S. banks and a multi-billion dollar hedge fund. Since 2010 he has worked as a consultant exclusively in the areas of Big Data and Big Compute in finance and insurance.

What Do Financial Engineers Do?

By Aaron Brown

Engineering is not merely knowing and being knowledgeable, like a walking encyclopedia; engineering is not merely analysis; engineering is not merely the possession of the capacity to get elegant solutions to nonexistent engineering problems; engineering is practicing the art of the organized forcing of technological change. Engineers operate at the interface between science and society.

—Gordon Brown

The function of finance is to connect providers of capital with users of capital. This can be a simple process. For example, a venture capitalist might find wealthy individuals to fund start-up companies. This venture capitalist might make use of tools such as a spreadsheet and quantitative theory such as discounted cash flow valuation, but has little need for a specialized financial engineer.

Most finance is done in more complicated ways, using intermediate institutions such as banks, exchanges, and special purpose entities. Many people with technical skills are needed to keep this system running. I do not consider them financial engineers, however. They work in finance and have quantitative skills, but they are doing niche jobs for which the field of application doesn't matter much. Designing databases or solving equations for a bank is not essentially different from doing the same tasks for, say, a parcel delivery service or an aircraft manufacturer.

I define a financial engineer as someone using technical skills in the finance industry *whose work is informed by the end-to-end, capital provider to capital user, effects of what he does*. It is not necessarily a better or more honorable profession than the specialists who make up most of the financial technical workforce. It does require different attitudes and skills, and it presents different challenges and offers different rewards.

There are three characteristics any engineer must have. First, she must accept reality. She does not spend effort worrying about how things might have been different, or complaining to the universe or agitating for other people to change their ways. She is not concerned with opinions, untestable propositions, or abstractions that do not affect decisions. Second, she must have a vision for how things could be better. It need not be an individual vision, many engineers function best on group projects, but random tinkering is not engineering. Third, she must have the drive and skills to accomplish her vision through her own efforts. She can fail at the third step and be a failed engineer. But if she fails at either of the first two steps, she's something other than an engineer. The engineer's prayer is, "Thank you ____ (fill in whatever you feel gratitude toward for existence) for the universe and for my eyes, my hands, my brain. I'll take it from here."

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This definition generates two questions. Do you need a financial engineering degree in order to be a financial engineer? The answer is "no"; some of the greatest engineers in history were self-educated. However, a good financial engineering program is the most efficient way to pick up the necessary knowledge. You would have to work for many years, in many areas of finance, to become familiar with the financial system end-to-end through direct experience. You can learn most of the technical skills from books and the Internet, but not the practical details that are essential to sound engineering. Thirty years ago, a quant with a good general education, a curious mind, and a diverse set of industry contacts could teach himself. Today it would be extremely difficult.

The second question is whether there is any reason to enter a financial engineering program if you do not want to be a financial engineer. This one is tricky. The reason employers hire people from financial engineering programs is they need employees with a breadth of technical financial knowledge. Only a few employers want engineers of any stripe; engineers can be disruptive. Employers are more likely to be looking for technical specialists who can move to different areas as needed, and who might avoid some tunnel vision mistakes of a quant without general financial training. So you might be tempted to get a financial engineering degree in order to have a better chance of getting a job as a technical specialist. That can work, but I think it's rarely a good idea. The trouble is people like that usually have short careers in finance. When you amortize the cost of the program along with the lost employment time while in the program, you might well end up making more money in a lower-salaried, less volatile career. More important, that lower-salaried career can progress naturally. You won't face a mid-career transition after being laid off from a high-paying job, having to start over in some other field. Another point is there are probably cheaper and easier things you can do to improve your chances of landing a technical specialist job in finance than get an MFE.

"What's it like to be a financial engineer? I have to start with caveat. The world is changing fast, and the financial world is changing faster. It's easier to predict functions than institutional roles."

What is it like to be a financial engineer? I have to start with a caveat. The world is changing fast, and the financial world is changing faster. It's easier to predict functions than institutional roles. For example, I'm pretty confident financial engineers will be describing the possible evolution of derivative prices for many years, and probably using some kind of generalized Monte Carlo to do it. But I have much less confidence that they will be doing it on anything like a modern dealer trading desk. Over my career, I have seen species of financial businesses spring up, evolve, and die out.

Nevertheless, to prevent this from getting too abstract, I'm going to use current institutional terms. Just remember to focus on the functions of the job, not how it is embedded in a financial business.

Let's begin with front office jobs, jobs in groups that generate direct revenue. These are the most exciting jobs with the best pay, also the most volatile and the ones where luck plays

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Since its beginning in 2003, QuantNet has grown from a small discussion board for MFE students to a global comprehensive resource dedicated to financial engineering. Whether you are thinking of a graduate degree or certificate, looking to upgrade your programming skills, or comparing your salary data, we have the right tools for you.

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the greatest role in career success. They reward aggressive, confident financial engineers, and may require subordinating personal lives. On the other hand, they allow the most professional freedom. Front-office financial engineers can choose to work in a wide variety of circumstances from one-person start-ups to the largest companies. A disadvantage is front-office skills are not transferrable to other professions. If your professional rewards and satisfaction are the biggest things in your life, and if you are sure finance is for you, the front office may be the best place to work.

The two forms of revenue in finance are trading profits and many flavors of fees. Financial engineers are needed to design and support trading strategies, create and manage structured products, develop software to be used in pricing or hedging, and other tasks that combine aspects of all three functions. The reason you should have a financial engineer for these tasks is all the revenue is extracted from a highly complex and fast-changing financial system. It's not enough to write good code or solve equations properly; front-office quants need to build systems that can thrive in a chaotic and competitive environment.

Next come back-office jobs. There are a lot more of them than front office jobs, and they afford better work-life balance. Success will depend on ability more than on luck and politics. Careers will be more predictable and if you do decide to leave finance, your acquired back-office skills will have some value. Your achievements are likely to have longer useful lives. Pay and excitement are lower than in the front office. Financial engineers can play important roles in back-office areas such as financial control, especially risk control, and systems development.

Back office is sometimes referred to as the "plumbing" of the financial system. Like plumbing, everyone ignores it when it works, but when it doesn't work, life can be very unpleasant. Also like plumbing, it's a lot more complicated than most people imagine.

Finally there is the middle office. A century ago, there were literal physical front and back offices in brokerage firms, the front office for clients and the back office for clerks. There never was a real middle office. The term was invented in the 1980s to describe risk management, because risk managers used front-office skills, and sometimes got injected into front-office decisions, but did not generate revenue directly. There's no generally agreed definition of the term; some people include departments such as treasury, information technology, legal, and compliance. Financial engineers are most often found in risk management and, if you include them in middle office, front-office IT and risk IT.

"It's not enough to write good code or solve equations properly; front-office quants need to build systems that can thrive in a chaotic and competitive environment."

In some respects—pay, glamour, and career volatility—middle office is (as you might expect) midway between front office and back office. In another respect, however, it differs from both front and back office. Middle office requires financial engineers. However specialized a financial task or institution, it can be affected by the end-to-end

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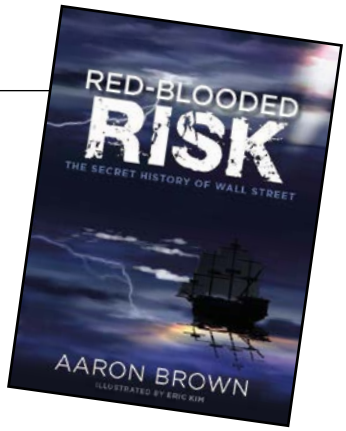
chain of capital in which it is embedded.

The great British engineer Henry Royce defined the simple ethos of the profession: "Strive for perfection in everything you do. Take the best that exists and make it better. When it does not exist, design it." This is a proud and noble undertaking, for those with the talent and energy to attempt it. And today, finance is one of the most exciting and useful places to practice engineering. You take it from here.



Aaron Brown is risk manager at AQR Capital Management and the current Global Association of Risk Professionals Risk Manager of the Year. He is the author of *Red-Blooded Risk* (Wiley, 2012), *The Poker Face of Wall Street* (Wiley, 2006, selected one of the 10 best books of 2006 by *Business Week*) and *A World of Chance* (with Reuven and Gabrielle Brenner, Cambridge University Press, 2008). In his 31-year Wall Street career he has been a trader, portfolio manager, head of mortgage securities, and risk manager for institutions including Citigroup and Morgan Stanley. He also served a stint as a finance professor and was one of the top professional poker players in the world during the 1970s and 80s. He holds degrees in Applied Mathematics from Harvard and Finance and Statistics from the University of Chicago.

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So You Want to Be a Financial Engineer?

By Todd Fahey

Preparing for a Career in the Field

When preparing for a career in Financial Engineering, it's helpful to know what you need to know in order to be considered a good candidate for a job, as well as how to be successful in that role once you are hired.

First, you should know that the general utilization of an MFE degree tends to be oriented toward quantitative roles on the desk (i.e., working on the trading desk and delivering the models, risk calculators, etc., directly to the traders who utilize their products), or in risk management, model validation, library control, CVA, or quantitative development and programming.

I've been a recruiter for more than 14 years, and have worked exclusively in quantitative finance for the last 12 years. My coverage spans global investment banks, hedge funds, proprietary trading companies, and asset management firms, focusing on the front-office quant and trading and technology professionals. The vast majority of roles that I cover are automated/systematic/algorithmic quants and traders through quantitative software and systems/platform developers and quantitative analytics and modeling on the desk. I will discuss in more detail how to prepare yourself for these roles, and help you focus on the subjects you need your degree program to teach you.

While the job market is very soft for new MFEs hitting the market to be desk quants, as well as those in exotics and structured finance, there is a significant need within the CVA, risk, and quant developer/programming fields right now. I anticipate this need will only grow stronger over time as there is significant emphasis on risk and credit at the moment—and the foreseeable future—specifically as it relates to the current regulatory environments both here and abroad.

The other area that is bright at the moment is within the world of automated, algorithmic, systematic, and quantitative trading. These roles are highly competitive for entry-level professionals. Further, they all require programming skills in core languages, along with a solid knowledge of statistical, neural network and/or artificial intelligence methods. If this is a route you are looking to pursue, you need to know that you will be facing some ridiculously stiff competition, and you may be best served by being open to relocation outside of the U.S.—Asia in particular. Also, work hard on getting solid skills and experience with C++, Python, Java, and/or Scala, as these tend to be the most utilized programming languages in the field.

My personal recommendation if you're looking for a job now, in terms of target companies would be, in order: hedge funds, asset management firms, proprietary trading companies and, finally, finally, banks. The reasoning behind this is that banks are in regulatory hell right now; proprietary trading companies could very well have some

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". . . there is still a lot of money waiting for deployment across the global spectrum right now. Asset management firms and hedge funds appear to be the beneficiaries of what we anticipate over the next 5-10 year stretch."

issues with the pending regulations in the U.S. and the UK, and there is still a lot of money waiting for deployment across the global spectrum right now. Asset management firms and hedge funds appear to be the beneficiaries of what we anticipate over the next 5-10 year stretch.

But how do you prepare for these jobs? First, it's helpful to know what to prepare for in terms of education, based upon your interests. For example, if you desire to pursue a path in high frequency futures trading, you should be aware that the vast majority of these people do not have PhDs, and some employers in this field actually believe them to be detrimental. A strong background in electrical and/or computer engineering (with a master's degree, preferably), very strong programming skills (C++, Java, C#, Scala, Python, etc.) and comfort with very large data sets is key.

If you are more interested in the mathematical side, a PhD is the preference, although not a necessity (MFEs typically work in this arena, as well). Typical coursework for these careers is Operations Research, Applied Mathematics, Mathematics, Theoretical Physics (not experimental—not a desirable math track), Electrical Engineering, Computer Science or Engineering, and Mechanical Engineering. If you decide that this is the path to pursue, understand that strong programming is a requirement and will be done every day. It is no longer optional. And, if you can only program in MATLAB, SAS, S+ or another RAD or statistical package, you will be at a disadvantage compared with those who can program in advanced languages mentioned above.

What do you need to know to make yourself competitive in the market wherever you choose to work in the world? Let's face it—this is probably the most competitive field of employment outside of professional sports. As such, talent alone might not get you in the door. There are things that you should do in order to make yourself stand out from the crowd. Including some things that may make you uncomfortable and push you in directions you may not have considered prior to pursuing this career path. I will highlight the things I believe that will best start you on the path to success:

Personality and Communication Skills

Believe it or not, you are not quite as unique as you might think you are. Everybody in this field is "smart". The ones who get jobs—and then progress upward through the

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"There are things that you should do in order to make yourself stand out from the crowd. Including some things that may make you uncomfortable and push you in directions you may not have considered . . ."

ranks—have one commonality: people (at least someone) like them. You need to be articulate and outgoing. Inquisitive, yet thoughtful.

One way to help your personality show through would be to join Toastmasters or a similar organization. While you may not ever be in sales or a refined public speaker, it will only serve to help differentiate yourself from being like everyone else.

Probably the most overlooked need beyond the technical skills required in this field is the need for communication, specifically, communication in the English language. English is the universal language of finance—the same as if you were an international airline pilot.

If you are not a native speaker, it would be extremely helpful to take communications courses to help with your grammar, presentation, and writing abilities. Even if this is not part of your curriculum, outside tutoring would not hurt you. After all, you may be the smartest mathematician in the world, but if you can't articulate it so that people understand you, or if your writing skills are so atrocious (author included here . . .) that it is impossible to follow in a linear fashion, you're severely disadvantaged.

Programming

If you're not good at it, get good at it. In almost every role in quantitative finance you will be required to program. The better you are, the easier it will be for you to land a job in the field. Languages to concentrate on are: C++, Perl, Python, Java,

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2013 Rotman International Trading Competition Result

THE 2013 COMPETITION WAS ATTENDED BY MANY TOP MFE PROGRAMS FROM OVER 40 UNIVERSITIES WORLDWIDE.

THE TOP 5 TEAMS THIS YEAR ARE

1. Laval University (Quebec)
2. Chulalongkorn University (Thailand)
3. Baruch College (Financial Engineering)
3. University of Toronto
5. BI Norwegian Business School

RESULTS FROM OTHER MFE/MATH FINANCIAL PROGRAMS

12. University of Chicago (Math Finance)
20. MIT
29. Boston University (Math Finance)
32. Rutgers University (Math Finance)
35. NYU (Math Finance)
37. Boston University (Math Finance)
38. UC Berkeley (Financial Engineering)
41. University of Chicago (Math Finance)

C# / .NET, Scala, Hadoop, MATLAB (not a substitute for C++!) and other functional programming languages.

Economics and Finance

In the world of quantitative trading, economics and finance classes are not important—other than for being a well-rounded professional at a macro level.

Math

There are a lot of different areas within math, but there is one thing for certain: if you're going to be a derivatives quant, you had best be good at stochastic calculus. Other areas of note are linear algebra, spatial geometry, and familiarity with partial differential equations and ordinary differential equations.

"The best way to find a job is to have one in hand as you get ready to graduate because you've interned at the company and they feel they need to have you on their team because you impressed them so greatly as an intern. Most importantly, you begin to network with other professionals in the field."

Within the world of quantitative strategists, there is a chasm.

Most banks and hedge funds look for those who have a rigorous math background. However, there are a number of hedge funds and asset managers who look to avoid those backgrounds. They want classically trained economists with PhDs from the major Ivy League schools. If you don't have a PhD from one of those schools and a top undergrad from the same level institution—don't waste your time. This field is fiercely competitive and you need to up your game to even have an opportunity to interview.

Internships

The ability to secure an internship should be a priority from the moment you walk in the door as a freshman in college. You get to learn about what these people do on a daily basis, and you may have an opportunity for a rotation.

You get to be on the Human Resource department's radar—a big thing once you are ready to enter the job market.

The best way to find a job is to have one in hand as you get ready to graduate because you've interned at the company and they feel they need to have you on their team because you impressed them so greatly as an intern. Most importantly, you begin to network with other professionals in the field. People move often and it is 99.99% likely that you will leave your first job within five years. The saying "It's not what you know, it's who you know," carries a lot of weight in the hiring world. Get to know as many people as you can and actively engage with your network often.

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"There are many different quantitative networking groups, conferences, and symposiums in every financial center to keep you engaged in the latest trends and ideas, and also—and I cannot stress the importance of this enough—the ability to network not only with your peers, but the level of successful professional that you all strive to be."

Continuing Education

If there were ever a time to recommend staying the distance if you have your sights on a PhD, now is the time. Entering the market later with a PhD may put you at the top of the candidate list, as well as position you to job search in a better market.

Not interested in a PhD? Not a problem. There are many different quantitative networking groups, conferences, and symposiums in every financial center to keep you engaged in the latest trends and ideas, and also—and I cannot stress the importance of this enough—the ability to network not only with your peers, but the level of successful professional that you all strive to be.

