ANDREW W. LO: So on behalf of the Sloan School I want to welcome all of you to 15.401 Finance Theory. This course is meant for first year MBA students. And so that's the focus, and I'm going to assume that that's the background that all of you will have. We may have a few other students in the class, but primarily it will be first year MBAs who are thinking about a career in finance, as well as those of you who aren't sure about a career in finance but are curious about it. Hopefully over the next 13 weeks we'll be able to satisfy that curiosity.

I want to start by talking a little bit about what finance is, and how I got interested in it, because I think it's often helpful in order to motivate a subject to get a sense of how somebody else decided to choose this as a profession. To do that I have to go back a little bit, and give you some background about my own educational experiences.

So let me start by mentioning that I've been at MIT for the past 20 years, and been in the finance group all that time. Before that I taught at the Wharton School for four years. And before that, I got my PhD in economics from Harvard University, and then graduated in 1980 from Yale also majoring in economics. And during that time I've learned an enormous amount both about finance and the real world, but one of the things that I keep coming back to is the fact that the finance field is almost unique in how it applies to practical management problems.

And what I want to try to do over the next 13 weeks is to convince you of the fact that finance is in fact, the most important subject that you'll ever encounter. That in fact, finance is at the core of everything that you will ever do in business and in management. Now that's a tall order I recognize, and I suspect that some of you are quite skeptical about the role that finance might play in your own career objectives. And I know many of you have very different career objectives. And I'm not even trying to convince all of you to go into a career in finance, but I am trying to convince all of you that finance is really the lifeblood and the basic lingua franca of all of business. And that's one of the reasons why finance is such an important subject.

Now before I begin, let me ask you a question. How many people have had no finance background whatsoever? Oh, that's great. I look forward to a challenge. But the other reason it's great is I have to tell you that it's a real privilege for me to be here in front of you to tell you about finance for the very first time. And it reminds me a little bit of my younger son who is an extraordinarily fussy eater, he's eight years old now. But ever since he was born he had some

allergies, and he just refused to eat most of everything.

In fact, my wife often says that my younger son is a vegetarian except he doesn't eat vegetables. So he's an incredibly fussy eater, and somehow when he was one year old he saw my older son eating an ice cream cone, and figured that that's something he ought to try. How he figured that out, I don't know. But he tasted it for the very first time, and you could see his face change in about four seconds from disgust to curiosity to absolute, you know, enthrallment with the taste and feel of ice cream. He just loved it thereafter. That's one of his major food groups now. It's ice cream.

And so I feel privileged to be able to share that experience here in the sense that once you get a taste of finance, I think you're going to be incredibly excited and enthralled by the subject. Because it's one of the few subjects, in fact, that's the only subject that I've encountered that is both rigorous, it's extraordinarily challenging from a research and intellectual perspective, and at the end of the day it's extremely practical. In fact, I would say it's indispensable for financial management. So I'm going to try to convince you of that over the next 13 weeks, and I'm going to do that by going over material that you will find indispensable.

As many of you know, at the end of the course we have a ritual where we hand out teaching ratings. And among the finance faculty, among all the faculty, we're very concerned about good teaching. So these teaching ratings actually matter. And I've always thought that having a teaching rating survey at the end of the semester, is somewhat misguided. What I'd like to do, and what I've proposed hasn't been adopted yet, I propose to have teaching ratings submitted five years after a course is done.

Now this may be a problem for some people who aren't up to speed in the classroom. But the reason I say this is, because it will only be after you get into your jobs, into your careers, before you realize how useful finance is. And five years from now, I suspect all of you will come back and say, gee, this is one of the most important courses you have ever taken. Not because of me, but because of the substance of what we're going to cover over the next 13 weeks. It's because of you and all of the work that you will put into this course. This will be the most challenging course you will ever love.

So I-- stealing from the military-- I think that you'll really appreciate how the discipline of financial logic will help you to think smarter about all of your management decisions no matter what you decide to do with your careers. Now that's a very tall order. I've built up expectations.

So I'm going to have to deliver over the next 13 weeks, and we'll see whether or not we can do that.

But let me start now by talking about what we're going to cover today. I want to start with a little bit of motivation, and then talk about the dramatis personae. These are the cast of characters that we're going to be focusing on over the next 13 weeks. And then I'm going to lay out the fundamental challenges of financial analysis. It turns out there are only two. There are only two challenges in financial analysis, and once you figure both of those out, you're done. So if by chance you can figure that out before the end of the class, you don't need to come back for the rest of the lectures.

Then I'm going to turn to providing you with a framework for thinking about these financial challenges. To me it's very important to have a framework to start with, because I like to organize my thoughts into things that I know and things that I don't know. And of the things that I know, how did it relate to the stuff that I already knew, or thought I knew. So I want to give you a sense of that kind of framework to think about financial analysis upfront. You probably won't fully appreciate it at this point, but sometime over the next 13 weeks you will get it. And so I want to give that to you so that you can start thinking about it subconsciously, unconsciously, and then eventually you will understand how all the pieces fit together.

I then want to talk about the importance of two aspects of financial analysis that make finance different from every other discipline you will ever encounter here at MIT and elsewhere. And that is time and risk. Without those two factors it turns out that finance is actually done. In other words, there's no real research challenges, no open questions left once you eliminate time and risk. Put in another way, the only reason that there exists a finance department, and finance faculty, and finance journals, and a finance industry, the only reason is because of time and risk. So I'm going to come back to that.

Then I'm going to conclude by giving you the six basic principles of finance. These are principles that you will encounter in all of your finance courses for the rest of your stay at MIT and elsewhere. These are the ideas, the fundamental ideas, that have shaped financial markets and that are at the root cause of all of the financial market innovations, as well as all of the financial market crises that we've seen including what's been going on over the last several months in the subprime mortgage market.

In fact, we're going to talk about the subprime mortgage problems after we cover fixed income

securities. Right now I suspect most of you know that there's something going on, know that it's bad stuff, but you don't know why, how, where, when, and what to do about it. Well, in about five lectures, you will. It's not complicated, but it's different from anything that you've ever encountered.

And in fact, financial analysis, I suspect, is different from anything most of you have ever encountered. I'm hoping that by the end of the course, it will change the way you think about everything. And again, I recognize that that's a tall order, but you tell me 13 weeks from now whether or not I've delivered.

And then I'll conclude by talking about the course overview, and then finally I want to say a few words about how as a student you can get the most out of this course. This is a part of the lecture that I've always felt is critical at the very start of a course like this, because there are a number of challenges that you will face over the next 13 weeks regarding this material. And I've always thought that it would be helpful for the instructor to let me know where those challenges might come from, and what I should do in advance to prepare for those challenges. So I'm going to do that at the end of this hour and a half.

For next time I'd like you to read *Brealey and Myers,* chapters one and two. We are going to be covering that today as well as next Monday. So please keep up with your readings. And at the end of this lecture, I will talk a bit about the course requirements and other aspects of the course mechanics. Any questions?

All right, let me start with some motivation about why you might want to study finance and why finance is so important. And I've always found that with motivation it's really best to do it in a personal way. That is, to try to find an individual or a group of individuals that personify a particular discipline or endeavor. And so there are three people that I'd like to introduce you to. I suspect you'll know at least two out of the three, but my guess is you won't know all of them.

The first person-- oh, before I do that, I want to introduce a very simple definition of what finance is. So this is the very first equation that you'll ever see in this course, and there'll be many others of course. But the first expression of exactly what is finance is this, finance is simply equal to mathematics plus money. Now that suggests that mathematics as a discipline is equal to finance without the money, but really that's not my point. Although it's true by the way, that's not my point.

My point is that finance is the study, the systematic and disciplined study of financial

transactions of money. Now when you see this you might think, well, gee, I don't really have a strong math background. Maybe I'm in the wrong place or the wrong class. And I want to explain to you that that's completely inaccurate, and inappropriate.

When I say mathematics, I'm actually talking about a very wide range of mathematics. Everything from the extraordinarily complex and profound to the extremely pedestrian and obvious. So literally the range from differential geometry and partial differential equations on one end of the spectrum to arithmetic and high school algebra at the other end of the spectrum.

Now since this is an introductory finance class, I assume that you know nothing. What I mean by that is, I assume that there are no prerequisites that you have other than what it took for you to get into here, which is pretty substantial by the way. Congratulations to all of you for getting in. But we're not requiring that you have any background in quantitative analysis, computers, upper level mathematics. So when I say finance is equal to mathematics plus money, there's a variety of kinds of mathematics that can be appropriate for creating an extraordinarily profitable career in this industry.

And now here are the three examples. Anybody know who James Simons is? Who is he?

AUDIENCE: Well, I know about Renaissance.

ANDREW W. LO: You know about Renaissance Technologies. Do you know what James Simons did before he started Renaissance Technologies? Yeah.

AUDIENCE: He's a math professor.

ANDREW W. LO: He's a math professor, that's right. James Simons is a math professor. Well, was a math professor. In fact, he was quite a well-known math professor. When I first heard of him, it wasn't because of Renaissance Technologies, which is a hedge fund that he started about 15 or 20 years ago. James Simons was a differential geometer who for many years was the chairman of the math department at Stony Brook in New York. And he authored with S.S. Chern a particular field of study in differential geometry called Chern-Simons theory, which has subsequently proved to be extraordinarily useful in an area of physics known as string theory. Extraordinarily abstract.

And Simon started a hedge fund about 20 years ago. And this is probably the single most

successful hedge fund in the history of the industry in terms of its performance record. Over the course of 15 or 20 years, he's put together a track record that has literally beaten every other hedge fund manager's track record by a lot. So it's not just a little bit. He's just sort of way out there. He's the Michael Phelps of quantitative investment strategies.

By the way, just to give you a sense of how successful he has been. In 2006, two years ago, it was reported by Institutional Investor's Alpha Magazine-- this is a trade publication for the hedge fund industry-- it was reported that James Simons was the single most highly paid hedge fund manager that year with a take-home pay of $1.7 billion. Now, that's not wealth, that's income. That was on his W-2. That was one year's compensation.

And he did it-- he did this by building a quantitative investment management company with 75 PhDs in mathematics, physics, computer science, and so on. And nobody, nobody knows what he does or how he does it. It's extraordinarily secret. But there's no doubt that he's incredibly successful. So that's one end of the spectrum. That kind of mathematics can make money, and can be extraordinarily relevant financial analysis.

Now at the other end of the spectrum, we have this guy. You may have heard of him, Warren Buffett. He is currently the richest man on earth. In 2008 Forbes ranked him number one in terms of wealth. At the time, February of 2008, he was worth $62 billion. In fact, in a private conversation I was told that when Simons found out he said, really? $62 billion? How did he get that? It's amazing. That's an extraordinary amount of wealth for an individual to put together. And what's extraordinary about it, is how he did it.