One other thing that you need to do is read. Voraciously. I'm not speaking about books, articles, and literature dedicated to your field of endeavor. I'm speaking of information flow that is real-time and/or relevant to recent events. If you don't know what is going on around you, it is hard to have an opinion about what is going on around you. Read *The Wall Street Journal*, *Financial Times*, and other newspapers. Subscribe to e-zines such as *Fierce Finance* or *FINAlternatives*. Join specific web communities such as QuantNet, Wilmott, or Nuclear Phynance. Read books by Michael Lewis or other topical books relevant to finance (I'm personally a huge fan of Roger Lowenstein's *When Genius Failed: The Rise and Fall of Long-Term Capital Management*.

Become a well-rounded quant and you will start to move away from the pack.

The purpose of this article is to give you a general overview of the market, the trends, and what skills I believe you should have based upon what positive and negative stresses I see in the market now and in the next few years.

Ultimately, I hope that you remember the ultimate lesson here: each of your own situations and experiences is unique to you. Clarity of your path is the most important thing to you. Keep the goal in mind as you make your decisions and, with a bit of luck and good timing, you will arrive at the point you're aiming for.

Todd Fahey is Executive Director, Global Head – Quantitative Strategies Practice, at Sheffield Haworth, Inc. He has trained quantitative and technical recruiters; published articles, blogs, and e-zines; and presented at various business schools. He can be reached at fahey@sheffieldhaworth.com. Todd also has a *Q&A column* on QuantNet where you can ask him questions about the quant job market.

A note from Todd Fahey: I am an executive search consultant, and my value to companies is to find experienced personnel. In order for me to maximize my time and efficiency, I need to look at what is the cost/benefit of my time usage. Simply, the majority of my clients are looking for me to find them the people that they are willing to pay for my services and that they would have difficulty finding on their own. That means that I more than tend to look at people who are currently actively working in the industry, have a minimum of three years of work experience, and carry a numerate degree from a top university globally. Beyond these criteria, it is a stretch to say that I am willing to work with an individual who don't meet the bar. I am always willing to offer advice and suggestions, but that doesn't mean that I can necessarily help any one individual.

Financial Engineering Education as a Gateway for a Quantitative Finance Career

Efficient Ways to Set Up a Successful Career

By Dan Stefanica

A graduate degree in financial engineering is primarily a way to start, or advance, a career in quantitative finance. It is not only useful academically, but practically as well by learning about various career paths and deciding which best suits your interests and background, and by creating opportunities to compete for the right openings at the right time.

Based on a long experience fostering careers of both young and mid-career students and alumni, I will briefly share pointers on how to put a master of financial engineering (MFE) graduate degree in the larger perspective of a successful career in quantitative finance, from deciding whether to pursue an MFE, to shaping your career path once you graduate.

Make sure you learn about possible career paths before deciding to apply for an MFE program. The comprehensive QuantNet Quant Internship and Graduate Recruitment Firms Listing includes an extensive list of career options from buy-side and sell-side employers. The book *The Complete Guide to Capital Markets for Quantitative Professionals* by Alex Kuznetsov and Mark Joshi's *On Becoming a Quant* guide are also good sources of information.

Once the decision to pursue an MFE is made, a three-pronged process begins: deciding where to apply, putting together a competitive application, and preparing for graduate studies.

Approach this from a career goals perspective: find the program that best suits and services your career needs and then *use the time you have before you start the program to strengthen and update your background*. By doing so, you will set yourself up for a successful graduate studies experience, and for better career options upon graduation.

There should be no doubt that programming will be an important part of your future work and studies. Improve your C++ and VBA skills, which will be valuable both in a highly quantitative role and in a business-oriented role.

Brush up on your math skills

- **Calculus**— My book *A Primer for the Mathematics of Financial Engineering* was written with this goal in mind.
- **Linear algebra**—Gil Strang's *Introduction to Linear Algebra* has a strong numerical flavor.
- **Probability**—*A Natural Introduction to Probability Theory* by Ronald Meester is both intuitive and rigorous.

Learn about financial instruments in a quantitative framework

- Salih Neftci's *An Introduction to the Mathematics of Financial Derivatives* is good background reading.

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Principles of Financial Engineering, also by Neftci, gives an excellent practical view of quant finance for trading applications.

I cannot overemphasize the importance of preparing for graduate studies from the moment you decide you want to pursue them. A strong and current knowledge of programming, mathematics, and fundamentals of finance when entering the program is, in my experience, a great attribute of highly successful graduates, which translates into significantly better career opportunities.

Once you accept an admission offer, you have several more months to prepare for your studies. It is then time to contact the program and ask for specific instructions on how to best use that time given your particular set of strengths and background knowledge.

During your studies, remember at all times that you are doing an MFE as a step toward a quantitative career.

Use the program resources—networking with graduating students, talking to industry professionals teaching in the program, and consulting with career advisors—to identify the areas you would like to work in by the end of the first semester of studies. Find out what skills are most valued by employers in those areas, and use this knowledge to decide which courses you choose subsequently, as well as what you need to emphasize in your studies.

Put your job search in a longer-term perspective. The goal should not be just to get a job upon graduation, but to find the right position that will allow your career to grow over time. This could mean a first job where you will further learn and grow your set of skills, or taking a position that could be used as an apprenticeship toward, why not, starting your own firm when the time is right several years down the road.

And it may all start the moment you begin preparing for your MFE graduate studies. You have more time between when you decide to pursue an MFE and when you start the degree, than between the beginning of your studies and when you start interviewing for internships. That time is precious and, if used efficiently, could make a big difference.

Good luck!

Dan Stefanica has been the Director of the Masters Program in Financial Engineering at Baruch College, City University of New York, since its inception in 2002. He teaches graduate courses on numerical methods for financial engineering, as well as pre-program courses on advanced calculus and numerical linear algebra with financial applications. He is also the author of *A Primer for the Mathematics of Financial Engineering,* QuantNet's #1 best-selling book three years in a row: 2010, 2011, and 2012.

READING LIST: Books about Financial Engineering

On Becoming a Quant

AUTHOR: Mark Joshi
PAGES: 20
FORMAT: Online PDF file
WHY YOU SHOULD READ IT: Mark Joshi's short guide advises students who want to become a quant. He covers the types of quant jobs and expected salaries, the areas of derivatives quants work in, the types of employers who hire quants, what a quant needs to learn, the current job market, and how to look for a job and what to expect during the interview.

The Complete Guide to Capital Markets for Quantitative Professionals

AUTHOR: Alex Kuznetsov
PAGES: 600
FORMAT: Hardcover, Kindle
WHY YOU SHOULD READ IT: This book is a must-read for those with a background in science and technology who are thinking of transferring their skills to the financial industry. Kuznetsov details how the financial industry works, as well as how different firms make their money. Then he describes how professional with different technical backgrounds fit into roles within the industry. A section on technology discusses how financial models are created and used.

My Life as a Quant: Reflections on Physics and Finance

AUTHOR: Emanuel Derman
PAGES: 308
FORMATS: Hardcover, Paperback, Kindle
WHY YOU SHOULD READ IT: This is the book that introduces "quant" as a profession for generations of students. Emanuel Derman discusses his journey as one of the first high-energy particle physicists to migrate to Wall Street, and along the way he analyzes the incompatible personas of traders and quants. Derman also notes the dissimilar nature of knowledge in physics and finance, while offering his thoughts on how to apply the principles of physics to financial markets.

The Big Short: Inside the Doomsday Machine

AUTHOR: Michael Lewis
PAGES: 266
FORMAT: Hardcover, Paperback, Kindle, Audio, CD
WHY YOU SHOULD READ IT: Michael Lewis' #1 best-selling book tells the story of the 2007-2008 financial crisis and how Wall Street missed the bad securities being issued backed by the subprime mortgage-backed securities (MBS) that destroyed more than $1 trillion in wealth.

Financial Engineering: The Evolution of a Profession

AUTHOR: Tanya S. Beder
PAGES: 616
FORMAT: Hardcover, Kindle
WHY YOU SHOULD READ IT: Part of the Robert W. Kolb Series in Finance, Tanya S. Beder has put together a collection of articles by practitioners and academics with a dedicated section on the Financial Engineering degree. This book details the different participants, developments, and products of various markets—from fixed income, equity, and derivatives to foreign exchange. Case studies from companies in different segments of the industry, a glossary, and a companion website offer additional information and support for those interested in financial engineering.

See more recommended reading at QUANTNET MASTER READING LIST FOR QUANTS.

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+ Campus in the heart of New York City's financial district.
+ Career services support from the NYU Wasserman Center for Career Development.
+ International conferences and workshops held regularly.
+ Research Internship Grant Fund, dedicated to raising one million dollars annually, allows deserving students to pursue research projects for six months after graduation.
+ Key financial technologies available to students including 12 Bloomberg terminals as well as a FINCAD grant worth seven million dollars.
+ The first curriculum to be certified by the International Association of Financial Engineers.
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SECTION 2:

Finding a Master of Financial Engineering Program

How to Identify a Master in Finance Program Worth Attending

By Anthony DeAngelis

With the increased popularity of specialized graduate degrees in finance (Finance and Financial Engineering), I have received countless emails, all with the question "Is this program worth attending?"

This is an important question considering the cost, both in time and money, that going back to school entails. With the ever-increasing number of programs out there, potential applicants should take into consideration the following before making their decision. These apply to both domestic and international students, but I will talk toward the end about specific things to look out for as an international student.

1) What are your goals?

If your goal is to use the MSF/MFE degree as your second chance at breaking into investment banking or trading, then you have to pick a program that has strong on-campus recruiting and a history of placement in this area. These programs tend to have highly ranked undergraduate business programs and are located near major metro areas. You can figure out if a program is for you by looking at their past placement stats and seeing if investment banks and other trading shops come on campus for recruiting.

If your goal is to study finance and break into the financial industry, regardless of the position, then you have a lot more flexibility. Look for schools that are known in their region or city, those with a wide range of recruiting and alumni (front office finance roles), or those that allow you to work while attending school. This will give you the opportunity to keep gaining experience while increasing your knowledge and skill set so that you can move up in your career or laterally into that financial position you are seeking.

2) Cohort program or flexible class load?

A few universities offer a lock-step cohort program. Everyone takes the same classes at the same time. Other programs allow students to specialize and customize their program. It is important for you to decide what kind of educational experience you want.

A cohort program is the most simple and direct way to go about a master's degree, and it ensures everyone is qualified and eligible for the widest variety of finance roles. You also build close friendships and a connection with the campus and university. The downside is that you lose the flexibility to

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customize your classes. These types of programs are ideal for fresh graduates who might not know what they want to do or who need more structure.
On the other hand, if you are looking for a program that gives you the opportunity to choose classes and specialize in the area of finance that truly interests you, then you want a program with flexibility.

"Flexible programs give you the opportunity to more effectively target a narrower field of employment, and the upside is you will be better prepared."

Flexible programs give you the opportunity to more effectively target a narrower field of employment, and the upside is you will be better prepared. In my experience, this tends to be optimal for people who have worked for a little bit of time or someone who has a clear vision of what they want to do post-graduation.

3) Does the program offer career services?

This is something to focus on if you recently graduated and need help obtaining your first job. Most specialized master's programs have a career office or officer that aids in placements and recruiting. The nuanced nature of these specialized programs really dictates the necessity of having a career services person focused on the program. Programs without a dedicated person rely on the overall career center, which can sometimes work, but oftentimes does not. The lack of dedicated career services happens for a variety of reasons, but mainly because these specialized master's programs are relatively small compared to undergraduate business programs and MBA programs. Because of this you have career officers who don't truly understand how to sell these students, how to work with them when it comes to placements and finding a job, and how to market the programs.

"Programs without a dedicated person rely on the overall career center, which can sometimes work, but oftentimes does not."

Pay special attention to this as this is something that can be part of your due diligence before the program begins. I suggest speaking with or meeting with the career resources individual who can tell you about placements, who comes on campus for recruiting, and can help you get in contact with alumni who can give you a firsthand account of how the program helped them.

4) How is the program ranked?

A program's ranking is important and where the master in financial engineering has a distinct advantage over other specialized master's degrees. QuantNet provides a comprehensive and important

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biannual ranking of U.S.-based MFE programs that gives students a quick and easy way to size up programs. Currently only the *Financial Times* ranks the master's in finance degree, and it is more relevant for European master's programs (and Asian programs to a lesser extent).

As these degree programs mature, more publications will rank them and increase the transparency, but until then you will have to use the options that are available.

Looking at a program's ranking gives students an idea of the reputation and performance of each school and which ones they should 1) focus on, and 2) which ones you will be competitive at when applying. Both of these factors are important to consider so you don't waste time or money.

"Looking at a program's ranking gives students an idea of the reputation and performance of each school and which ones they should 1) focus on, and 2) which ones you will be competitive at when applying."

A SPECIAL NOTE FOR INTERNATIONAL STUDENTS

International students should pay special attention to placements and career services. The economy in the U.S., as well as globally, is still recovering, and sponsoring graduates is an added cost that many firms prefer not to shoulder. Financial engineering tends to be more forgiving than a general master's in finance, but it is still something you should consider. I recommend casting a wide net and focusing on larger employers, as they are both used to sponsoring students and financially able to.

Choosing a graduate program is always going to be a hard decision, but by factoring in these things to look for, the decision should become a little easier. While this article does not cover every issue potential students must consider, I believe this should help clarify the primary choices you should make. Make the decision that you feel most comfortable with, and once you decide on the course of action, commit to it. It might take some time and effort, but if you remain focused and work hard you will achieve your goals.

Anthony DeAngelis is a 2010 graduate of the Villanova Master in Finance program and owner of MSFHQ.com, a site dedicated to the Master of Finance degree. He previously worked for The Bank of New York and HSBC and is currently working in fixed income.

How to Pick an MFE Program

By Aaron Brown

From Amsterdam to Zurich you can attend financial engineering masters programs in all the financial centers in the world, or places off the financial beaten path such as Bethlehem, Coimbra, Potchefstroom, or Stillwater. You can be taught by some of the great names in academic quantitative finance—such as Carol Alexander, Marco Avellaneda, Emanuel Derman, Darrell Duffie, John Hull, Robert Jarrow, Mark Rubinstein, Philipp Schönbucher, and Steven Shreve (leaving out many just as distinguished)—or by professors who may be as competent, but whose names will not resonate with as many potential employers. You can pay $20,000 to $80,000, and no doubt more or less, and spend one to two years or, in some cases, attend part-time.

There are financial engineering programs with stellar international reputations, enviable starting salaries and top placement statistics; with graduates placed highly in most global financial institutions, but you can also opt for less famous programs that may be cheaper, easier to get into, more convenient, or that offer special features that interest you. There are also programs as prestigious as the top financial engineering masters programs that offer similar master's degrees such as computational finance, mathematics in finance, and financial mathematics. There are lesser-known programs associated with great schools, and top programs associated with less well-known schools. Then there are bad programs. There really are, and some of them are at schools with good reputations. I won't name them. I'm not shy, but I don't want to taint their graduates. Anyway, it's something you should find out for yourself. If you don't do the due diligence to eliminate the bad programs, you won't have the information you need to make a decision.

A bad program is a cynical attempt to get tuition dollars from students who are good at math and desperate for jobs, and deliver in return lectures from people who have nothing better to do. Some clues that a program is bad are:

- Few students have financial experience or successful career experience.
- Enrollment fluctuates with demand for financial quants.
- No distinguishing approach, just a bunch of standard courses.
- Instructors with no publications or experience in quantitative finance.
- Few courses that truly combine math and finance, just pure courses in math, statistics, computers, and other quantitative fields, plus basic finance courses.
- Dated content.
- Exclusive emphasis on lecture and multiple choice or numerical answer exams.

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Beyond these signs, you may be able to tell by the people you meet. Do the administrators, faculty, and students strike you as a group of successful people working together to create an exciting future? Or do they seem to be unsuccessful people trying to use each other for personal benefit?

Once you eliminate the bad programs, the next question is whether to try for a top program or select a lower-ranked one that may have other advantages. My general advice is to go for the highest-ranked program that will accept you, even if it is less convenient, more expensive, and less suited to your particular situation. That's not universal advice. There are times to overrule it. But make sure you have clear, strong reasons if you do. Top programs have top faculty, top students, and top alumni networks. The best ones also have unique approaches. Along with the brand name advantage, those are powerful tailwinds to a career. Lots of people succeed without them, but why make things harder than necessary?

"Top programs have top faculty, top students, and top alumni networks. The best ones also have unique approaches. Along with the brand name advantage, those are powerful tailwinds to a career."

For some students, that is the end of the process. Once they eliminate the bad programs, they find there is only one acceptable alternative, or one obviously superior choice. But for many students, especially those who are willing and able to relocate anywhere in the U.S., there are going to be several suitable programs of roughly equal reputation and quality, at any level from first-tier to third-tier.