As many of you know Warren Buffett is an investor based in Omaha, Nebraska. His office is probably smaller than many of the conference rooms here at Sloan. The number of people he has working for him, I suspect, is fewer than many of you who have done your startups or plan to. He's got an extraordinarily small staff. Mainly it's Charlie Munger and him, and a couple of secretaries, and maybe a few accountants here and there, and lawyers of course.

But what he does is to read company prospectuses, income statements, balance sheets. And with literally high school arithmetic he's built this incredible investment empire by looking at valuation. Simple accounting. Now I say simple accounting, but there's nothing simple about what he does. And so clearly he has certain skills that also involve mathematics, but not the kind of mathematics that James Simons uses.

And finally, the third individual that I'd like to introduce you to is this fellow, Jack Welch. Now

again, many of you know him or know of him. You know that he actually teaches a course here at Sloan. But you may not know that his PhD was actually in engineering. And he started out at General Electric in 1960. Became CEO in 1981, and at that time the revenues of General Electric was about $26 billion a year. So it was already a big and successful company. And Jack Welch took it over in 1981. At the time there were 400,000 employees for General Electric.

Five years later, there were 300,000 employees at General Electric. He eliminated 100,000 jobs. That's one of the reasons why he developed the nickname Neutron Jack, because like a neutron bomb, he eliminated a huge segment of the population. But five years later with 300,000 employees, he increased the market value of General Electric by several fold. And at the end of his tenure in 2001, 20 years later, General Electric's revenues was not $26 billion, it was $130 billion. He increased it by a factor of 4 and 1/2 over the course of 20 years. It's an extraordinary accomplishment for an individual.

Now why do I put him up here? It's because one of the things that Welch did at General Electric, one of the things that he was extraordinarily good at, was making good decisions about investments, making good decisions about costs, being able to understand the language of finance despite the fact that he used none of his PhD skills in his job. He was an engineer by training, not a manager. He didn't go to management school, although he did a lot of executive education after his PhD.

The reason that I give you these three cast of characters is because they are so different in what they do. They have such different backgrounds. They're all extraordinarily successful, but there's one thing in common. The thing in common is that they all understand innately, deeply, fundamentally, the language of finance. And what we're going to cover over the next 13 weeks, are the very basics. Things that they take for granted. Things that they use on a daily basis to do their jobs.

So it's not to say that if you do well in this course you'll end up being one of these guys, but it's certainly a prerequisite I would say. There's nobody that's been successful in business, truly successful, without having an understanding, at least an innate or instinctive understanding, of the concepts that we're going to cover over the next 13 weeks. So to me, that's exciting.

Now again, I'm not trying to motivate you by greed. I'd rather motivate you by the intellectual challenge of finance, and there will be some extraordinarily challenging ideas. Ideas that are

not natural for any of you at this point, but which I hope will be very natural at the end of this 13 weeks.

So let me start with the cast of characters that we're going to be studying over the next 13 weeks. There are going to be four components of the economy that we're going to focus on. Now this is a flow diagram of the economy. Since we're at MIT we have to have flow diagrams at some point, right? So here's my version of a flow diagram. This is a flow model of the economy, and there are four components that comprise the financial system. Households, financial intermediaries, non-financial corporations, and then capital markets.

Now obviously the economy is comprised of additional components like labor markets and product markets. We're not going to focus on that. Although there are certain financial aspects of those markets. Given that we only have 13 weeks, our attention will be spent on those four components, and I'm going to cover each of those four components, both in parallel and to a certain degree sequentially, all right?

So I want you to be familiar with these four, because we're going to be talking about them interchangeably at various points in time. Financial analysis applies to all of these components in exactly the same way. But once you apply them to the specific context, the terminology may change, the particular applications may look different. What I'm going to try to teach you in this 13 weeks is the underpinning theories that unify all of the various different kinds of ideas. So these are the four components that we're going to be looking at from now and then.

Now let me talk about the fundamental challenges of finance. I told you that there are only two, right? And here they are. There are two aspects of financial analysis that we're going to be focused on. The first is the valuation of assets. And the second is very simply the management of assets. That's it. That's all there is to it. Valuing and managing. And I can tell you exactly what the managing part is going to look like. Managing is going to involve figuring out which of two possibilities is more valuable. And then you know what? You take the more valuable option. That's it. That's all there is to it.

Figuring out the value, that's going to be challenging. So we're going to take that first challenge to start with, and try to understand valuation. I'm going to argue that all business decisions, any kind of business decision, involves those two challenges. Valuing something, and then once you value it, make a decision on what you want to do with that value. This is why I've argued that finance is the most important subject, because literally any business

decision that you will ever engage in, constitutes those two components. Valuation and management.

Now valuation is going to be a challenge by itself, because it's not at all clear what value we're talking about. In other words, what is value? Is water valuable? Well, life can't be sustained without it. At least carbon based forms of life. So water is pretty valuable. But water is not that expensive. At least before Poland Springs came along. Now what about diamonds? As far as I know, humans do not need diamonds to survive, and yet diamonds are extraordinarily expensive. There are certain gems that are invaluable. Now how can that be? Clearly we have to think more carefully about what we mean by value.

And of course, once value is established then management is relatively easy to do. Objectives plus valuations obviously leads to decisions. So once you tell me what you're trying to achieve, and then you value all the various different possibilities, then I can tell you what the right decision is. Pick the decision that is the most valuable for achieving the objectives that you want. Now that doesn't really help a lot if we can't apply this to specific contexts, and come up with specific value.