The next thing I would look at is the level of mathematics required. You have to dig deeply to find this out. There are, believe it or not, financial engineering programs in which a professor cannot work a simple calculus example and be confident that the class is following. Everyone passes a calculus exam of course, but that's quite different from being able to use calculus or other mathematics in a classroom setting (not to mention a real-world setting). I think you will usually do best to choose the program with the highest level of mathematics that you can handle—and if that level is below calculus you should find another field. I'm talking about the actual mathematics used in classrooms, discussions, and cases; not the course or exam requirements.

"I think you will usually do best to choose the program with the highest level of mathematics that you can handle— and if that level is below calculus you should find another field."

The other factors like faculty reputation and experience, placement statistics, rankings by independent parties, and

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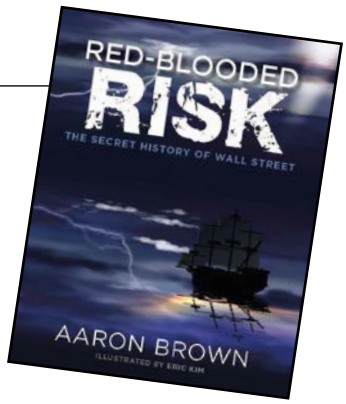
"If everything above is not sufficient to make a choice, consider whether you are sufficiently decisive for financial engineering. After you get the degree, you will have to make much harder choices with less information at higher stakes if you want to use it."

admission metrics I lump together as general quality. They are too highly correlated to make decisions by weighting one versus another, you're overfitting if you try (if you don't know what that means, find another field). If you are accepted by two programs of the same overall quality and mathematics level, I think your choice is likely to come down to idiosyncratic personal factors rather than any systematic advice I can give you.

If everything above is not sufficient to make a choice, consider whether you are sufficiently decisive for financial engineering. After you get the degree, you will have to make much harder choices with less information at higher stakes if you want to use it. If you can make a choice, congratulations, and I wish you the best. I look forward to the benefits your financial innovations will bring to the world, making my eventual retirement secure and happy.



Aaron Brown is risk manager at AQR Capital Management and the current Global Association of Risk Professionals Risk Manager of the Year. He is the author of *Red-Blooded Risk* (Wiley, 2012), *The Poker Face of Wall Street* (Wiley, 2006, selected one of the 10 best books of 2006 by *Business Week*) and *A World of Chance* (with Reuven and Gabrielle Brenner, Cambridge University Press, 2008). In his 31 year Wall Street career he has been a trader, portfolio manager, head of mortgage securities and risk manager for institutions including Citigroup and Morgan Stanley. He also served a stint as a finance professor and was one of the top professional poker players in the world during the 1970s and 80s. He holds degrees in Applied Mathematics from Harvard and Finance and Statistics from the University of Chicago.

2013–14 QUANTNET RANKING
Master of Financial Engineering Programs

The 2013-14 QuantNet ranking is the most comprehensive ranking to date of master programs in Financial Engineering (MFE) and Mathematical Finance in North America. QuantNet surveyed program administrators, hiring managers, and quantitative finance professionals from financial institutions around the world for statistics reflecting student selectivity and graduate employment.

RANK	UNIVERSITY	PROGRAM	TUITION	SCORE
1	**Carnegie Mellon University** Pittsburgh, PA	Computational Finance	$77,100	100
2	**Columbia University** New York, NY	Financial Engineering	$56,808	99
2	**Princeton University** Princeton, NJ	Master in Finance	$84,140	99
4	**Baruch College, City University of New York** New York, NY	Financial Engineering	$35,040 $24,315 (resident)	98
4	**University of California, Berkeley** Berkeley, CA	Financial Engineering	$58,895	98
6	**New York University** New York, NY	Mathematics in Finance	$62,000	97
7	**Columbia University** New York, NY	Mathematics of Finance	$54,720	92
8	**Massachusetts Institute of Technology** Cambridge, MA	Master of Finance	$74,900	90
9	**Cornell University** Ithaca, NY	Master of Engineering, Financial Engineering concentration	$69,000	89
10	**Georgia Institute of Technology** Atlanta, GA	Quantitative and Computational Finance	$54,144 $20,772 (resident)	82
10	**University of California, Los Angeles** Los Angeles, CA	Financial Engineering	$55,600	82
12	**Rutgers University** New Brunswick, NJ	Mathematical Finance	$47,250 $28,539 (resident)	79

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RANK	UNIVERSITY	PROGRAM	TUITION	SCORE
12	**University of Toronto** Toronto, Canada	Mathematical Finance	CAD 42,000	79
14	**Boston University** Boston, MA	Mathematical Finance	$65,955	78
14	**University of Chicago** Chicago, IL	Financial Mathematics	$51,012	78
16	**NYU-Poly** Brooklyn, NY	Financial Engineering	$44,979	75
16	**Rutgers University** Newark, NJ	Quantitative Finance	$58,317 $35,445 (resident)	75
18	**Fordham University** New York, NY	Quantitative Finance	$50,875	74
19	**Johns Hopkins University** Baltimore, MD	Financial Mathematics	$60,000	73
20	**University of Illinois** Urbana, IL	Financial Engineering	$51,000 $25,500 (resident)	70
20	**University of Michigan** Ann Arbor, MI	Financial Engineering	$63,184 $33,671 (resident)	70
20	**University of Minnesota** Minneapolis, MN	Financial Mathematics	$40,470 $32,870 (resident)	70
20	**University of Washington** Seattle, WA	Computational Finance & Risk Management	$37,800	70
24	**Claremont Graduate University** Claremont, CA	Financial Engineering	$81,120	66
25	**Illinois Institute of Technology** Chicago, IL	Mathematical Finance	$49,104	62

INTERNATIONAL LIST

Education Programs in Financial Engineering and Quantitative Finance

This list comprises an international list of programs in Financial Engineering and Quantitative Finance. Organized by geographic region, the list details the programs offered; whether each is full-time, part-time, or both, the degrees offered, and the location. Each university's name links directly to the program website, where you can find additional information on the admission process and deadlines, contact information, faculty, pricing, and program length.

NORTHEAST		
Baruch College New York, NY	Financial Engineering (FT/PT)	Master
Boston University Boston, MA	Mathematical Finance (FT/PT)	Master, PhD
Carnegie Mellon University Pittsburgh, PA	Computational Finance (FT/PT)	Master, PhD
Columbia University New York, NY	Financial Engineering (FT)	Master
Columbia University New York, NY	Mathematics of Finance (FT/PT)	Master
Cornell University Ithaca, NY	Financial Engineering (FT)	Master
Fordham University New York, NY	Quantitative Finance (FT/PT)	Master
George Washington University Washington, D.C.	Finance (FT/PT)	Master
Hofstra University Hempstead, NY	Quantitative Finance (FT/PT)	Master
Johns Hopkins University Washington, D.C.	Financial Mathematics (FT/PT)	Master
Massachusetts Institute of Technology Cambridge, MA	Finance (FT)	Master
New York University New York, NY	Mathematics in Finance (FT)	Master
NYU-Poly University Brooklyn, NY	Financial Engineering (FT/PT)	Master

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NORTHEAST *continued*		
Princeton University Princeton, NJ	Finance (FT)	Master
Rensselaer Polytechnic Institute Troy, NY	Financial Engineering and Risk Analytics (FT)	Master
Rutgers University Piscataway, NJ	Mathematical Finance (FT/PT)	Master
Rutgers University Newark, NJ	Quantitative Finance (FT/PT)	Master
Rutgers University Piscataway, NJ	Financial Statistics & Risk Management (FT/PT)	Master
Stevens Institute of Technology Hoboken, NJ	Financial Engineering (FT/PT)	Master
Stony Brook University Stony Brook, NY	Applied Mathematics, Quantitative Finance Track (FT)	Master, PhD

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NORTHEAST *continued*		
Temple University Philadelphia, PA	Financial Engineering (FT/PT)	Master
University at Buffalo Buffalo, NY	Finance with Financial Engineering track (FT)	Master
University of Connecticut Storrs, CT	Applied Financial Mathematics (FT)	Master
Worcester Polytechnic Institute Worcester, MA	Financial Mathematics (FT/PT)	Master
MIDWEST		
Ball State University Muncie, IN	Financial Mathematics (FT)	Bachelor
DePaul University Chicago, IL	Computational Finance (FT/PT)	Master
Illinois Institute of Technology Chicago, IL	Mathematical Finance (FT/PT)	Master
Purdue University West Lafayette, IN	Computational Finance (FT)	Master, PhD
University of Chicago Chicago, IL	Financial Mathematics (FT/PT)	Master
University of Cincinnati Cincinnati, OH	Financial Mathematics (FT/PT)	Master
University of Dayton Westerville, OH	Financial Mathematics (FT/PT)	Master
University of Illinois at Urbana-Champaign Urbana, IL	Financial Engineering (FT/PT)	Master
University of Michigan Ann Arbor, MI	Financial Engineering (FT)	Master
University of Minnesota Minneapolis, MN	Financial Mathematics (FT/PT)	Master
University of Notre Dame Notre Dame, IN	Computational Finance (FT)	Master
SOUTH		
Asbury College Wilmore, KY	Financial Mathematics (FT/PT)	Bachelor
Florida State University Tallahassee, FL	Financial Mathematics (FT/PT)	Master

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SOUTH *continued*		
Georgia Institute of Technology Atlanta, GA	Quantitative and Computational Finance (FT/PT)	Master
Georgia State University Atlanta, GA	Mathematical Risk Management (FT/PT)	Master
Louisiana State University Baton Rouge, LA	Mathematical Finance (FT)	Master
North Carolina State University Raleigh, NC	Financial Mathematics (FT)	Master
UNC Charlotte Charlotte, NC	Mathematical Finance (FT/PT)	Master
WEST		
Claremont Graduate University Claremont, CA	Financial Engineering (FT/PT)	Master
University of California at Berkeley Berkeley, CA	Financial Engineering (FT)	Master
University of California at Los Angeles Los Angeles, CA	Financial Engineering (FT)	Master
University of Hawaii Honolulu, HI	Financial Engineering (FT)	Master
University of Southern California Los Angeles, CA	Mathematical Finance (FT)	Master
University of Southern California Los Angeles, CA	Financial Engineering (FT)	Master
University of Washington Seattle, WA	Computational Finance and Risk Management (FT/PT)	Master, Certificate
CANADA		
HEC Montreal Montreal	Financial Engineering (FT/PT)	Master
McMaster University Hamilton, Ontario	Financial Mathematics (FT)	Master
Universite du Quebec a Montreal-Ecole Quebec	MSc Applied Finance (FT/PT)	Master
CANADA *continued*		

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University Laval Quebec	Financial Engineering (FT/PT)	Master
University of Toronto Toronto, Ontario	Mathematical Finance (FT)	Master
University of Waterloo Waterloo	Quantitative Finance (FT)	Master
UNITED KINGDOM & EUROPE		
Alcala University Madrid, Spain	Quantitative Finance (FT)	Master
Bar Ilan University Ramat Gan, Israel	Financial Mathematics (FT)	Master
Birkbeck University London, England	Financial Engineering (FT/PT)	Master
Birkbeck University London, England	Mathematical Finance (FT)	PhD
Birkbeck University London, England	Finance/Finance and Commodities (FT/PT)	Master
Bocconi University Milan, Italy	Quantitative Finance and Risk Management (FT)	Master
Bogazici University Istanbul, Turkey	Financial Engineering	Master
Dublin City University Dublin, Ireland	Financial and Industrial Mathematics (FT)	Master
Ecole Polytechnique Federale de Lausanne Ecublens, Switzerland	Financial Engineering (FT)	Master
EISTI Cergy-Pontoise, France	Quantitative Finance and Risk Management	Master
Erasmus Universiteit Rotterdam Rotterdam, Netherlands	Quantitative Finance (FT)	Master
ETH Zurich and University of Zurich Zurich, Switzerland	Quantitative Finance (FT/PT)	Master
HECTOR School of Engineering & Management Rotterdam, Netherlands	Financial Engineering (PT)	Master
ICMA Centre Rotterdam, Netherlands	Financial Engineering (FT)	Master

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UK & EUROPE *continued*		
Imperial College of London London, England	Risk Management and Financial Engineering (FT)	Master
International University of Monaco Monte Carlo, Monaco	Financial Engineering (FT)	Master
London School of Economics and Political Science London, England	Financial Mathematics (FT)	Master
Mälardalen University Eskilstuna, Sweden	Financial Engineering (FT)	Master
Reykjavik University Reykjavik, Iceland	Financial Engineering (FT)	Master
The Karol Adamiecki Academy of Economics Katowice, Poland	Quantitative Asset and Risk Management	Master
Tilburg University Tilburg, Netherlands	Quantitative Finance and Actuarial Sciences (FT)	Master
Universidad Nacional de Educación a Distancia Madrid, Spain	Stock Markets and Financial Derivatives (FT)	Master
University College London London, England	Financial Mathematics (FT)	Master
University of Birmingham Birmingham, England	Mathematical Finance (FT/PT)	Master
University of Cambridge Cambridge, England	Finance with Financial Engineering Specialization (FT)	MPhil
University of Edinburgh Edinburgh, Scotland	Financial Mathematics (FT)	Master
University of Glasgow Glasgow, Scottland	Quantitative Finance (FT)	Master
University of Konstanz Constance, Germany	Mathematical Finance (FT/PT)	Master
University of Leicester Leicester, England	Financial Mathematics and Computation (FT/PT)	Master

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UK & EUROPE *continued*		
University of Reading Reading, England	Financial Engineering (FT/PT)	Master
University of Warwick Coventry, England	Financial Mathematics (FT)	Master
University of York York, England	Mathematical Finance (FT/PT)	Master
University of York York, England	Financial Engineering (FT)	Master
Wits University Johannesburg, South Africa	Mathematics of Finance (FT)	Master, PhD
WU Vienna University Vienna, Austria	Quantitative Finance (FT)	Master
PACIFIC RIM		
City University of Hong Kong Kowloon, Hong Kong	Financial Engineering (FT/PT)	Master
Hong Kong University of Science and Technology Kowloon, Hong Kong	Financial Mathematics and Statistics (FT/PT)	Master
Nanyang Technological University Singapore	Financial Engineering (FT/PT)	Master
National University of Singapore Singapore	Quantitative Finance (FT/PT)	Master
National University of Singapore Singapore	Financial Engineering (FT/PT)	Master
Singapore Management University Singapore	Quantitative Finance (FT)	Master
The University of Hong Kong Hong Kong	Finance with Financial Engineering Track and Risk Management Track (FT/PT)	Master
The University of Melbourne Melbourne, Australia	Applied Finance (FT/PT)	Master
University of Colombo Colombo, Sri Lanka	Financial Mathematics (FT)	Master
University of New South Wales Sydney, Australia	Financial Mathematics (FT/PT)	Master
University of Technology Sydney Sydney, Australia	Quantitative Finance (PT)	Master

Quant's Next Top Model

By Rachael Horsewood

As repercussions from the crisis continue to reshape the world of financial services, one question for those people thinking of pursuing a career in quantitative finance is where and why should they go for a masters in financial engineering (MFE).

—Rachael Horsewood compares notes from London

The quant scene on both sides of the Atlantic flourished in the 10 years leading up to the credit crisis of 2008. In London, this was hugely due to a boom in asset securitization and credit derivatives activity. New job opportunities popped up and, according to academics in the UK, an increasing amount of applicants to master's in financial engineering (MFE) showed how inherent quants were becoming to the financial services industry. But like all fields in this industry the quant one is not exactly what it used to be.

John Crosby, a quantitative analyst at Grizzly Bear Capital in London, says: "There's definitely less demand for people with derivatives pricing skills now given all the losses and downsizing in these markets. It's not that maths are no longer important. It's just that economics is already becoming a much bigger focus in the finance world. It's about seeing the bigger picture and understanding economic risks. This more than anything else will be shaping quant roles moving forward. Banks and other financial institutions will consider it more important than a PhD in maths or physics."

Crosby, who is a visiting Professor of Finance for the Centre for Economic and Financial Studies in the Department of Economics at Glasgow University, as well as an invited lecturer for the M.Sc. Mathematical Finance course in the Mathematical Institute at Oxford University, believes the impact on MFE programs is yet to come. "There are hundreds of MFE programs around the world now and considering what has happened since the crisis it will be difficult to see how some of them don't struggle moving forward," he adds. He says interest in top-ranked MFE programs might become stronger while the bottom-half find it more difficult to attract as many applicants. "MFE programs are definitely differentiated by the reputations of their respective universities," he asserts.

James Sefton, a professor of economics at Imperial College London and a senior quantitative analyst at UBS in London, agrees that the reputation of Imperial College's MSc in risk management and financial engineering is helped by the fact that Imperial College is consistently ranked in the top 10 universities in the world.