So I want to hammer this home, and to do that I want to talk about how it is that financial markets helps us establish value through the price discovery mechanism. And to do that, I am going to do a simple demonstration. Now when I was growing up I went to one of these specialized high schools that focused on science. So we were always getting these various different kinds of neat demonstrations of the Tesla kind of coil. I've always been very jealous of these science teachers, because they have these cool demonstrations that we in finance don't.

So I've developed a little demonstration of my own. It's a simple one that has to do with the price discovery mechanism, and because I teach two sections, I'm going to have to make it a little bit more involved than normally. So I need two volunteers. The first volunteer-- thank you. I'd like you to take these two pieces of paper, these are blank pieces of paper. On one of them write heads, and the other write tails. And then place them face down, and shuffle them so you don't know which is which.

And I need another volunteer who has a coin that they can flip, because-- thank you. So as soon as he's done, I'm going to ask you to flip a coin. Do you have a coin by the way?

AUDIENCE: Yeah.

ANDREW W. LO: OK. I have two items here. One of which is going to be auctioned off in this section, and the other is going to be auctioned off in the later section. And since I don't know what your preferences are for one or the other, I want to randomize this so that there's no chance that I favor one section or the other. So are you done with that? You shuffled them. You don't know which is which. OK, I'd like you to take these two face down, and put one in front of one of these packages, and the other in front of the other face down as well.

While you do that, can you go ahead and flip your coin? And as soon as he puts that on there, I want you to tell me whether you flipped heads or tails. And based upon that, the particular object that is chosen will be auctioned off in this particular section. OK, go ahead. What have you got?

AUDIENCE: Tails.

ANDREW W. LO: Tails, OK. So tails. This is heads, and this is tails. So here is the item that I'm going to auction off. Before I do that, I'm going to ask somebody. Anybody know what's in here? Nobody knows what's in that box? Well, what do you think its value is? Zero? Negative? Can't be negative, right? There's limited liabilities. You can't owe me for something that's in there. So good. We've established some information. There's a zero lower bound. Well, I don't know what the value is. So what we're going to do is we're going to figure it out. Rather, you're going to figure it out.

I'm going to auction this off, and now this is for real. So don't bid if you can't pay me, and by the way, I expect to be paid in cash. All right? So I'm serious. This is a serious game. So if you don't want to participate, you're not prepared to pay me in cash at the end of this lecture, do not bid. All right? OK, I'm going to open it up. Anybody want to start bidding for this item?

AUDIENCE: $1.

ANDREW W. LO: $1.

AUDIENCE: Three.

ANDREW W. LO: $3.

AUDIENCE: $4.

AUDIENCE: Four.

AUDIENCE: Six.

ANDREW W. LO: Six.

AUDIENCE: Five.

ANDREW W. LO: All right, $6 is the high bid. Can't do that. All right, $6 is the high bid.

AUDIENCE: Ten.

AUDIENCE: Ten.

ANDREW W. LO: Ten. OK, we got two tens here. You were the first. So that's your bid. Your bid is the high bid. $10.

AUDIENCE: 20.

ANDREW W. LO: 20. We have 20. Wow!

AUDIENCE: High roller.

ANDREW W. LO: $20. You do see that this package is smaller than this one, right? It's a tiny little thing. $20.

AUDIENCE: 30.

ANDREW W. LO: $30. $30. High bid. Any more than $30?

AUDIENCE: Can I ask a question, please?

ANDREW W. LO: Yes.

AUDIENCE: Where does the money-- who gets it?

ANDREW W. LO: I get the money. That's a great question. That's a great question. This is going to go to the foundation to support Andrew Lo. I'm the charity. So this is not a charity auction. This is going to go to me. By the way, I paid for these items. So that's why it's going to go to reimburse my teaching costs.

AUDIENCE: It's going to ice cream, [INAUDIBLE]

ANDREW W. LO: Right. OK, $30 high bid. Any higher bid than that? $30? Nothing higher?

AUDIENCE: 31.

ANDREW W. LO: 31.

AUDIENCE: 35.

ANDREW W. LO: 35. OK, do I hear 40? Anybody want to do 40? $40?

AUDIENCE: I'll give you 40.

ANDREW W. LO: $40. All right, we've got $40. Anybody willing to go 45? $45? All right.

AUDIENCE: 45.

ANDREW W. LO: $45. Wow! OK. Do we hear 50? $50? 45 is the high bid. Anybody for 50?

AUDIENCE: Can I short too?

ANDREW W. LO: No shorting, sorry. I'm the only auctioneer here. $45 is the high bid. Anybody here 50? Going once. Going twice. All right, sold. $45. Now you're going to pay me, right?

AUDIENCE: Yep.

ANDREW W. LO: All right. We established the value. It's $45. That's the market at work. None of you knew what was in here. It could be nothing actually. But I suspect that you didn't think it was nothing, because you bid for it, right? Moreover, I didn't let you touch it. I didn't let you feel it. I didn't let you shake it. There was no information whatsoever other this very pretty packaging. And yet somehow magically you were able to come up with a value. Now we could argue whether that value is good or bad. But it's a number, and it's a number that can now be used for analysis.

Now again, I'm not commenting on how good or bad the number is. In a minute we're going to find out, because I'm going to open this. Or let this gentleman here open it, and see what he bought. But before he does that, I want to comment that knowing nothing without any information whatsoever, we've established value. That's remarkable.

Now it's not true, though, that there is no information. In fact, there's a tremendous amount of information in this room. Tremendous amount. Because you know a number of things. You know about the size of packages. You know about the fact that I'm a professor, and if I really cheat you then I might get in trouble with the dean. There are a number of constraints that are

in place, and with this audience those constraints affected the value.