"Imperial's MSc in risk management and financial engineering prepares students for a wide range of quant jobs—whether it is risk management,

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developing pricing models, high frequency finance and algorithmic trading, or quantitative investment, which is the area that I work in at UBS. The maths is obviously more intense for those interested in pricing models, whereas those pursuing quantitative investment might broaden their focus with other subjects such as computer programming and database management," he explains. Like most MFE programs in the UK, Imperial's MSc in risk management and financial engineering, lasts for one year (beginning in September). It takes about 100 students each year, which is a bit more compared to other programs in the UK.

"We have a great mix of practical and theoretical teaching styles—for example, I'm not the only professor who also works in the industry. Our faculty is made up of a lot different experiences and areas of expertise. This breadth can help prepare the students for the job market. It can give them an edge when they are interviewing and giving presentations," Sefton adds.

Michael Dempster, a professor of finance and management science emeritus at the University of Cambridge, agrees that economics has become more of a lure for people considering MFEs. He says the prevalence of systemic risks in recent years is no doubt leading people to try to model macroeconomic effects more. "Financial quants have to take some responsibility for the demise of the derivatives business. Most did not understand the parameters for these products. This is why economics has become a more major focus," he explains.

"Financial quants have to take some responsibility for the demise of the derivatives business. Most did not understand the parameters for these products. This is why economics has become a more major focus."

Michael Dempster, Professor of Finance and Management Science Emeritus, University of Cambridge

"Our MPhil in Finance is a post-grad degree that specializes in financial engineering. It has a broad range of disciplines and is not purely quantitative. The curriculum incorporates other subjects such as, economics, and lectures are provided by professors from other departments too, not just from the Judge Business School," says Dempster, who is a founder of the University of Cambridge's Centre for Financial Research. He adds that applicants to Cambridge's MPhil in Finance (one of the first MFEs established in the UK) still come from all over the world, not only the UK and Europe.

"We also have built strong ties in China, having set up a system for the Agricultural Bank of China and the Industrial and Commercial Bank of China. We have provided executive education for other Chinese banks too, mainly by training middle managers earmarked for top management," Dempster notes.

But what do employers think about MFEs? Ed Fishwick, managing director and co-head of BlackRock risk and quantitative analysis group in London, says: "If I were to speak before a group of new graduates today I would say that they need strong technical skills, strong communications skills, and a keen interest in the financial markets. That might seem obvious but there was a time when you could have a PhD in quantum gravity and come in not knowing a thing about a

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market but yet still get hired as a quant. You need to bring more to the table now. You need to understand the markets and the people who work in them and that is the case no matter where you are based or what speciality you enter into," he explains. "We definitely require quantitative knowledge, but it can come from a degree in various subjects whether it's economics, maths, statistics, engineering, or science. I look out my office window right now and see an array of educational backgrounds. The one skill we look for regardless of their educational achievements is communications. They were hired because they could prove what they know. They were hired because they have passion about what they do," Fishwick replies.

Loic Fery, founder and chief executive of Chenavari Financial Group in London, adds: "We like our quants to have a good understanding of business. Their interaction is not a one-way exchange, as both risk managers and portfolio managers bring their experience and comprehension to the table. Quants are not only here to support but also to suggest and create."

"Quants need to have a very good level of IT knowledge. We work more and more with many different types of systems, and you must be able to understand how they work—how to fix and improve them. Quants need to have a better understanding of the market too. You need to understand the data you work with, as well as the practical assumptions and risks involved. Market data plays an important role. You cannot rely on any data and must extract relevant samples of data. Pricing models is the basic, you cannot go without them. You need to

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Did You Know?

QuantNet's Events page lists upcoming conferences, seminars, workshops, and meetings for financial engineers. Each event lists the date and location, along with a link to its complete information so you can see what's going on in your area and across the industry.

Sign up or log in to create an event on QuantNet.

be able to understand them perfectly," he explains.

"At a bachelor level, you rarely would have studied and had time to acquire a mathematical and financial background. The science background is nearly compulsory, the finance one not always. We mainly look at people who have studied at French engineering schools—Grandes Ecoles, which means 'great schools' in French—or someone with a bachelor in either maths or science and a master of finance. An MFE is important if the student has a good level in programming and maths. Desire is equally important. We have interviewed many students and professionals who cannot answer basic maths questions (for example, define the variance, correlation) or simple IT questions (what is oriented object language), even though their CV says that they are good at it," says Fery, who has an MsC in finance and entrepreneurship from the HEC School of Management in Paris.

Indeed, the attractiveness of MFE programs varies across Europe considering all of the language and cultural differences. Jan Kallsen, a professor of mathematical finance at the University of Kiel in Germany, says most of his students come from Germany and go onto work for German or Swiss firms. "Most students in Germany leave universities with a master's degree, no matter what the subject is, not a bachelor's degree. Thus, comparing a master's degree to work experience does not really apply to the German job market," he explains.

"Some of our courses are taught in English (i.e., those with an overlap to a degree in 'quantitative economics'). We think our program is an alternative to a master's in mathematics in the sense it is for people who know that they would like to specialize in financial mathematics. Another attraction of our program is that it is free. We do not charge tuition even though the course program is similar to very expensive international ones," adds Kallsen.

Indeed, one of the biggest questions for MFE candidates is job placement, especially in Europe given the euro crisis. "Many of our MPhil grads go on to do their PhDs. Our relationship with them is personal and long-standing. I write a lot of references, but often a contact in the City or on Wall Street will call and ask whether I see a student with a certain skillset or ambition, and I recommend them in that sort of way. Most of the jobs they get are risk-related, and definitely more executive or front-office," says Dempster.

"These grads go to all types of financial institutions, money managers, technology companies, and even insurers. The insurance industry has become a lot more like banking. Insurance companies have to price products and of course those in Europe have to adopt similar risk management principles under Solvency II, which comes into effect next year. Most actuaries today are

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"We have interviewed many students and professionals who cannot answer basic maths questions (for example, define the variance, correlation) or simple IT questions (what is oriented object language), even though their CV says that they are good at it."

Loic Fery, Founder and Chief Executive of Chenavari Financial Group in London

not that different from financial quants since they essentially have to use a lot of the same techniques that bankers do," he adds.

Sefton says: "A lot of our grads get work at hedge funds and other money managers. Most end up in London or the U.S. because that is where the bulk of financial quant jobs are, but we have seen them go all over the world. The quant industry is global."

won't have a problem sorting it out for you. I haven't seen any problems with the many foreign people who I know and have worked with," he explains.

He also emphasises the benefit of networking. "It is really helpful not just for job opportunities but also for exchanging ideas. There are a lot of events worth going to in London. Most cost money but there are always free opportunities through trade

than ever before so quant investors are focusing a lot on this now too," Sefton adds.

Human resources sources at banks say that most of the job prospects in London right now are risk-related. Fishwick explains why quants remain one of the most integral parts of risk management. "When I entered into this industry 28 years ago, quantitative finance was a fringe activity and quants themselves were a tiny minority of the financial services world. Now quants are everywhere and many of the processes, products, and functioning of financial markets involve the use of quantitative techniques. This is now a very important part of the whole industry. In fact, they are intrinsic and that is not going to change. All of the fundamental changes in technology, computer power and data are not going away. It's all here to stay," he says.

"Computing, economics, and data management are all useful subjects but it is a very competitive job market and being able to show your passion for it is what's really going to help you."

James Sefton, Professor of Economics, Imperial College London

Sefton also says it has become more important for students to develop views of their own and to show that they are genuinely interested in this industry. "Computing, economics, and data management are all useful subjects but it is a very competitive job market and being able to show your passion for it is what's really going to help you," he explains.

Crosby says work visas are usually not a problem in the UK, especially if the applicant studied there. "In most cases, if a firm really wants you they

associations and university alumni groups. The annual ICBI conference, which was held in Barcelona this year, is one of the biggest quant gatherings in the world," he adds.

Sefton says quant investment requires a lot more dedication than it did before the crisis. "The glory days are over and investors are no longer willing to trust the strategy almost unconditionally. They want to understand the approach in more detail and have an idea of why your approach is innovative. Risk control is obviously more vital

"That said, the crisis and events since have shown us how important it is to strike a balance between judgment, experience, and analysis. While the nature of the job has not changed much in recent years, there is more competition for

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fewer roles. The financial crisis reduced demand in the job market as a whole," Fishwick adds.

Overall the job picture for quants, at least in London, is still quite institution-specific. For example, sources say that smaller institutions are less likely to have distinct front and middle-office roles; instead quants are more likely to work across different areas. "For the desk quant, which in my view probably represents 95% of quants (the other 5% being research quants), you must understand the needs of the business and provide adequate solutions for them. These quants work on measure whether it is measuring the current risk of the book or the potential risk to add. This requires a good background in maths, financial maths, IT, as well as a good comprehension of the financial market. The maths, financial maths, and IT skills are mainly acquired at university. As for understanding the business, you learn it on the desk with the people already working in the business. This is true for most jobs in finance," explains Fery.

"To sum it up, what matters is not your degree, but your knowledge. The degree gets you the interview because it means you have the basics in the fields we are interested in. But you must be able to prove that you master what you studied and experienced," Fery concludes.

Understanding the Quantitative Finance Industry in Asia

By Chyng Wen Tee and Christopher Ting

The practice of quantitative finance used to be the prerogative of global trading hubs such as New York or London. When major investment banks, hedge funds, or proprietary trading firms were expanding to Asia, they tended to send senior executives from New York or London to selected Asian cities to head quant teams, and staff the team with local junior hires —traditionally smart graduates fresh from college. The quant teams in Asia would look to deploy mathematical models developed and implemented in the U.S. or Europe to the Asian market. In other words, the Western world was the center of innovation in quantitative finance and finance in general, while Asia was passively adopting the products and models developed in the West.

However, the situation has changed drastically. The past decade has seen the global focus shifting toward the East, with the Asian market rapidly gaining liquidity, complexity, sophistication, and independence. As the market matures and with regional institutional investors playing increasingly dominant roles, financial institutions have adjusted their staffing strategy and are now looking to hire local talents with practical Asian market knowledge, experience, and contacts for the senior roles. Airlifting experts from the West is no longer seen as a viable way to form quant teams—the Asian market needs locally groomed talents with a good understanding of the domestic market and regional economy in order to perform effectively.

Differences Between the U.S. and Europe

So what are the differences between a quant role in the U.S. or Europe vs. Asia? The key distinguishing factor is the breadth of products and currencies coverage. Quant teams in the U.S. or Europe are highly specialized. These include exotic products teams responsible for highly structured deals, flow teams covering liquid securities and vanilla derivatives, high-frequency quant trading teams covering electronic market making and trading, and short-term interest rate teams covering repo and money market, to name a few. On the contrary, an Asian quant team will need to function independently while covering all the scopes described above. One will need to be able to model exotic deals, and at the same time be capable of dealing with highly liquid flow products such as futures. As an example, an Asian quant might spend a typical working day determining the volga and vanna of a particular exotic deal using a two-factor model in the morning, discussing the wrong way risk and funding implications with the trading desk and corporate treasury in

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the afternoon, and preparing the pricing platform and database for a when-issue government bond that will start auctioning the next day in the evening.

The breadth of currency coverage is also significantly wider in Asia. A quant team in New York will be covering USD and CAD, whereas a team in London will be devoted to EUR and GBP. On top of these, there are Latin American and emerging market subdivisions, formed with quants having complementary skill sets and sitting alongside designated teams described above to cover specific markets. A single Asian quant team, in contrast, will need to cover at least 12 currencies, ranging from highly liquid (e.g., JPY or AUD) to the less liquid ones (e.g., VND). In fact, any standard-size trading desk in Asia will typically have exposure and trading activities in AUD, CNH, CNY, HKD, IDR, INR, JPY, KRW, MYR, NZD, SGD, and TWD. Each of these currencies has their own conventions and market preferences, and yet the Asian market on the whole is closely interlinked and possesses distinct regional flavors. The ability to multitask, to keep up-to-date with market development, and to compartmentalize one's knowledge so that one can switch seamlessly between ongoing projects is vital for effective performance.

"A single Asian quant team, in contrast [to quants in other parts of the world], will need to cover at least 12 currencies, ranging from highly liquid (e.g., JPY or AUD) to the less liquid ones (e.g., VND)."

There are also the added challenges of managed currencies, transaction restrictions and government regulations. These give rise to the need to distinguish markets between onshore and offshore, deliverable and non-deliverable. How do we account for onshore and offshore CNY markets, and how are these two related to CNH? How are these markets, in principle of the same currency, interrelated, and how should the modeling approach be formulated? These are the challenges facing an Asian quant. Solutions are very often derived from the first principle, as the standard assumptions made in conventional quantitative finance modeling are not necessarily valid. Quants will need to liaise with the legal department, corporate treasury, and trading teams to keep up-to-date with the latest developments in governing policies and adapt their modeling approach accordingly. Locally trained quants with a good understanding of the domestic economies will possess the competitive advantage to tackle the problem more effectively.

Master of Quantitative Finance Programs: A Case Study of Singapore

In tandem with the growing demand of quants in Asia, many Asian universities have launched master degree programs to equip students with the necessary knowledge and skills in applying mathematical models and in computing. In Singapore, for example, there are at least five programs located in this tiny city state where two large sovereign wealth funds, GIC and Temasek Holdings, are incorporated.

One of the earliest to launch the Master of Financial Engineering (MFE) program in Singapore was Nanyang Technological University (NTU). The NTU MFE program is offered under her Nanyang Business School,

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and draws upon the faculty members in the schools of engineering to teach the more mathematically demanding courses and programming. The NTU MFE program includes a seven-week term at Carnegie Mellon University (CMU). Upon successful completion of the seven-week term, students are awarded a certificate in Computational Finance from CMU.

At the National University of Singapore (NUS), the Master of Science in Quantitative Finance (MQF) program is offered by the Department of Mathematics with the cooperation of the Department of Economics and the Department of Statistics & Applied Probability. The university-level Saw Centre for Quantitative Finance is entrusted with providing the necessary support to manage the program. In addition, the Risk Management Institute affiliated to NUS runs a separate MFE program.

The University of Chicago's Singapore campus offers the Master of Science in Financial Mathematics. Curriculum and coursework are identical to the main Chicago campus. Simultaneously, students in Singapore and at the Stamford campus "electronically attend" lectures as they are presented live at the Chicago campus via real-time interactive video conferencing.

Beginning September 2012, the Lee Kong Chian School of Business at the Singapore Management University (SMU) begins to offer the Master of Science in Quantitative Finance jointly with Cass Business School at City University London. Students of this joint three-semester MQF program spend the four-month second semester at Cass Business School, where they study the same five core modules together with their fellow students of Cass. Upon successful completion of the program, SMU students are awarded a degree scroll jointly endorsed by the two universities.

One of the reasons that five similar programs are able to co-exist in Singapore is that many of the students are from overseas: China, India, Malaysia, Indonesia, and other countries in the region. It is also worth mentioning that the Monetary Authority of Singapore (MAS), the central bank of the city state, is actively grooming a critical mass of specialists in targeted fields such as risk management, quantitative finance, financial engineering, and actuarial science. MAS holds the policy view that these specialized skills are necessary to support the long-term growth of Singapore's financial services sector.

"One of the reasons that five similar programs are able to co-exist in Singapore is that many of the students are from overseas: China, India, Malaysia, Indonesia, and other countries in the region."

Besides Singapore, universities in Hong Kong, Australia, Taiwan, and Korea also offer specialized master's programs in response to the trending demand in Asia for quants. The simple reason is that there is still ample room for growth in Asia, especially in the areas of derivatives trading, risk management, and quantitative hedge fund investments. Many Asian banks are acutely aware of the importance of risk management, and they are strategically positioning themselves to adopt the industry best practices, even beyond what the Basel committee has recommended.

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What Is the Value of a Master Degree in Quantitative Finance?

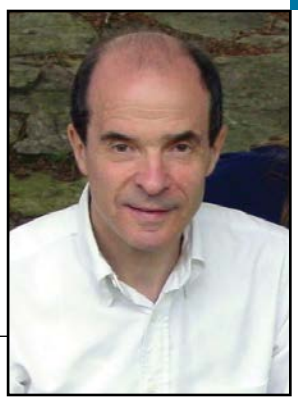
A quantitative finance degree in Asia will not only grant you access to the major investment banks, hedge funds, and proprietary firms with Asia presence, but you will also be sought after by Asian institutions, which are vigorously building their institutional sales and trading teams to compete locally and globally. In addition, you will find employment at sovereign wealth funds, asset management groups, commercial banks, central banks, and government subsidiaries responsible for regulations and market monitoring. The Asian market on the whole is upbeat, sanguine, and filled with vitality. It continues to evolve and to grow in importance in a vibrant economic environment.