For the next five weeks that's what we're going to be doing, is talking about valuation and trying to understand how what just happened happened. OK, would you like to open it up, and let us know what you've got for your $45? And you'll let me know whether this has been a good deal or a bad deal for you and for me. Oh, just rip it. My wife does this all the time. It drives me crazy. My sons are just--

AUDIENCE: I'm enjoying my [INAUDIBLE] $45.

ANDREW W. LO: Fair point. Fair point.

AUDIENCE: Oohhh!

[APPLAUSE]

ANDREW W. LO: Anybody know what the retail value of that is? It's an iPod Nano 4 gig version.

AUDIENCE: 125.

ANDREW W. LO: 149 to be precise. So you had a good deal.

AUDIENCE: Yeah, yeah. Thank you.

ANDREW W. LO: You're welcome. Thank you, because what we did was to engage in a price discovery process with limited information. With limited information. I couldn't get the value out of that that I wanted to. I would have loved to have gotten a bid of $149, but would any of you be willing to pay that for a box with no information at all? Probably not. So the lack of transparency, the lack of information, actually reduced the value of that object.

But nevertheless, it did have a value. Because some of you were willing to take a chance that there might be something interesting in that package. That is what we're going to try to understand over the next 13 weeks, and for the first five of those weeks we're going to try to take it apart. We're going to try to understand how it is that the market comes up with the value.

And it's going to be a challenge. This is hard to do, because just like if we decided to spend the rest of the lecture figuring out how you came up with a $45 bid, or why you weren't willing to go to 50. It's going to be really hard for us to tease out all of the thinking that went into this

kind of discussion. So that's why we have work to do. It will be exciting work, because at the end we are going to come up with specific quantitative analysis that will tell us how valuation is done. So that's where we're going to focus on for the next few weeks.

Clearly once we figure out valuation, we can then focus on management. And the first two-thirds of this class will be focused on valuation. The last one third will be focused on taking those ideas, and applying them to management contexts like capital budgeting and risk management.

For valuation, the kind of questions that we're going to tackle are ones that implicitly we did in just a few minutes here. It's going to be how are financial assets valued versus how should they be valued, and is that always the same? Is it the case that financial assets are valued the way they should be valued, and what do we even mean by whether or not it should be valued in a way or not.

And finally, we're going to ask the question for valuation, how well do financial markets really work? Can we always rely on them to work well? In this case, I don't know if you would call this particular auction one that worked out well. Certainly worked out well for you, but it didn't work out well for me. So in what sense did it work out well? Well, it worked out well in the sense that if I really wanted to get rid of that box, if I really wanted to unload it, I actually was able to do that.

And I got something for it. Sight unseen, with no information whatsoever, I actually got $45. Roughly a third of the value of the asset. That's actually not too bad. If you're trying to sell an asset sight unseen, and you need to do it immediately, a 66% discount is actually pretty fair. Now we're going to see more examples of that over the next few weeks.

Once we determine value, then the question is management. How much should I save or spend? That's a management question that all of you have to deal with at some point or another in your lives. What should I buy? What should I sell? When should I buy and sell it, and how should I finance the transaction? Those are the problems of financial analysis plain and simple.

These are problems that apply to Jack Welch, to James Simons, to Warren Buffett, and to you. And it applies to you not just from the corporate perspective, but from a personal perspective as well. Every one of you have to think about these issues on a daily basis. And so finance really is completely inclusive in the sense that it applies to virtually everything that you will ever

encounter in life.

To do that I have to go over the framework of financial analysis, and the starting point is accounting. Accounting is the language, the lexicon of finance in that it's the beginning of how to measure economic concepts. Like profit and loss, revenues and costs, and so on. So while many of you may not have accounting backgrounds, you will learn a fair bit of accounting in this course, just because you're going to have to in order to understand the material in the lectures.

So you'll need to get familiar with the basic terms of accounting, and in particular you're going to have to focus on two concepts that are probably alien to you. The notion of a stock and a flow. Now when I say stock, I don't mean common stock or equities, I have a different term in mind. By stock in this context, I mean the stock of assets. The level of assets. And by flow I mean the rate of change of assets.

You know when I was in grad school, we started discussing this concept on the first day of macroeconomics, and then one of the students in the back of the room said, excuse me, Professor, but isn't that just the distinction between a variable and its first derivative?

And the professor was a little bit taken aback and said, well, yes, that's right. But let me give you another way of thinking about it that is somewhat more intuitive. And that is, think about a bathtub, and think about the faucet turned on and the water flowing into it. The stock is the level of the water. The flow is how fast the water is coming into the tub. And so after that explanation the student still seemed confused, and so the professor said, you know what, some people find bathtubs intuitive, other people find derivatives intuitive. So to each his own.

These two concepts are extraordinarily critical to financial analysis. And accounting counterparts are nothing more than the balance sheet and the income statement. The balance sheet measures the stock of wealth of a company. What your assets are, and what your claims on those assets or liabilities are. On the other hand, the flow of wealth into a company or out of a company is measured by the income statement. This tells you how much the company is making per unit time versus its losses.

So the framework for financial analysis that we're going to be coming back to time and again is this framework of a corporation. A corporation has a certain set of assets. It's got claims on those assets, which are called liabilities. So this picture, this snapshot, measures the level of

the bathtub. But that's not enough to understand how a company is doing. You also have to look at the income statement, which tells you the sources of funds, and the uses of funds over any time period. Typically on a quarterly basis.

So we're going to come back to this concept as the framework for financial analysis. And by the way, this is the sum total of the tools that Warren Buffett uses for analyzing his investments. That's it. Believe it or not. Nothing fancier. So it's an incredibly powerful set of ideas if you know how to read it.

That framework when you think about it from a corporate financial decision perspective, involves making decisions at five points in time. Corporate financial decisions involve thinking about how to deal with cash raised from investors. How to think about cash invested in real assets, and how to deal with cash generated by operations. How much cash to reinvest, and how much cash you give back to your investors.

So from this you should get the idea that as a corporate financial officer you are focused on cash, the flow of cash. In fact, cash you can think of as the lifeblood of a company. If you follow the cash, you will eventually hit upon every important aspect of the modern corporation's operations. And as a financial officer, you will be responsible for analyzing that flow. And as a decision maker, as a leader of a corporation, you're going to have to make decisions about that cash flow. Jack Welch uses the information to be able to make those decisions. But he doesn't just get those decisions prepackaged for him, he has to understand what those numbers mean. Just like Warren Buffett.

Now the corporate financial decisions involved, obviously, have a variety of different components from a perspective of career paths. From the management perspective real investment decisions involve two and three. So if you're thinking about investing in a new division or a new plant or getting involved in a new product area, you've got to focus on two and three.

On the other hand, if you're the chief financial officer, and you're thinking about how should the company finance its operations, you're going to be focused on one and four. If you're the board of directors, and you're deciding how much to pay out to the shareholders, you're going to be thinking about five. And if you're engaged in managing the risks of the corporation, you're going to be worried about one and five. And ultimately your objective as a shareholder and as a manager of this corporation is to do well by the owners. So your objective is to

maximize shareholder wealth, and the framework that I've introduced is going to allow you to do that.

Now again, this may seem kind of theoretical to you, and I realize that. So I'm going to ask you to make this more personal. And to do that, I'm going to ask you to turn this into your own personal household financial decision making framework. So I'd like you to take all of these ideas and literally apply them to yourself. Think about the cash flows that are flowing through your own life. There may not be that much right now since you're at school, but believe me, it will grow.

So the household, this is you, sits in between real economic activities. In other words, your job, and financial assets and liabilities, which are all of the financial transactions that you deal with. So this cash flow process that I outlined for corporations, it works for you too. So there's cash raised from financial institutions, right? Like student loans or borrowing or home equity loans. There's cash invested in real assets. What's the biggest real asset that you are all investing in right now?

AUDIENCE: Education [INAUDIBLE].

ANDREW W. LO: Exactly. Human capital, yourselves. Your own education. Cash generated by labor supply. Well, obviously, when you get a job you're going to be generating cash. Cash consumed and reinvested in real assets. So consumed means beer or pretzels or whatever, and investing in real assets means you invested either in yourself or you invest it in a home or your children. Those are real assets. Sometimes they're also real liabilities, but that's a separate issue.

And finally cash invested in financial assets. Most of you may not have a lot of financial assets at this point, but you actually have some. I suspect 401(k) plans, retirement, Social Security. Those are financial assets that whether you know it or not, you're invested in. And so when you think about management, think about personal management. How are you managing yourself? You've got to think about real investment. Consumption and financing, savings and investment, risk management, and, obviously, what is your overall objective in life? And what you ought to be doing is with that objective in mind, managing your real and financial assets to maximize the likelihood of achieving those objectives.

So what I'm asking you to do is, I want you to take this course personally. I want you to take the ideas. Every single idea that I mention, and whether I tell you to or not for the next 13 weeks, I want you to take that idea and ask the question, how does that make my life better

off? How can I use that in my own personal management activities to improve the kind of decisions that I'm making? Because if you could do that, if you learn how to do that instinctively, you will then take those ideas and apply them to management contexts in your career. And it will make it much more likely that you'll get more out of this course than you otherwise might.

Now there are two other factors that I describe that make financial analysis challenging, and those two factors are time and risk. I've argued before that without these two elements finance is complete. There is no more research to be done. There's no more analysis to be done, and all of you probably will already be able to intuit a lot of the decisions that you're going to be forced to make. Because without time-- and by time I mean decisions at different points in time-- without time and without risk financial decisions actually reduce to basic micro economic analysis.

If you've taken an undergraduate course in microeconomics supply equal demand, well, you've learned all there is to learn about finance without time and risk. The only reason that finance is interesting, the only challenging aspects of what we do are because of time and risk. The fact that cash flows now are not the same as cash flows later, and that time flows in only one direction.

In about four lectures, I'm going to give you an alternative proof of the theory of special relativity. And this proof will have to do with the fact that interest rates are not negative. It turns out that there's a very deep philosophical connection between finance and physics that we're going to get to. But this is something that you don't need to be a physicist to understand.

In fact, I'd argue that Warren Buffett, although he may not be able to articulate these principles, these are principles that are somehow inbred in his worldview. He knows that $1 today is not the same as $1 next year. And he also knows that $1 today without risk is not the same as $1 today with a little bit of risk. Even a tiny little bit of risk, he knows that. And at the end of this course, you will too.

So risk we have to talk about in a much more serious way. We're not going to get to that for probably six weeks, because that's going to take a whole different set of tools to understand. So what I'd like to do for the first three or four weeks is to focus on time and just time, and then I'm going to bring in risk once we develop a little bit more machinery to understand how to capture risk. And when we put these two together, we're going to get modern finance. So that

will happen some time in week six, seven, and eight.