So what sort of qualities are Asian employers looking for? Standard quantitative finance training and the quintessential quant traits aside, employers are also looking for individuals displaying the aptitude to multitask, an avid interest in the financial market, and good communication skills. Unlike traditional quant roles, having a keen interest in the mathematical side of finance is not sufficient. As the Asian market continues to develop, new products are continually being introduced, and government policy and regulation continue to play a crucial role in shaping the market. Convince the interviewer that you can multitask by effectively handling an array of projects, that you are up-to-date with the general trend of Asian market development, and that you are an effective communicator and can be relied upon to conduct or support businesses in more than a dozen Asian countries, and you will get the opportunity to apply your mathematical skills to a breadth of products in one of the most exciting and rewarding markets for decades to come.

Chyng Wen Tee is Assistant Professor of Quantitative Finance at Singapore Management University. Prior to joining the quantitative finance faculty, Tee spent three years as a quantitative analyst at the exotic interest rate trading desk at Morgan Stanley, London, and another three years as a desk strategist at the macro trading desk at Goldman Sachs, Hong Kong. He has a PhD from the University of Cambridge.

Christopher Ting is Associate Professor of Quantitative Finance and head of the quantitative finance faculty at Singapore Management University. He is also the academic director of the MSc in the Quantitative Finance Program. He has worked in the industry as a proprietary trader, and he teaches quantitative trading strategies in the Program. His research interests include high-frequency market microstructure, derivatives, and statistical arbitrage. He has a bachelor degree and a master's degree from the University of Tokyo, and a PhD from the National University of Singapore.

Making Sure Your MFE Application Stands Out



By Bill Stanley

The Mathematics in Finance masters program at the Courant Institute of NYU has long been recognized as an outstanding program, not just in the United States, but also internationally. As such, it attracts applicants from Asia, Europe, and North and South America. One feature is the program's success in helping students to find internships during the summer before their third semester. This is due to the strong relations that the University has had for many years with the major Wall Street firms. The admissions process is very competitive and the caliber of the applicants is very high. The class size is limited, and, as a result, less than 10% of applicants actually receive an offer. For three years, I have helped the faculty of the Courant Institute screen the applications. During this process, I have read more than 1,500 applications and have been able to observe how they fared in the admissions process.

For the most part, the standard of the applicants is very high. However, in some cases, it is apparent that a capable applicant would have fared better with more careful preparation. There are things that candidates could do to improve their chances of admission, especially if they give some thought to this well before the submission deadline. The purpose of this article is to help prospective applicants to improve their submissions. Although my experience has been with the NYU program, I suspect that the admission criteria for other prestigious programs would not differ much.

". . . there is flexibility in the process. An application that is weaker in one area might be accepted because of strengths in other areas."

1. Coursework: Your undergraduate and graduate coursework is shown in your transcripts. You do not need to have majored in mathematics since many successful applicants have an undergraduate degree in economics, engineering, physics, statistics, or some other quantitative field. Nor is it necessary to have graduated from a top-rated university. Many offers are made to fine applicants from less well-known schools. However, a strong mathematics background is needed. At the very least, an applicant should have a course in calculus (including multi-variable calculus), linear algebra, and probability. If you do not have these, you should be aware that you will stand a much better chance if you take courses to remedy that deficiency.

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Most applicants, however, have more than the minimum background described above. Some helpful courses include ordinary and partial differential equations, and subjects such as real variables, complex variables, and others that show evidence of interest and ability in mathematics. Courses in business, finance, and economics will also help your application.

"You will have a better chance of admission if you have a depth of knowledge in one quantitative area rather than a superficial knowledge of several areas . . . "

You will have a better chance of admission if you have a depth of knowledge in one quantitative area rather than a superficial knowledge of several areas, even if they are all relevant to a career in finance.

All these are not necessarily requirements of the faculty but rather a practical reflection of the competitive nature of the process. No matter how strong your application may be, if there are others which are exactly equal to yours but with more and stronger coursework in relevant subjects, then those will obviously have an advantage in the admissions process.

Most of the applicants have very good grades for all their undergraduate coursework, mostly A and B grades, especially in the quantitative subjects. An occasional C in a subject not related to mathematical finance such as painting or music will not hurt the application. But the hard fact is that that you are competing with applicants who have no C grades. Similar comments apply to graduate coursework for applicants who have a master's degree.

If you think the program's faculty might have difficulty understanding your transcript (for example, if your courses are called Mathematics I, Mathematics II, etc., rather than Calculus, Linear Algebra, etc.), it can be helpful to provide information such as the topics that were covered and textbooks that were used.

HELPFUL TIP: If you have taken a course with a generic name, such as Mathematics III or Computers I, provide a cover sheet that explains the courses in detail (the subjects covered, for example, probability, linear algebra, differential equations, etc., grade, books used, materials covered, and so on). This will be more helpful to an appraiser than just knowing that you received an A in Engineering Mathematics.

MFE Candidate Must-Haves

Mostly A and B grades

Strong background in math

Focus on one or more quantitative areas

Computer programming coursework and/or work experience

GRE Quant Score of >94%

2. Statement of Purpose: The Statement of Purpose should be a simple document that describes why you came to choose this field. It should be clearly written and have a logical construction. Although some international students might not yet have perfect command of the English language, nevertheless their ideas will come through, which is what is most important here.

It is not necessary to state again your coursework and grades because these are shown on your transcripts. Some applicants, in their statement, lavish praise on the program and the faculty or the University. This may not

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QuantNet MFE APPLICATION TRACKER

QuantNet's MFE Application Tracker is used by hundreds of MFE applicants every year to evaluate their chance of admission to the top programs. It now tracks 68 master's programs in financial engineering and quantitative finance worldwide.

By adding profile data to the Tracker, applicants can get a detailed comparison of their applications against others who have applied and been accepted to the same programs. The Tracker tool collects the following information:

- Grade point average
- GRE scores
- Application submission date
- Interview date
- Acceptance/rejection status and date notified
- Notes from the applicant (if any)
- If accepted, the applicant's decision

hurt your application but it will certainly not help—it is just a waste of space.

HELPFUL TIP: Customize your essay for each program that you apply to. Many students use a general format for each program, regardless of the specific questions. Ask a friend who is a native English speaker to proofread the essay.

The objective of the statement is to explain clearly and logically how and why you chose this field and what you hope to do with your master's degree after completing the program.

3. References: There is no specific requirement for the sources or content of letters of reference. Ideally, your references should be from your undergraduate instructors who demonstrate that:

- They really know you well.
- They have worked with you in a relevant subject.
- They have observed outstanding ability and accomplishments.

Recommenders who know you through projects or advanced classes are better choices than those who know you only through basic courses. At least one reference should be from someone who knows you in a highly quantitative context. For graduate applicants and others who have been out of school for some time, it is important to have at least one reference from an individual who currently knows you well.

"Most applicants have at least one course in computer science, but many have more than that."

4. GRE Quant Score: The GRE Quant Score is a measure of the quantitative ability of a candidate. Clearly, students need to have quantitative ability if they are to benefit from a master's program in mathematics. The GRE quant exam has recently changed to a different structure based on a maximum score of 170 instead of 800 as before. Because of this, it is more convenient to discuss this topic in terms of the percentile quant score. The experience at NYU is that approximately 60% of the applicants to this program are at or above the 94th percentile of candidates who take the GRE quant exam. This is by no means an absolute indicator since candidates with lower scores have been accepted in the past when they have presented strongly along other dimensions. So you do not need to have a percentile score of greater than 94% in order to stand a chance, but you must remember that your application will be compared to those with very high scores. If your GRE score is low, it is recommended that you take the GRE a second time to improve your score.

5. Computer Science: You will need some familiarity with computers and programming in order to complete this program. Most applicants have at least one course in computer science, but many have more than that. In addition, it is helpful to show evidence of programming ability from projects or work experience, particularly of object-oriented programming. Lack of experience in programming will not exclude an application, but once again, it will be competing with many others that do demonstrate such skills. If your computing skills are weak,

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you should take at least one programming course. Competence in C++ or Java or MATLAB is definitely an advantage.

HELPFUL TIP: Be sure to describe your programming background. Some applicants don't bother to mention their technical skills. You can use your essay or resume to elaborate on which languages you are familiar with and the kind of projects you have done in these languages. This will give the reader a better idea of your skills.

6. English language: NYU has many students from non-English speaking countries and the faculty understands very well that a student who arrives with weak English language capability usually learns quickly after moving to the United States. However, once again, no matter how capable you are, you will be competing with other international candidates who do have very good English language skills. Our experience at NYU is that of those students who take the TOEFL, more than 60% have a score of 100 or more. Although this is not a requirement, especially if your application is very strong in other areas, the fact is that if your score is less than 100, you are at a competitive disadvantage. It might be worthwhile to improve your English skills and then take the TOEFL a second time to try for a higher score.

7. Resume: This should be a clear record of your education and accomplishments. However, the educational and work experience should be supported by the transcripts and reference letters.

HELPFUL TIP: Use a professional format and standard fonts to make sure that the final document has a good appearance.

8. Memberships: It is a good idea to participate in a professional organization such as IAQF, SQA, etc., and you should join a website such as QuantNet. This will show that you have taken the time to learn something about the industry and understand that this is something that you really want to do.

I hope that these guidelines help ensure that your application fully reflects your abilities and accomplishments. The latter will help you obtain the highest ranking possible in a very competitive admissions process. BEST OF LUCK!

Bill Stanley earned his M.A. in mathematics at the University of Oxford in England. On moving to the U.S., he completed an M.S. in Operations Research at New York University (NYU), while working for JPMorgan Chase. Later, he worked for Citigroup where his role was to document various kinds of derivative securities. Bill is also a C.P.A. in New York State. For the last three years, he has appraised more than 1,500 applications for the MS program of Mathematics in Finance for NYU's Courant Institute.

C++ PROGRAMMING FOR FINANCIAL ENGINEERING

Online Certificate

This 16-week C++ Programming for Financial Engineering online seminar is a joint project by the Baruch MFE program, Dr. Daniel Duffy, and QuantNet. The content was developed by best-selling author Dr. Daniel Duffy and the course is delivered entirely online by QuantNet. The Baruch MFE Program provides a teaching assistant to each student and grants a Certificate of Completion upon passing the final exam.

AUDIENCE: This certificate is designed for people interested in pursuing graduate studies in financial engineering and covers essential C++ topics with applications to finance. Approximately half of the students who successfully completed the seminar prior to July 2013 are now enrolled in financial engineering graduate programs.

TOPICS COVERED:

- **Basic C/C++ Language and Syntax**
- **Object-Oriented Programming (OOP) in C++**
- **Inheritance and Polymorphism**
- **Generic Programming in C++ and Standard Template Library (STL)**
- **An Introduction to Boost C++ Libraries**
- **Applications in Computational Finance: Black Scholes pricing and Greeks, Monte Carlo methods, finite difference methods** (Euler, Crank-Nicolson), lattice methods, exact methods (Barone-Adesi-Whaley, bonds, swaps, swaptions)

FORMAT: The C++ online seminar consists of 10 levels, each with video lectures, reading materials, programming homework, and a quiz. Each student is assigned a personal teaching assistant (an alum of the Baruch MFE Program). A dedicated forum is available for discussing homework problems.

TESTIMONIALS

The course is very comprehensive in its curriculum and provides students with insight into numerou=s valuable C++ libraries and an introduction into programming for financial applications. The support of the TA and other students was invaluable.

"It's a balanced mixture of theoretical approach and practical implementation. The curriculum was designed with many hand-on exercises which will help students to familiarize themselves with the actual code in action. Also the coherency between chapters makes the whole understanding process firmer."

It has been a wonderful experience. The learning is no less rigorous than the classroom environment. Anyone who wishes to embark on a financial engineering career who has yet to learn the programming skills should definitely come check out this program.

"The course was phenomenal and obviously one-of-a-kind. A lot of material was covered. I had absolutely great support from my TA."

This course teaches from the most basic aspect of C++ to the usage of industrial-grade codes. Fantastic forum and TA, plus useful materials. For example, lecture videos can be downloaded and use on off-line devices. Highly recommended.

For more information about the C++ online certificate, click here.

Graduate Schools Want Thoughtful, Well-Rounded Students

By Gwen Stanczak

The decision to pursue a degree in financial engineering is an important step in advancing your career. Congratulations! Whether you are seeking to switch careers or advance within the financial services industry, the skills you will acquire are vital to mastering the strategic and analytical demands of the industry.

Applying to graduate school is a big decision—as well as a significant investment of time and resources—and the emotional and rational aspects can influence candidates' applications and interviews. Those students who prepared in advance have the advantage of conveying a clear and compelling idea of what is motivating their application . . . which is not only important for admission counselors but a worthy exercise for students themselves!

The process of researching, applying to, and interviewing at graduate schools does not need to be a daunting task. Just as there is no "one best" school, there is no singular formula for gaining admittance into the university of your choice. Often, the most challenging aspect of the admission process is the personal due diligence prospective students must conduct. Ask yourself the important questions regarding your priorities and expectations. What is most important to you? How do you weigh the pros and cons of each school? What are you seeking from the career services staff? Do you expect networking opportunities from a well-connected alumni network? You should expect the process to be a helpful back-and-forth between you and the school(s) into which you're seeking admittance.

The Balancing Act

The admissions process is holistic. Ultimately, the admissions staff is seeking candidates with the potential for success academically as well as professionally. Academically, financial engineering programs are seeking candidates with strong quantitative backgrounds who have shown strong performance in a depth of mathematics courses including calculus, linear algebra, differential equations, and a calculus-based probability course. Many quantitative finance programs have differing degrees of programming requirements, but often are looking for candidates to have some introductory programming experience. Check with each individual program to determine the requirements set forth. If you are lacking a prerequisite course for your program of study, it doesn't mean that you are out of consideration. However, a strong foundation is the key to academic success, so you should consider taking any prerequisite course(s) that

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you are missing in advance of applying in order to strengthen your candidacy.

From a career perspective, while having relevant experience is preferred, it's not always required. Those lacking experience or those who are switching careers should start taking steps to understand the field of quantitative finance. For some it might be the daily reading of *The Wall Street Journal* or informational interviews with those in the field. Stay abreast of current market trends as well as changes occurring within and among companies, and you'll strengthen your career goals and trajectory.

Finally, any manager and executive will tell you that the less quantitative skills—communication, presentation, team leadership, and interpersonal skills—are also important indicators of success. Admissions counselors and recruiters alike expect that financial engineering graduates have the ability to communicate effectively both orally and in writing in English.

The Essay: Clarity Is Worth a Thousand Words (or Less)

It's not surprising that many financial engineering candidates are less than enthused about tackling the essay accompanying their application. After all, GRE and GMAT scores speak for your qualifications, right? Wrong. It's important that you convey your aspirations in a way that helps admissions counselors familiarize themselves with you . . . outside quant.

Be sure to answer the question you're being asked. There's no need to infer and unnecessarily read between the lines. Often candidates will try to be wordy and elaborate in the essay, and they ultimately lose site of the question the program is truly seeking to answer. Be clear, concise, and direct and avoid any misinterpretation.

Evaluate your career goals. Take time to read and talk with others in the industry, including students and alumni of the programs to which you are applying so that you can present a clear career plan. Also, take the time to understand the programs. No two are alike, and, in fact, many are very different. Take those strong quant skills and use them for your own benefit by assessing the differences among programs. It is your responsibility to understand each program's unique differences and which differences best support your career goals. Within your essay, show the admission counselor that you understand the program and are familiar with its mission and distinctions . . . and how it aligns with your goals. As admissions counselors, we are trained to spot pat answers that appear to be "one size fits all" essays. Don't fall into the trap of thinking one essay will meet the needs of all applications.

". . . any manager and executive will tell you that the less quantitative skills—communication, presentation, team leadership, and interpersonal skills—are also important indicators of success."

Proofread! There is no excuse for typos and obvious grammar errors. Employers expect strong verbal skills, and schools are no different. Use your computer's spell check function and be sure to proofread your essays. I always advise candidates to pass along essays to friends and family and ask them to guess what question preceded the essay question. If they guess correctly, you've done a terrific job of providing a clear, direct response . . . and they may also spot the errant typo!

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Don't fall prey to the temptation of presenting yourself as something you're not. Programs are seeking authenticity—admissions counselors want to know who you are . . . not who you think you are. Be sure to write an essay that is honest and don't second-guess yourself. Allow your personality to come through, and tell the story of who you are, your interests, and goals within the field of quantitative finance.

Making the Most of the Application Process

There are a few aspects of the application process in which candidates make common errors. Because you've been thinking about grad school for quite some time, it's easy to assume that admissions reps understand what's on your mind. But, not so! There are many thousands of applicants each year, men and women who have varying motivations, backgrounds, and expectations.

Just as there is no one "typical" financial engineering program, there is no one "average" student.