Now finally, I want to talk about the fundamental principles of finance, and then I'm going to talk specifically about this course. There are six fundamental ideas that finance has come up with that really will change the way you think about the world, and you won't appreciate it today. I know that. But I want to put it into your subconscious today, because sometime over the next 13 weeks, at least I hope over the next 13 weeks, your face will light up and you're going to get it one day. You're going to get it in the sense that you will understand at that point in time how these six principles can be used to make any financial decision that you need to make for the rest of your careers.

The first principle is pretty obvious. There is no such thing as a free lunch. Actually all of these principles are approximations to a much more complex truth. So if you really want to be strict about it, it should read, there may be free lunches on occasion, but there's no such thing as a free lunch program. There isn't systematic free lunches. You might be able to find one or two every now and then if you're lucky and if you work hard, but systematic transfers of wealth for no reason at all are unlikely.

Second principle. Other things equal-- and this is a phrase that you'll hear economists utter all the time. And of course, other things are never equal, but let's pretend that they are. Other things equal, individuals satisfy three characteristics. They prefer more money to less. That's often called non-satiation. They prefer money now to money later, and they prefer less risk to more risk when risk is defined properly.

Now I'd argue that these principles are in fact fairly universal. Not that you can't find exceptions every now and then for every individual, but by and large over periods of time and over a large population this is generally true. And if you don't believe me or if you know people that don't satisfy these principles, please introduce them to me after class. I'd like to get to know them, and do some business with them.

Principle three. All agents act to further their own self-interest. Now again, this is not to say that there aren't Mother Teresas out there. That there aren't people that care about the general welfare of the public. But economists in their own unique and annoying way have been able to redefine preferences to even argue that Mother Teresa is incredibly selfish, because her utility function is the function-- the utility function of other people. And so by doing all this good, Mother Teresa was only furthering her own self-interests. Isn't she so selfish.

Now, so in a way when the economist defines preferences, they almost define it as a tautology. But finance makes economics practical in the sense that I'll describe in a few weeks exactly what kinds of preferences are actually embodied in decision making, and why this principle is more often than not, a pretty good approximation to a much more complex reality.

Now the last three principles I'm not going to talk about in great detail, because those really embody a much larger set of issues about economics and finance. We're going to talk about those three principles, but only in the last lecture oddly enough. We're going to use them. We're going to use these principles, but in the last lecture I'm going to question all of the framework that I've developed for you, and show you where the holes are. For the first 13 weeks, I'm going to need you to willingly suspend your disbelief as we describe the relatively straightforward and standardized framework for thinking about financial problems.

And in the last lecture I'm going to describe to you where the approximations were made, and why you need to take advanced courses in finance to fill those gaps. So with that said, let me now turn to course overview, and then I'll take questions about course mechanics. There are going to be four sections of the course as outlined in the syllabus. The four sections are the introductory material, which we've gone over today. Section B, which we will cover for the next three or four lectures is valuation. Discounting and the mathematics of net present value. Pricing stocks, bonds, futures, forwards, and options, and the relative kinds of issues that come up across those different asset classes.

Section C will focus on risk, and introduce risk into the framework of section B. So once we complete Section C, we will then have focused on time and risk. And finally section D will be how to apply those principles to problems in corporate finance. What Jack Welch did from 1981 to 2001. How do you take these ideas, and apply them to practical circumstances.

And then the last lecture will be a lecture-- this is not the same last lecture as other last lectures. I'm not going to die, but so I don't mean to call it the final lecture. That sounds a little ominous. The idea behind this last lecture is to put it all together, and explain how these financial theories interact with imperfections in the marketplace, and what is-- or is not good approximations.

Let me talk about course requirements now. Obviously the lectures and the readings, and attendance and participation will be an important part of the course. We are not going to cover the entire tome of *Brealey, Myers and Allen.* This is a book, which if dropped off of a six-story

building could actually kill somebody if it hit them. So we can't possibly cover the entire textbook. We'll cover selected chapters, but this is Finance 401, so it's an introductory course. And so the readings that you are going to be responsible for are the ones that are outlined on the reading list, and that I've listed in every lecture. So for example, chapters one and two, you are now responsible for.

And we will be grading class participation. So I expect you to come to class prepared, and ready to discuss material, and possibly questions that we may have raised in the previous lecture. And there will be one case study that you will be responsible for writing up and handing in, and that will be worth 10% of the grade. And attendance and participation will be worth another 10%. So that's 20% of your grade.

And then finally the midterm and final exam will be worth 25% and 55%. Let me explain a little bit about how the midterm and final exam works, because it's a little different in this class than in some of the other classes. And by the way, this grading scheme and the particular mechanisms are identical in these two sections that I teach, and in the sections that Professor Wang teaches. So he and I have coordinated to have the same approach, so as not to advantage or disadvantage any one section.

In your readings packet will be a collection of problems that we've put together. And actually I don't know if it's in there right now or if it's being photocopied, but we will prepare a list of problems that you can work on. These are completely optional. And there are far too many problems for you to be able to do even in one full semester. The reason we give them to you is, because the only way to learn finance is to do finance.

If you come into the class and listen to my lectures you may be entertained for an hour and a half, you won't learn the material. In fact, I've now changed the way I talk about the course, and I don't describe what I do as teaching anymore. Because teaching implies that I can force feed knowledge into your brains. It turns out it can't be done. And my two sons have proven that to me time and again. You have to want to learn the material, so you have to pull the knowledge from me into you. In other words, you have to be an active participant.