The tips below will assist in avoiding some common application mistakes:

- Treat the admissions interview as if it were a job interview. The level of professionalism you lend to gaining admittance into graduate school is no less than the standard you would lend to a new job. Be sure to arrive on time, even a bit early. Dress appropriately in business attire. Allow the meeting to proceed as a dialogue (with two people), not a monologue (featuring only your comments).

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2013–14 Ranking of Financial Engineering programs

The 2013–2014 Quantnet ranking is the most comprehensive ranking to date of master programs in Financial Engineering (MFE), Mathematical Finance in North America. QuantNet surveyed program administrators, hiring managers, and quantitative finance professionals from financial institutions around the world for statistics reflecting student selectivity and graduate employment.

Click here for the Ranking list.

- Be prepared. Understand your goals and be ready to communicate how your aims for a graduate school education support your career plan. Rather than say, "I want to get a job in finance," share your knowledge of the industry and how the school in which you are interviewing will advance your career objectives.

- Often, there is a lot to be learned via the questions that are asked, so be sure to ask questions of the interviewer as well. School websites may not have 100% of the information you are seeking, so make a list of questions that were not obvious from your secondary research.

- Your letter of recommendation is a key tool that helps to tell the story of who you are. Applicants often wonder about whom they should ask to write a letter of recommendation. Remember that title doesn't matter as much as content and familiarity. When selecting recommenders, choose someone who knows you well and can provide a robust recommendation letter with examples of your technical and/or professional qualities that will make you a good fit for the program. It is not, for example, advantageous to you to send along a letter signed by a CEO who only shares general information that lacks specificity and detail.

- Take the time to talk with your recommender in advance of applying to assure that he or she understands the program(s) to which you are applying and your goals associated with a financial engineering degree. This will help your recommender write a genuine letter that is thorough, thoughtful, and highlighted by examples of your analytical skills as well as your potential for career success.

Most importantly, take the time to prepare that is commensurate with the effort you will ultimately put forth in grad school. The admissions process is an ideal opportunity for self-reflection. Schools won't need to be convinced that you're a larger-than-life leader in the making, but rather, admissions officers are genuinely seeking to understand your goals and interests in the field of quantitative finance . . . so don't make them work hard to appreciate your story! The strongest application is the one that is supported by preparation, so invest in yourself and enjoy the return on investment.

Gwen Stanczak is the Director of Admissions for the Carnegie Mellon University MSCF Program. Gwen holds a dual BA in Psychology and Spanish from Kutztown University of Pennsylvania and a Master in Public Management from Carnegie Mellon. Gwen is available to discuss all aspects of the application process with prospective MSCF students and to assist admitted students in the transition into the MSCF program.

READING LIST: Books for Applicants and Students of Financial Engineering Programs

This Reading List recommends books to help prepare students who will apply for or begin their MFE study soon. The books cover many topics MFE students should know when they interview for quantitative finance internships during their first semester.

A Primer for the Mathematics of Financial Engineering

AUTHOR: Dan Stefanica
PAGES: 352
Format: Paperback
WHY YOU SHOULD READ IT: Dan Stefanica's book is used by many prospective MFE applicants to refresh mathematical concepts and understand the quantitative models used in financial engineering. It contains 175 exercises, many of these being frequently asked interview questions. The book also includes pseudo-code allowing readers to implement numerical methods in a programming language of their choice.

Options, Futures, and Other Derivatives

AUTHOR: John C. Hull
PAGES: 864
FORMAT: Hardcover
WHY YOU SHOULD READ IT: This book is considered "the Bible" for finance practitioners and a popular textbook for business students, particularly those with a limited background in math. The book covers the major financial products, their practical uses, and valuations.

An Introduction to the Mathematics of Financial Derivatives

AUTHOR: Salih N. Neftci
PAGES: 527
FORMAT: Hardcover, Paperback, Kindle
WHY YOU SHOULD READ IT: This book provides an excellent treatment of the mathematics underlying the pricing of derivatives. Aimed at professionals and students in PhD or MBA programs, Neftci provides clear explanations of complex financial products from a practitioner's point of view.

Frequently Asked Questions in Quantitative Finance

AUTHOR: Paul Wilmott
PAGES: 624
FORMAT: Paperback, Kindle
WHY YOU SHOULD READ IT: The book provides a broad overview and FAQ of main topics that every financial engineering master student should know in order to prepare for their internship and job interviews. Wilmott discusses quantitative finance theory as well as everyday practice, including how to solve popular models, equations, and formulae.

See more recommended reading at QUANTNET MASTER READING LIST FOR QUANTS.

SECTION 3:
Getting a Job

Job Search Strategies & Interview Techniques

Questions and Answers

By Ellen Reeves

Can I Wear My Nose Ring to the Interview? *is based on the real job-hunting questions my students and clients have asked me over the years. In preparing students for the quant job hunt at Baruch's Master's in Financial Engineering program in New York and the Master of Science in Computational Finance and Risk Management program at the University of Washington, I've been asked the following questions:*

How do I approach looking for a job?

Stop Looking for a Job and Look for a Person

The mantra of my book is the strategy I advise for all job-seekers: Stop looking for a job and start looking for a person. The right person will lead you to the right job or opportunity.

Applying blindly is less effective than targeting specific jobs and companies and then using alumni and other community contacts and social media to get inside the company, to have informational interviews, and get your name and resume circulated from inside. It takes work, but you can usually find someone to connect you. Use LinkedIn and Facebook to post a note asking if anyone knows ANYONE at a company you're interested in or where you're applying, and ignore geography; for example, someone in the West Coast office of a company is likely to have some contacts in their East Coast office.

The 80-20 Rule

Stop sending your resume hurtling into the black void of cyberspace. It's depressing, and statistically, only 20% of jobs are filled by over-the-transom applications. Eighty percent of all jobs are filled by personal referral, and 80% of all jobs (although not the same 80%; I know I can't pull the statistical wool over quant eyes) are never even advertised; they exist in what we call the Hidden Job Market. I'm not a quant, but even my basic math tells me that it's better to spend 100% of your time on 80% of the opportunities. But you have to know what you're looking for, understand the requirements of the jobs you want to apply for, and be able to spin your past experience to the needs of the employer. Recruiters and hiring managers will tell you that authenticity wins out every time; an interviewer can sense if you really want a job or not. Don't apply for a job just because you can get it. Apply for it because you want it. Self-confidence is key; it's a lot easier to feel confident if you know you're as prepared as you could be and that you really want the job at hand.

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"Recruiters and hiring managers will tell you that authenticity wins out every time; an interviewer can sense if you really want a job or not."

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Tap into the Hidden Job Market

To tap into the Hidden Job Market, you've got to get out there and start talking to people. Hone your "elevator pitch" and let people know who you are, what you can do for them, and what you're looking for. Employers have two concerns: making money and saving money. Show them how you can do this for them and you're golden.

The Rule of 3

It's important to break what could be an overwhelming job search or career transition into manageable, bite-sized tasks. Use what I call "The Rule of 3." Vow to reach out by phone or email to three people a day to jumpstart your job search. Ask each person for another lead to a job or informational interview. If you did this every day for a year, even taking the weekends off, you'd speak with almost 1,000 people—and this is obviously more than you need. But you can handle three contacts a day: one in the morning, one at lunch, one in the evening, right? If this seems overwhelming, aim for three a week.

"Set easy goals: go to one lecture or event each week and introduce yourself to three people."

Start today. Make a list of the people to whom you can reach out easily. Begin with family and friends who will be most receptive and let the circle widen from there. Make sure you have an up-to-date resume and LinkedIn profile, and a business card with your name and contact information (just name, phone, and email address).

How can I stand out at a career fair or recruiting event?

Career fairs and recruiting events can feel like insane, giant meat markets. You are not going to have just one interview; you may have a dozen impromptu interviews! Just as you'd prepare for a regular interview, prepare for the fair. Try to find out in advance which companies will be represented and who is representing the company. Research the companies and representatives as much as you can. Get a good night's sleep and come having eaten a good breakfast or lunch. Remember these tips:

- Dress neatly and presentably with some memorable, but not outlandish, detail: a good tie, great scarf, bright color, or interesting piece of jewelry.

- Be extremely knowledgeable about the company and ask intelligent questions. Ask to set up an informational interview at a later date because you're so committed to the company whether the jobs listed (if they have specific openings) pan out or not. Be well-prepared for what could be a real, on-the-spot interview! Be ready with your 30-second pitch and concrete, brief examples to convince the recruiter what you can do for the company. Your delivery must be enthusiastic and energetic but authentic.

- Make sure you know with whom you're speaking so you can spin your pitch accordingly. Is this an HR person? The person for whom you'd be working? Be sure to get his/her card or title so you can thank the person and follow up.

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- Have an excellent resume and cover letter tailored to each company's needs and to a specific job description if there is one (i.e., find out what might be available online ahead of time). Target the companies you'd really like to work for. Have a business card ready.

"Do not take upall the recruiter's time . . . say, 'I'd like to talk more. . . . Could we exchange cards and set up a phone meeting or another time to talk?'"

- Do not take up all the recruiter's time. If the representative is alone and can't leave the booth, offer a favor: "May I get you a glass of water?" If you are engaged in a great conversation but there's a line of people, say "I'd like to talk more, but I know other people are waiting. Could we exchange cards and set up a phone meeting or another time to talk?" And if you see shy colleagues or classmates waiting on the periphery, say, "May I introduce my classmate John?"

I'm sure you know the "quant" types here are mostly Asian males, introverted types. The language barrier is one reason they don't network as much as they should. How would you advise they break the ice and better sell themselves?

It's a vicious circle, because the less you interact with people, the less you feel you can, because your language skills and confidence aren't developing if you're not talking as much as possible with native speakers. A few things to think about:

- Improve your language skills, both passively (listening to the radio, watching TV, and movies) and actively by getting involved in an activity you like or having lunch with native speakers.

- I ask my more outgoing students to take shyer students under their wing, and I tell the shy ones to ask the more outgoing ones for help.

- Set easy goals: go to one lecture or event each week and introduce yourself to three people. You have to get used to saying politely "May I join you?" but prepare yourself for a not-always friendly response. Don't take it personally. You may go through uncomfortable periods, but if you stick with it, you'll be amazed at how your confidence level and language will improve.

- If you know someone who has conquered these barriers, ask about his/her story.

Do you have advice about a LinkedIn profile?

The LinkedIn profile is an uploaded version of your resume. You can add a professional photo if you choose, but remember that if you do, you may be giving employers access to information it's illegal for them to ask about, including race, age, and gender. Recommendations should be current—recommendations that are not from this year are too out of date. Have at least one from this year to offset older ones. Tailor the headers of categories to what you're looking for and the keywords you read in job listings. As you would for a resume, avoid self-assessment and adjectives that are subjective: "excellent communication skills" or "strong programming skills." Instead, use neutral, unassailable, objective language showing what you have done with that skill: "extensive experience with C++" or better yet, a line about a project you did using it. BE SPECIFIC!

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In my experience and from asking clients and students, LinkedIn is more useful for finding leads and making connections than being an actual source of jobs (apart from headhunters scanning them).

"Learning how to talk about your transferable skills is the name of the game."

How do I talk about my previous experience and/or a career change?

Highlight Your Transferable Skills for the Employer

Learn to talk about past experience in terms of the language of your target job. Make analogies for the employer. Do the work and make the connections for him or her by doing enough research and informational interviewing before the actual interview so that you know what the company is looking for and how your past experience may be valuable. Learning how to talk about your transferable skills is the name of the game.

When You're Job-hunting, Nothing is Bad: X was Good; Y is Better

Even if the reality is that you hated your previous work, speak only positively about it: "Although I learned so much working on my PhD in chemistry, the more I learned about quantitative finance, the more I realized how well my background would serve me and how interesting the field is." Then give a concrete, specific anecdote to illustrate your point.

How important is appearance?

Project the Best Professional You Possible

As Mark Twain says, you never get a second chance to make a first impression. This is your only chance to look professional with advance notice; what you are saying in an interview with how you look and dress is: This is the best professional me I can be. Everything is an act of self-presentation and everything is a signal to the employer about what kind of work you will do for him or her, whether you can follow directions and whether you understand the conventions of the industry. A loose button, wrinkled clothes, sweaty palms, ragged nails and cuticles, unkempt hair, body odor, or bad breath means you haven't taken care of things you could have taken care of, that you aren't meticulous and attentive to detail.

What to Wear to the Interview

Get your clothes tailored; have someone look you over before you leave for the interview; check yourself in the restroom before the interview starts. Err on the side of dressing conservatively.

FOR MEN: A dark suit, preferably navy or charcoal gray. The risk of the black suit is looking like an undertaker, so be careful. Choose a conservative, matching tie and a solid white shirt. Your shoes should be well-polished, lace-up black shoes. Make sure your belt matches your shoes (plain, professional belt buckle) and that the socks match pants. Socks should be solid color and match each other. You must be clean-shaven with a good haircut and well-groomed nails and eyebrows. No visible jewelry besides a professional watch. Use no/very little cologne or aftershave.

HERE'S ADVICE FROM A WALL STREET MANAGER: Think Brooks Brothers if your budget permits it; otherwise, consider Jos. A. Bank and Land's End. The latter two have business wear that is reasonable in price and popular with Wall Street people.

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FOR WOMEN, an equivalent conservative suit or pants suit or professional-looking dress—not evening or casual day-time wear—with properly fitting and concealed undergarments. Wear nude stockings, minimal jewelry and makeup, shoes with an appropriate heel, natural nail color, and hair groomed and not constantly in your face. You don't need to look like a man, but you need to look like a professional business woman.

As classes start and students are distracted by their academic responsibilities, how can we stay prepared for the interview process?

Go into the semester with a job-hunting plan and goal in place. The community of your school is so important, and I always tell my students that they—and the faculty and staff—are each other's best resources when it comes to interviewing if the spirit is collaborative and not competitive.

- Sit down with your class schedule, block out times for study, eating, sleeping, exercise, family, social and work responsibilities, and schedule coffee, lunch, or a drink with people who can enlighten you about what they do.

"Go into the semester with a job-hunting plan and goal in place."

- Block out time every week to read industry periodicals and attend recruiting sessions and special lectures where you can introduce yourself to people in the industry.

- Find out where everyone worked this summer or had internships. If there are 25 students in a class, this means you've got 25 (well, 50) feet in the door already, plus the families and friends of those fellow students.

- Set up exploratory interviews with and through classmates, faculty, former colleagues and connections through LinkedIn to find out what kind of job you may want.

- Choose a capstone or independent project if your school has one to test out an area and see if you like it.

- Take time every week to browse QuantNet, LinkedIn, and other sites of interest.

- If you've already defined companies or areas in which you'd like to work, focus on networking there. I recommend choosing the top three, then focusing on the first one until you've exhausted all your resources and connections, then move on to number two.

- Plan your interview wardrobe.

- Practice your elevator pitch.

How do I prepare for the first interview? Second interview?

- Review your resume.

- Make sure you have rehearsed a brief anecdote highlighting your contributions and achievements for everything on it.

- Do some mock interviewing with colleagues or college or graduate school career services, and rehearse answers to both basic and tough questions: "Why do you want to work here? Why should we hire you? What are your strengths and weaknesses?" and so on.

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- If the company will tell you, find out with whom you'll be interviewing; look up LinkedIn profiles, and set a Google alert for the interviewers and for the company or department.

- Research the company and department and do as much informational interviewing as you can around the position. The more you know about how the company works, from those who work there or from clients or competitors, the better.

- Prepare a list of questions you want to ask and points you want to bring up in the interview.

- At a first interview, ask "If I were hired, what would be my first tasks?" If you have a second interview, come prepared with a plan for how to handle some of the tasks or issues they've said you'd be responsible for: "I took the liberty of thinking about X."

- Demonstrate that you really want the job and can hit the ground running. Ask "I know what the stated job description says, but can you tell me more about what has worked and not worked for you in the past?"and then spin your answer with anecdotes to address their interests and concerns.

For more on topics including what to do in the waiting room, getting rid of anxiety, handling difficult or illegal questions, see "Getting Through the Interview" in *Can I Wear My Nose Ring to the Interview?*

"The note stresses why you want the job (framed as what you can do for the employer), and why you're the right person to do the job.]."

What do I do after the interview? Should I waste time sending a thank-you note?

Follow Up After the Interview

WASTE YOUR TIME? To me, the thank-you note is an essential part of the interview. Email a note right away (this way, it can be easily circulated; don't send the exact same note to everyone!) and follow up with a neatly handwritten note. This gives you a chance to reiterate how much you want the job, to note anything you left out, and to show that you are someone who follows up. There ARE no jobs that don't require some kind of follow-up, and the thank you note is key.

The note stresses why you want the job (framed as what you can do for the employer), and why you're the right person to do the job. And even if you don't want the job, why not stand out as someone polite and professional? You've made a professional connection through the interview—maintain it! If, after the interview, you know you wouldn't take the job if it were offered to you, withdraw your candidacy politely. ("Dear Ms. So-and-So: I so much enjoyed our interview today. Thank you for taking the time to meet with me. Given that the job entails x, y, and z as you described today, I am writing to withdraw my candidacy; I am looking for a position that involves more . . . . If you have or know of another such opening in another department, I'd be very interested. Best, . . . ")

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Ask for the Job If You Want It

Use yourself as a litmus test for what's annoying. You don't want to be perceived as a stalker, but you must follow up. Employers say that the reason many people don't get jobs they've applied for is that they don't follow up after an interview. They never say they actually WANT the job. They don't send a thank-you note; they just wait for the judgment to be handed down. NO! The successful job search is actually the intersection of two searches—yours for the right job, and the employers' for the right employee.

"Everyone has an accent . . . never pretend you understand what someone is saying if you don't."

Ask What the Hiring Timeline Is

At the end of the interview, find out what the hiring timeline is and how you should follow up. You are not going to be denied the job because you ask this question: "What's your hiring timeline? If I don't hear from you, may I check back in two weeks? Would you prefer to be contacted by phone or email?"

I am a non-native English speaker and worried about interviews, particularly phone interviews—or conversely, I am a native English speaker but can't understand the accent of my interviewer. Any tips?

Don't Pretend You Understand If You Don't

Everyone has an accent. It's important never to pretend you understand what someone is saying if you don't.

- Be direct with the interviewer. At the beginning of the interview, say, "As you can probably tell from my accent, I'm not a native English speaker, and I can function perfectly well in English, but I hope you won't mind if I ask you to speak slowly or to repeat things." This is especially important for phone and video or Skype interviews.

- Improving your accent: Listen to National Public Radio (NPR). If you are interested in working on your language skills and accent—and this goes for native speakers, too—listen to NPR hosts (not the guests!), most of whom speak clear and standard English.

Tackle One Language Issue at a Time

Don't try to tackle everything at once; choose one issue to work on, for example the "th" sound in "the." Practice saying words with "th." Exaggerate the sound by 1) Making sure your tongue licks the bottom of your top teeth, 2) Placing your forefinger in front of your mouth, and 3) Making sure your tongue touches your finger as you make the "th" sound.

People can't pronounce my name. Should I use a nickname, a transliteration, or a classically "American" name?

This is an individual decision about your own identity; a compromise may be to use a transliteration of your real name with a nickname, and on your resume list the nickname in parentheses, that is, Yingxue (Jay) Cheng if that's comfortable for you.

Make it Easy for the Interviewer

Interviewers don't like to feel incompetent, and if they can't pronounce your name or tell whether you are male or female—even though it's not your fault at all—they may literally move on to the next resume, so make it as easy as possible for them.

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Offer Gender Markers

The field is male dominated; if you are a woman, offer a gender marker on your resume if your name doesn't indicate gender to an English-speaker: (*Member, Women in Business, Baruch College*).

Offer Pronunciation Aids

When you meet the interviewer, state your name clearly and offer some help with the pronunciation: "Hi, I'm Samita, like Anita" or "My name is Xin—like shin" (and point to it).

Get American Friends to Work with You

With friends, practice things like greeting an employer. For example, when greeting employers or colleagues in America, you must look people in the eye and have a firm handshake.

If you are used to bowing and/or looking down, or covering your mouth when you speak, you must practice NOT doing these things.

If you're interviewed over a meal or invited for a meal or drink after an interview, you have to make sure not to eat with your mouth open, not to slurp or make noise while you eat, not to order the messiest or most expensive items on the menu, and so on. These are the small things that can sink you despite a great interview, and it's likely that no one will tell you. Etiquette resources like the classic Emily Post or Miss Manners books can help!

"(Dining etiquette) is about showing that you understand cultural conventions and can work within a new culture."

I sometimes feel I am at a disadvantage since I am from another country. How do I deal with cultural differences?

Your Cultural Advantage

To the contrary! You have an advantage. You speak your language and probably others, as well as English; you have insider knowledge of another culture or cultures including how business is done, how the economy of that country functions—embrace it and use what you know! You can easily learn about and work on questions of etiquette.

Learn American Dining Etiquette

You must learn which utensils are used for which foods. At dinner one night, I saw one of my highly talented students with a PhD butter her roll with a fork. She was about to have 10 interviews at Citibank, and I knew this could jeopardize her candidacy. While you might think something like this has nothing to do with one's capacity to do the job, it's not about that: it's about showing that you understand cultural conventions and can work within a new culture.

I tend to be shy. How do I talk to people and maintain my network? How do I follow up with people, build and maintain my network?

Don't Be a Wallflower

If you're offered the chance to go to a recruiting event, cocktail party, or any kind of professional development event, go! Set a goal for yourself of meeting and talking to at least three new people. Ride the coat tails of your more outgoing colleagues or classmates; ask if they (or the hosts and organizers) will introduce you to people. If someone offers a card, follow up with a note and a brief reminder of how you met and what you talked about.

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"... it's the employer's job to offer you as little as possible and see what's the lowest you will accept, and it's your job to advocate for the best package you can get."

Don't Forget About Your References

Remember that your references are a key part of your network. Check in with them periodically, ask them for leads, thank them, and follow up. Seek new references as necessary.

How do I negotiate salary and benefits?

You've Got to Negotiate

You never have more leverage than between the time you've been offered the job and the time you accept it. People are uncomfortable negotiating for themselves. So if you're going to feel sick, which would make you feel sicker? Negotiating and getting a better package, or not negotiating and finding out that someone else was hired at the same level but with a higher salary and better benefits simply because he/she negotiated? Remember that it's the employer's job to offer you as little as possible and see what's the lowest you will accept, and it's your job to advocate for the best package you can get.

- Stay positive; assume you can reach a compromise. Say "I'm really excited about this job. I know we can make this work."
- Ask "Is there any flexibility there?"
- Try not to put all your cards on the table at once. The lowest number you state may be your salary, so be careful.
- Negotiate based on what you bring to the position, not what you think you're worth or what you "need." Your lifestyle choices or debt are not the employer's problem.
- Go in armed with a sense of the salary range not only for this industry but for the company and geographical location.
- Find out what the employer values most. Think beyond salary—benefits, vacation, and perks may be negotiable.

Above All: Feel Valuable, Not Vulnerable

Take control of your job hunt with these tips. I want you to feel valuable, not vulnerable. There's no reason why you shouldn't have the job you want—even in this economy.

I didn't get an offer for a job I really wanted. I feel depressed and rejected. What do I do?

When someone doesn't get an offer, I say: Congratulations! A bullet dodged you. This means it wasn't the right job for you, for whatever reason. Because if it were, you would have gotten it. You were spared for the right job. Here are a few things to consider, excerpted from my book *Can I Wear My Nose Ring to the Interview?*

- If you feel you had a good rapport with the interviewer, it doesn't hurt to ask for feedback. "I'm very disappointed. I'm wondering if, at your convenience, you might be able to offer suggestions for improving my candidacy."

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One candidate found she was competing with a pool of MBA candidates; she was also told that during her interview, her "headlining" skills were weak. They expected her to be able to offer a brief, focused summary of her resume orally, tying her skills and experience to the stated job requirements.

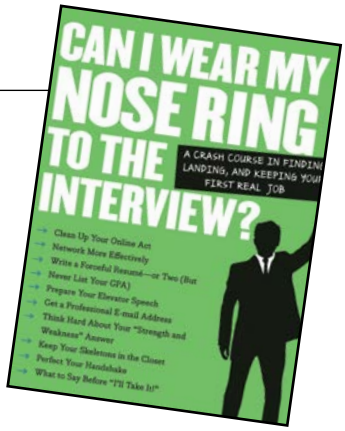
- Were you perceived as overqualified? Time to rethink your resume or the jobs for which you're applying.

- Take steps to remedy any obstacles that might be standing in your way. If you think you're lacking experience, go out and get some. Intern, volunteer, or temp in the field.

"If you think you're lacking experience, go out and get some. Intern, volunteer, or temp in the field."

If the interviews went well and you get the sense that you were a top candidate, communicate how much you enjoyed the interview process and the people; express that you're more determined than ever to find the right position at the company, and ask if they'd be willing to keep your resume on file. Keep in touch. Another position might become available in a few months or even weeks.

Good luck!



Career and workplace advisor Ellen Gordon Reeves, QuantNet career columnist, is the author of the *Business Week* bestseller, *Can I Wear My Nose Ring to the Interview? A Crash Course in Finding, Landing, and Keeping Your First Real Job,* featured in media including CNN, CBS, ABC, FOX, NPR, and *Money Magazine*. She teaches communications, interviewing, job-hunting, and self-presentation skills in programs including Baruch's Masters in Financial Engineering and the University of Washington Masters in Computational Finance, preparing students for the job market. Read her career advice column at https://www.quantnet.com/threads/ask-ellen-job-hunting-and-career-development-advice.10689/.

Contact her at caniwearmynosering@gmail.com to sign up for *Extreme Professional Makeover: Boot Camp for the 2014 Quant Job/Internship Hunt* (December, NYC), to inquire about bringing the boot camp to your campus, or to bring her *DIYPD (Do-It-Yourself Professional Development): Making Your Workplace Work for You or DIYPD: Making the Most of Your Internship* workshops to your firm or organization.

Finance Industry Dictates Changes to Job Market

By Ken Abbott

The job market for quants has changed inexorably. The "particle finance" trend of the last 20 years is on the wane. While funds will still be able to trade on a prop basis, banks' ability to do so has been severely restricted. Some may see this as a pendulum, but most agree that the aggressive trading styles seen in regulated financial institutions will never be seen again.

Does that mean that there are no more jobs for quants? Certainly not. It does mean, however, that the nature of the job market will be different. The growing number of quant finance programs also suggests that there will be much more competition for these jobs.

The following suggestions may be helpful in the job hunt.

- Stop focusing upon HFT positions—there aren't that many jobs out there, and many of the people who get those jobs find that it's VERY hard to make money.
- Consider positions in model review, audit, and price verification. Those areas are growing rapidly.
- Check the job ads at the regulatory agencies (FRB, SEC, OCC, CFTC, and FINRA). Many people get their start at these organizations.
- Think about jobs outside of banking. Corporate treasuries need quants, too, as do data/media companies.
- Know the industry. Be able to identify the top firms in each sector in which you interview (hedge funds, banks, insurance companies, etc.) Read the industry press. Know the regulatory landscape.
- Know the company. Read their annual report. Know their position in the industry and their strengths and weaknesses. Read all recent news articles about them.
- Don't spout off about all the big-name academics you know. Everyone else knows them, too.
- Have a good reason for wanting to be in finance. Wanting to make lots of money isn't one of them. Be convincing or you'll be tagged as a gold digger.
- Dress the part. Show up for your interview in business attire. Wall Street isn't Silicon Valley.

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- Speak clearly. One of the biggest challenges facing many quants is being articulate. Most senior executives, while intelligent, aren't quants. Be able to express complex concepts in simple terms.

- Don't pad your resume. If you make a major omission or misstate something, there's a good chance you'll be discovered and dismissed. Be prepared to discuss any topic you mention in your vitae. The quickest way to get dinged is to come off as a faker.

- Have an opinion. Show that you've thought about the issues facing the industry. Keep on top of current events.

- Don't get thrown off by a tough question. Pressure is part of the business. Do the best you can. If you simply don't know the answer, say so. Don't try to fake it. One flubbed response doesn't ruin an interview.

- Don't talk salary. The market is reasonably efficient. If you try to negotiate too hard, you will run into difficulty.

- Stop worrying about your GPA. It probably won't matter that much unless it's really low.

- Don't brag too much about your programming expertise unless you're interviewing for a programming job. While there's an overlap, most quants aren't programmers and most programmers aren't quants.

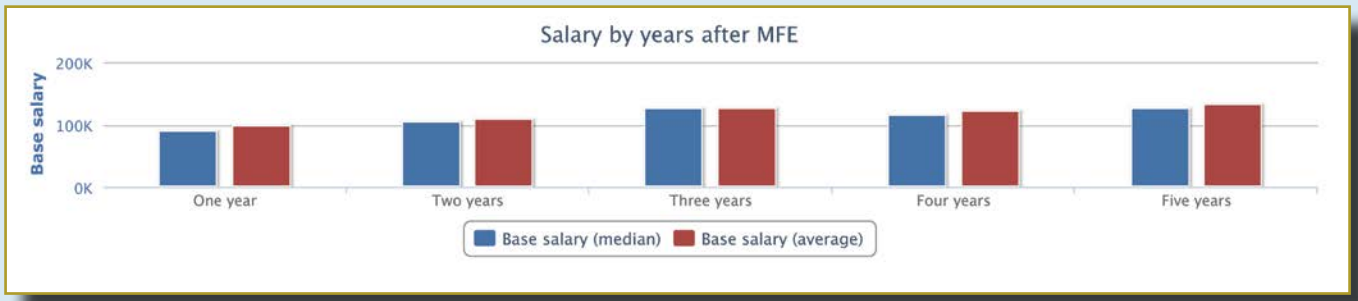
Kenneth Abbott is a Managing Director at Morgan Stanley, where he is the Chief Operating Officer for Firm Risk Management. In addition, he also supervises the risk management of the Investment Management businesses. He is also responsible for legal entity risk management for Morgan Stanley's US swap dealers and and sits on the investment and valuation committees for the Morgan Stanley Private Equity and Infrastructure funds. Previously, he ran market risk management for Bank of America's Investment Bank. He has over 30 years banking experience, including 14 years at Bankers Trust as an analyst, trader, and risk manager. Ken has a B.A. from Harvard in Economics, an M.A. from NYU in Economics and an M.S. from NYU/Stern in Statistics and Operations Research. He is an adjunct faculty member at NYU, Baruch, and Claremont and sits on the Board of Trustees for the Global Association of Risk Professionals (GARP) and the NJ Scholars Program.

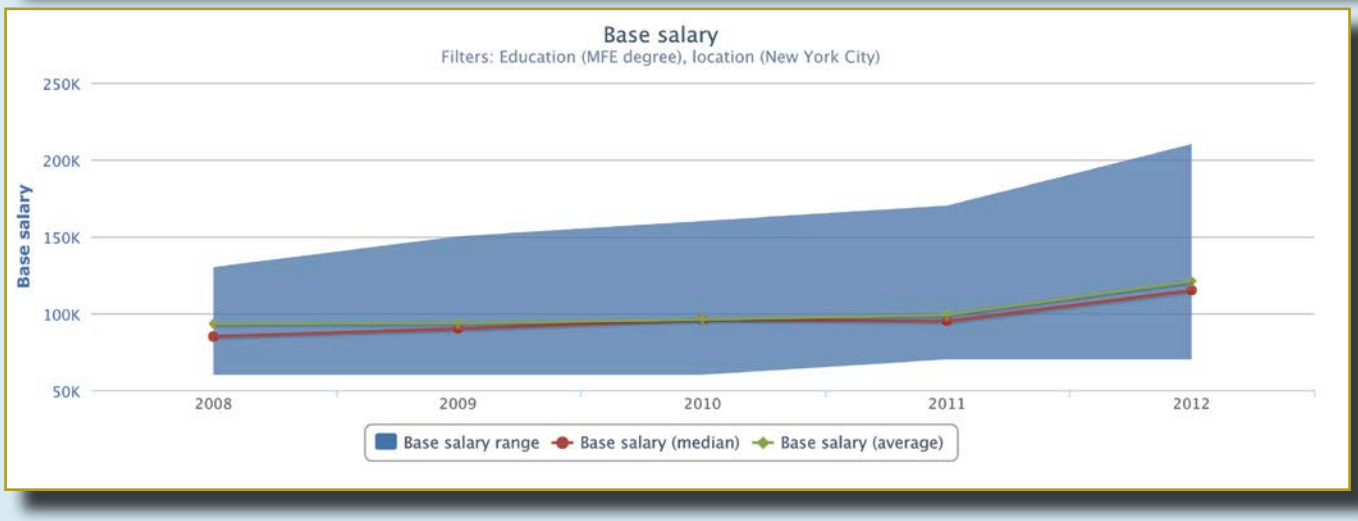
QuantNet SALARY SURVEY

Ever wonder how your compensation compares with other MFE graduates with a similar job and experience profile?

Ever wonder about the base/bonus when you move to the buy side?

Go to quantnet.com/salary to see the results of the QuantNet Salary Survey, a constantly updating tool that allows you to anonymously compare your base salary and bonus against others. Using QuantNet's filters, you can create a more precise comparison based on your education level, location, job type, employer type and size, years of work experience after MFE and other factors.





Questions Asked at Quant Interviews

These are sample questions similar to those you might be asked during an interview. For more questions and solutions, visit the Quant Interviews section.