My 12th grade math teacher used to say that mathematics is not a spectator sport. That's the same for finance. Finance is not a spectator sport. You actually have to do it. You have to confront yourself with problems time and again, and think about how to apply the principles in our lecture to those problems. The purpose of a lecture is to give you the motivation, and take

you through the most difficult aspects of the principles and the theories of financial analysis. But it's your job to do the analysis. And to that end we're going to give you some motivation.

And the motivation is that the midterm and the final exams are structured so that most of the weight is placed on the final. The reason is the final is cumulative. So it's going to cover twice the material as the midterm. Therefore it should be worth roughly double. But the other reason is that financial analysis is alien to the typical human cognitive process. None of you are hard wired to engage in net present value calculations.

And so it's going to take some time before you get it, before it sinks in. And I've taught this class many times before, and usually somewhere between week eight and week 13 a light goes off in your head, and you get it. And I see this by the bright smiles on your face around that time. It could be because you're getting to the end of the semester, and you're glad to be done with the class. But I like to think that it's because at some point you actually get it. In a few rare cases it happens at week 14, which is not so good, but hopefully before the final exam.

Now in order to provide you with extra incentive to do problems, and given this is an MBA class, I realize that all of you have very busy schedules, and you can schedule your own activities better than we can. So rather than have weekly problem sets that are due, and you have to hand them in, we have to hand them back. It's a hassle for everybody. There are no problem sets in this class. None.

However, we're going to give you a package of problems and solutions upfront. You'll get that within the next few days. And I will promise you that the majority of exam questions will come verbatim from this package of problems. Majority. Meaning more than 50% of the points will come from the package. So if all you did was to memorize this entire stack, you could ace the course. But of course, that would mean you would spend enormous amounts of time in finance, which is not such a bad outcome either.

So we want to do this to eliminate a lot of the fear and anxiety with financial analysis. It is challenging, but it's a lot of fun too. We want you to have fun, because that's the only way you're going to learn this material well. So it's up to you as to how much you want to do. The recitations will cover selected problems. So you're not going to be left on your own. The recitations will go over problems and how to solve them. I'll do a few in class, the ones that are particularly challenging, but then you'll need to do more on your own. And if you do that, you

will be prepared for the final exam better than most.

The other material will be readings and lecture material, and therefore there will be some customization, because my lecture style is different from Professor Wang's. But the majority of the exam will be identical, and it will be drawn from these problem banks that you're going to get a copy of in advance. Now frankly, I have to tell you that I don't really like to give grades at all, but I'm forced to do so. And so that's why we set up this process for assigning grades.

In fact, a few years ago, I came up with what I thought was a brilliant way to assign grades, but I haven't been able to convince the dean's office to let me do that. And you know what it is? It goes like this. Let me show you. I propose to give everybody in this class a B. That's it. Everybody gets a B. Now before I do this, how many people would object to that? Raise your hand. All right, those of you with your hands up, you get As. Done. You see how brilliant that is? I get a grade distribution. No work. The only problem is it only works once. And when you're teaching two sections, so somehow the second section, it doesn't work as well.

So I'm sorry I have to give grades. You're all adults. I realize that. But nevertheless, this is a necessary part of the curriculum. So that's how we're going to be assigning grades. In the last four minutes, and I think I'm going to try to keep on time for the entire semester so we end at five before the half hour, and we start five after the hour. In the last four minutes, I want to tell you a little bit about how to get the most out of this course. And we can take this up next time if you've got questions, but I want you to spend time thinking about this.

Most of this course will be devoted to theory. But finance is not a theoretical subject unlike algebraic topology. That's a theoretical subject. I've never heard anybody become a practical or applied algebraic topologist. Finance on the other hand, there's no finance without practice. So while the course will be focused on the theory, I need you to think about the practical elements of it, and I'm going to help you in a couple of different ways. One is by problems, but the other is to encourage you to sit in on a pro-seminar called the Practice of Finance.

This is a new pro-seminar that we're launching. September 17 is the first meeting. It doesn't carry any units, so you can come and go as you please. But it'll give you a sense of the practical aspects of the industry, and in particular information about the career aspects of the industry like what are starting salaries for financial analysts. Or how do I get a job in finance if I don't have any background in it. It'll go through those kinds of issues. So I'd encourage you to keep that in mind.

The second thing is with respect to the course, I will give you lecture notes ahead of time for all of the lectures. I expect you to take a look at them in advance. Just skim them. You don't have to read them, and try to sort out what I'm saying. But I want you to skim it at least. And then in class I urge you to take lots of notes, because the lecture notes are not meant to be complete. In fact, they are purposefully incomplete so that you have to use your hand and write down your impressions of the material as I'm speaking. Because in that method, you will actually absorb more of the material, and it'll stay with you longer.

I would urge you to review the lectures afterwards. Review what I said. Because you may have heard what I said, but you may not have understood what I said, and you may not be able to apply what I said. So you need to spend time afterwards soaking it in. I urge you to work on the assignments in groups, but also alone. Because when you do the midterm and final exams, you'll be doing them alone. So do both. Don't just assume that you can do the same in groups what you will do alone.

And finally, I would ask you to ask plenty of questions. I'm going to manage the class discussion. So that if we have time, I'd be happy to talk about issues that are current and on your mind. Even whether or not you should refinance your auto loan. We're happy to take those kind of questions assuming that it's apropos, and that we have the time to be able to cover that. I want you to get engaged. I want you to take this course personally, because that's the only way you're going to really learn the material.

All right, thank you very much. We're out of time. We'll see you next Monday.