Brainteasers

1. You and other Santas are attending a Santas-only Christmas party where every Santa knows exactly 22 other Santas. Among the 22 Santas, each Santa knows none know each other. But any two Santas who do not know each other have exactly six mutual friends present. How many Santas are at the party?
2. There are two sealed envelopes: one has $50, and another has $100. You get to choose one at random and keep the money. How much would you be willing to pay for this?
3. Assume now that you have $50M and $100M. How much would you be willing to pay this time?
4. You and a friend are playing a game where a random number X between 1 to 20 is chosen. One of you will pick a number and then the other will pick a different number. The one who guesses the closer number wins X dollars. Should you choose to go first? What number should you choose?
5. There are 60 blue ribbons in a box such that all 120 ends are hanging out and you cannot see which ends belong to which ribbons. You randomly join all 120 ends together into pretty bows and dump out the box. Depending on chance you will form anywhere from 1 to 60 loops. How many loops would you expect?

Programming

1. Write one line of code to swap the contents two variables without using a temp variable.
2. Write a program to print 1-100 and backward without using loops.
3. Write a function to compute factorial using recursion.
4. Do the same for Fibonacci numbers.
5. Write a class, in an object oriented programming language, which performs arithmetic operations between arbitrarily large numbers.
6. With an integer represented as a string, write a function that represents this number with the thousands separated by commas.

Finance

1. How do you price swap rate? How do you price swaption? What is Macaulay, modified, effective, dollar duration?
2. Which bond has higher duration: the five-year coupon bond or the five-year zero-coupon bond?
3. If the cost of money (prevailing interest rate) rises from 4% to 5%, does that affect a five-year zero coupon bond's duration?
4. What is the value of an ATM European call with time to maturity as infinity? What is the value of American ATM with time to maturity infinity?
5. Consider a one-period binomial tree with r = 0, u = 10, and d = 5. Write the equations you would write to get a risk-neutral world. Calculate the price of the option. What's wrong with the price you get?

Firms that Employ Graduates with MFE Degrees

These firms hire graduates with master's of Financial Engineering degrees. While this list is by no means exhaustive, it does show the international reach of the field, as well as a place to begin your job search. *Click on the company names (below) for site links.*

INVESTMENT BANKS
Bank of America Merrill Lynch
Barclays Capital
BNP Paribas
Citigroup
Credit Suisse
Deutsche Bank
Goldman Sachs
J.P.Morgan
Morgan Stanley
Nomura
Societe Generale
UBS

PROP TRADING
Chicago Trading Company
Chopper Trading
DRW Trading Group
GETCO
Jane Street
Jump Trading
Nico Trading
QuantRes
RSJ
Spot Trading
TransMarket Group
Walleye Trading
Wolverine Trading

HEDGE FUNDS
AQR Capital Management
Aviva Investors
Bogle Investment Management
Bridgewater
Citadel Group
Clinton Group
DEShaw
DFG Investment Advisers
First Quadrant
GBAR
Glenwood Capital Investment
Houlihan Lokey Howard & Zukin
Infinum Capital Management
Investec
Knight Capital Group
M&G Investments
Mitsubishi UFJ Securities International
Numeric Investors
Nuveen Investment
Optiver
QVT Financial
SIG Susquehanna
State Street
Tower Research Capital
Two Sigma Investments

COMMERCIAL BANKS
Commerzbank
HSBC
ING
Royal Bank of Canada
Royal Bank of Scotland
Standard Chartered Bank
Wells Fargo

FINANCIAL SERVICES
Bloomberg Financials
FINCAD
Gloucester Research
Interactive Brokers
Numerix
Opera Solutions
Quantifi Solutions
R^2 Financial Technologies
Thomson Reuters

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Firms That Employ Graduates with MFE Degrees *continued from page 79*

INVESTMENT/ASSET MANAGEMENT
Bank of New York Mellon
BlackRock
Oxam
PIMCO
TD Securities
Wellington Management
Putnam Investments

ACCOUNTING
Deloitte
Ernst & Young
KPMG
PwC

INSURANCE COMPANIES
American International Group
Aflac
Ameriprise Financial
Genworth Financial
Lincoln Financial Group
MassMutual Life
MetLife
Nationwide Financial Services
Pacific Life
Principal Financial Group
Prudential Financial

RATING AGENCIES
Fitch Rating
Moody's
Standard & Poor's

Did You Know?

The average base salary for quant professionals with a master of financial engineering or quantitative finance degree increases with each year on the job?

The base salary for new MFE graduates is $95,540 (average) and $85,000 (mean). For MFE grads with two-years experience, the numbers are $97,631 (average) and $95,000 (mean). Source: QuantNet Salary

For more information about salaries in the industry, click here.
You can also input your own salary and bonus information, along with your location and other factors to see how your pay compares to others in the industry.

Looking for a job now? Click here to visit the Jobs Forum.

Interested in posting a new job on QuantNet's Jobs Forum? Click here to submit.

Why Join a Professional Organization?

By Peg DiOrio

It doesn't matter whether you are a seasoned financial engineer or new to the field, you can benefit from membership in an industry organization. Professional organizations offer the opportunity to keep abreast of current trends and challenges in financial engineering, mix with industry leaders, and gain access to online informational databases and job boards, among other benefits. Some of these groups also publish their own journals, giving academics and students the chance to showcase your research.

Several of the organizations listed on the next page offer heavily discounted student memberships that carry the same benefits as professional memberships. For those just starting out, a student membership is a great way to meet people in your chosen field, find a career mentor, narrow your field of interest, learn more about the companies that hire financial engineers, and network for a job. Several groups give discounted event entry for members of other groups so your membership dollars go farther.

The chart on the next page lists four organizations with different focuses on financial engineering topics. The names link to the organizations' websites.

Peg DiOrio is a quantitative analyst whose projects over her nearly 20-year career include asset allocation, investment planning, portfolio optimization, alpha signal research, and multi-asset return modeling. She has extensive experience with high net worth and institutional clients. Peg holds an MS from NYU's Courant Institute and a BS from SUNY Stony Brook.

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	CHICAGO QUANTITATIVE ALLIANCE (CQA)	INTERNATIONAL ASSOCIATION FOR QUANTITATIVE FINANCE (IAQF)	QUANTITATIVE WORK ALLIANCE FOR APPLIED FINANCE, EDUCATION AND WISDOM (QWAFAFEW)	SOCIETY OF QUANTITATIVE ANALYSTS (SQA)
WHO SHOULD JOIN	Quantitative Investment Professionals	Quantitative Finance Professionals, Academics & Students	Investment Management Professionals & Quantitative Researchers	Quantitative Investment Professionals, Academics & Students
EVENTS & NETWORKING	Spring & Fall conferences, American Finance Association, European Finance Association, CQ Asia, Academic Review Sessions, Seminars Sample Event: "CQA/SQA Quantitative Trading Seminar"	Lectures, Master Classes, RiskMinds USA, Conferences, Committees, Job Board, Online Resources, Videos, Publications, Fisher Black Foundation Sample Event: "Models Behaving Badly: A Talk by Emanuel Derman"	Monthly Chapter Meetings, Job Boards (depending on chapter) Sample Event: "Hedge Fund Replication: Methods, Challenges and Benefits for Investors" by Michael Markov, Markov Processes	Monthly Meetings, Conferences, *Journal of Investment Management,* Discounted Institutional Publications, Job Board, Sample Event: "Learning and Adaptation in Financial Markets" Membership Description
MEMBERSHIP DESCRIPTION	Plenty of senior-level quants to network with. Good forum for discussing ideas.	Large proportion of students and recruiters from the industry. Meetings can be large (~75-100) which can make personal networking challenging.	Very informal, spirited, interactive meetings held in a bar, predominantly investment professionals.	Predominantly investment professionals and relevant academics. Monthly meeting size (~30-50) allows good personal networking opportunities.
MEMBERSHIP TYPES & FEES (PER YEAR)	$1,000/Regular membership. Waiting list for membership, which is restricted to those in quantitative investing. Fee includes access to all conferences.	$200/Practitioners, $100/ Academics, Student and Young Practitioner rates available. Students free if part of IAQF Academic Affiliate MFE program.	Rates vary by chapter, additional fees to attend another chapter's events.	$200/Regular, $100/ Academic, Transitional and Student rates available.

READING LIST: Books to Help Prepare for Quant Interviews

This Reading List recommends books to help students prepare for their interviews for quant internships and full-time jobs.

Quant Job Interview Questions and Answers

AUTHOR: Mark Joshi
PAGES: 326
FORMAT: Paperback
WHY YOU SHOULD READ IT: Designed for those seeking a job in quantitative finance, Mark Joshi's book contains more than 225 interview questions asked during actual interviews in New York City and on Wall Street. Each question comes with a full detailed solution, discussion of what the interviewer is seeking, and possible follow-up questions. The questions cover topics such as option pricing, probability, mathematics, numerical algorithms, and C++. The interview process and the non-technical interview are also discussed.

Frequently Asked Questions in Quantitative Finance

AUTHOR: Paul Wilmott
PAGES: 624
FORMAT: Paperback, Kindle
WHY YOU SHOULD READ IT: The book provides a broad overview and FAQ of main topics that every financial engineering master's student should know in order to prepare for their internship and job interviews. Wilmott discusses quantitative finance theory as well as everyday practice, including how to solve popular models, equations, and formulae.

Heard on the Street: Quantitative Questions from Wall Street Job Interviews

AUTHOR: Timothy Falcon Crack
PAGES: 268
FORMAT: Paperback
WHY YOU SHOULD READ IT: This is the original and most popular book on quantitative questions for finance job interviews. The revised 13th edition contains 185 quantitative questions collected from actual job interviews in investment banking, investment management, and options trading. The quant questions cover pure quant/logic, financial economics, derivatives, and statistics.

Cracking the Coding Interview: 150 Programming Questions and Solutions

AUTHOR: Gayle Laakmann McDowell
PAGES: 508
FORMAT: Paperback
WHY YOU SHOULD READ IT: No quant interview is complete without questions on programming, algorithms, and debugging. The book is highly technical and focuses on the software engineering skills required for many of the top quant algo trading jobs. The book includes 150 programming interview questions and answers, as well as tips on how to prepare and ace your programming interviews.

See more recommended reading at QUANTNET MASTER READING LIST FOR QUANTS.

SECTION 4:
Appendix

Excel 2007/2010 Shortcuts

CTRL Shortcuts

CTRL + A	Select All
CTRL + B	Bold
CTRL + C	Copy
CTRL + ALT + V	Paste Special
CTRL + D	Fill Down
CTRL + F	Find
CTRL + G	Go to
CTRL + H	Replace
CTRL + I	Italic
CTRL + K	Insert Hyperlink
CTRL + N	New Workbook
CTRL + O	Open File
CTRL + P	Print
CTRL + R	Fill right
CTRL + S	Save workbook
CTRL + T	Create Table
CTRL + U	Underline
CTRL + V	Paste
CTRL + W	Close window
CTRL + X	Cut
CTRL + Y	Repeat
CTRL + Z	Undo
CTRL + 1	Format Box
CTRL + 5	Strike-through
CTRL + 9	Hide row
SHIFT + CTRL + 9	Unhide row
CTRL + 0	Hide column
CTRL + ~	Show formulas/values
CTRL + ‘	Copy formula from above cell
CTRL + [	Precedents
CTRL +]	Dependents
CTRL + ;	Display date
SHIFT + CTRL + :	Display time
CTRL + Space	Select column
CTRL + Enter	Fill selection w/ entry

Columns and Rows

SHIFT + Spacebar	Highlight row
CTRL + Spacebar	Highlight column
SHIFT + ALT + →	Group rows/columns
SHIFT + ALT + ←	Ungroup rows/columns
CTRL + Minus sign	Delete selected cells
SHIFT + CTRL + Plus Sign	Insert blank cells
ALT + P + V + G	View gridlines
ALT + P + V + H	View headings

ALT Shortcuts

ALT + Tab	Switch program
ALT + ‘	Display style
CTRL + ALT + V	Paste special box
CTRL + ALT + V + T	Paste format only
ALT + W + S	(Un)split panes
ALT + W + F	(Un)freeze windows
ALT + H + O + M	Move/ Copy a sheet
ALT + H + D + S	Delete worksheet
ALT + W + Q	Change view sizing
ALT + H + O + I	Fit column width
ALT + H + O + R	Change tab name
ALT + H + E + A	Clear cell
ALT + H + L	Conditional format
ALT + H + A	Align
ALT + H + F + P	Format painter
ALT + H + F	Formatting
ALT + F + W + V	Print preview
ALT + F4	Close program
ALT + F8	Macro box
ALT + F11	Visual basic editor

Formatting Shortcuts

ALT + ‘	Display style
ALT + H + 0	Increase decimal
ALT + H + 9	Decrease decimal
CTRL + 1	Format Box
SHIFT + CTRL + ~	General format
SHIFT + CTRL + !	Number format
SHIFT + CTRL + @	Time format
SHIFT + CTRL + #	Date format
SHIFT + CTRL + $	Currency format
SHIFT + CTRL + %	Percentage format
SHIFT + CTRL + ^	Exponential format
SHIFT + CTRL + &	Outline border
SHIFT + CTRL + _	Remove border
SHIFT + CTRL + *	Select region
SHIFT + CTRL + Enter	Enter array formula

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Excel 2007/2010 Shortcuts

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Function Key Shortcuts

F1	Excel Help Menu
F2	Edit cells
F3	Paste Name
F4	Repeat or anchor cells
F5	"Go to"
F6	Zoom, task, sheet, split
F7	Spell check
F8	Anchor to highlight
F9	Recalculate workbooks
F10	Activate menu bar
F11	New chart
F12	Save as
SHIFT + F2	Insert a comment
SHIFT + F3	"Insert Function" Box
SHIFT + F4	Find Next
SHIFT + F5	Find
SHIFT + F6	Zoom, task, sheet
SHIFT + F8	Add to selection
SHIFT + F9	Calculate active sheet
SHIFT + F10	Display shortcut menu
SHIFT + F11	New worksheet
CTRL + F1	Min / Restore Ribbon
CTRL + F3	Name a cell
CTRL + F4	Close window
CTRL + F9	Minimize workbook
CTRL + F10	Maximize window
CTRL + F12	Open File
Windows Key + D	Minimize program
Windows Key + E	Windows explorer

Navigation and Data Editing

Arrow keys	Move to new cells
ALT + ↓	Display a drop-down list
ALT + Tab	Switch programs
CTRL + Pg Up/Down	Switch worksheets
CTRL + Tab	Switch workbooks
CTRL + Arrow keys	Go to end of contiguous range
SHIFT + Arrow keys	Select a cell range
SHIFT + CTRL + Arrow keys	Highlight contiguous range
Home	Move to beginning of line
CTRL + Home	Move to cell "A1"
F5	"Go to"
ENTER	Move to cell below
SHIFT + ENTER	Move to cell above
TAB	Move to cell to the right
SHIFT + TAB	Move to cell to the left
BACKSPACE	Delete cell and get inside
DELETE	Delete cell/selection
F2	Edit/ highlight dependent cells
When inside cell	
ALT + ENTER	Start new line in same cell
SHIFT + Arrow keys	Highlight within cells
SHIFT + CTRL + Arrow keys	Highlight contiguous items
BACKSPACE	Delete preceding character
DELETE	Delete character to the right
F4	Anchor "Fix" Cells
ESC	Cancel a cell entry
F7	Spell check
SHIFT + F2	Insert a comment
CTRL + F3	Name a cell
ALT + N + V	Pivot table
ALT + N + K	Insert charts
ALT + P + S + P	Page setup
ALT + A + S	Sort options
ALT + A + F + W	Data from web

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Excel 2007/2010 Shortcuts *continued from page 86*

Formulas and Auditing

=	Start a formula
SHIFT + F3	Display “Insert Function” box
ALT + “=“	Insert AutoSum formula
CTRL + ‘	Copy formula from above cell
SHIFT + CTRL + “	Copy value from above cell
CTRL + ~	Show formulas/values
F9	Recalculate all workbooks
Auditing formulas	
ALT + M + P	Trace immediate precedents
ALT + M + D	Trace immediate dependents
ALT + M + A + A	Remove tracing arrows
ALT + M + V	Evaluate formula
ALT + R + G	Track changes
ALT + W + G	Zoom to selection
CTRL + [	Go to precedent cells
CTRL +]	Go to dependent cells
SHIFT + CTRL + {	Trace all precedents (indirect)
SHIFT + CTRL + }	Trace all dependents (indirect)
F5 + Enter	Go back to original cell
Turn on NUM LOCK, and then press the following keys by using the numeric key pad:	
ALT+0162	Cent ¢
ALT+0163	Pound sterling £
ALT+0165	Yen ¥
ALT+0128	Euro €
F4	Anchor “Fix” Cells
ESC	Cancel a cell entry
F7	Spell check
SHIFT + F2	Insert a comment
CTRL + F3	Name a cell
ALT + N + V	Pivot table
ALT + N + K	Insert charts
ALT + P + S + P	Page setup
ALT + A + S	Sort options
ALT + A + F + W	Data from web

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