There are four features of this course which you should be warned about at the start: it's going to be dull, easy, useful and dangerous.

Contrasted with such subjects as quantum physics, which deal with the secrets governing the burning of stars, engineering economics deals only with the sordid details of handling money. It lacks poetry, glamour and permanent value.

On the other hand, it's easy. There is a certain amount of mathematics involved, but nothing beyond tenth-grade level. There are no difficult concepts to be mastered. There is one new idea -- that money has a time value -- which we will have covered by the end of the first lecture.

Furthermore, this is almost certainly the first of the courses you've taken which you'll find directly useful, and you can expect to go on using it for the rest of your life -- whenever you buy a car, get a mortgage, consider life insurance, or start your own company. Among other things, you can use it to compare the financial advantages of going to graduate school versus starting work immediately. (It turns out that going for a PhD is almost always a poor investment.)

The course material is dangerous because applying the methods covered in the course can occasionally yield results that are contrary to common sense. We'll discuss several such examples later in the course. Here's one illustration: what is the cash value of a human life?

One option is to say, ``You can't play the numbers game with human lives. Each life is unique and of inestimable value. Attempting to treat lives on the same basis as dollars is both cold-blooded and ridiculous."

But this really won't do. For example, medical administrators have a responsibility to save lives, and they have limited resources to meet this responsibility. If they are to apportion their resources rationally, they must be prepared to compare the results of different strategies.

And in any case, we can demonstrate that we all agree that there is an upper bound on the value of a human life. For example, suppose research showed that, by making structural alterations to a car, we could reduce the likelihood of a fatal accident by 1% -- that is, given 100 cases in which accidents had led to fatalities, the proposed alterations would reduce this to 99 fatalities. The alterations cost $1,000 per car. Would you buy the altered car yourself? If you were the government, would you require all car manufacturers to make these alterations?

I suggest that you wouldn't pay $1,000 for such a slight improvement. After all, the chance of being in an accident is pretty low anyway, otherwise nobody would drive. Are you going to pay $1,000 to reduce it by 1%?

There are about 6 million cars sold per year across North America, so the total cost of the changes would be 6 billion dollars. About 60,000 people die in motor accidents per year, so the changes would save 600 lives. So we agree that it's not worth spending $10 million to save a life.

We can locate Engineering Economics among several related disciplines. Firstly, it is needed to complete engineering itself; without an economic background, most engineering problems are trivial. For example, the problem of air pollution could easily be solved by giving everyone an electric car. It is only when we add the economic constraint that electric cars are too expensive for most people that the real engineering begins. (It is for reasons like this that Arthur Wellington defined engineering as ``The art of doing well with one dollar what any bungler can do with two." [*The Economic Theory of the Location of Railways*, Wiley, New York, 1887].) Secondly, it is a close relative of Operations Research, and its cousin, Management Science: these two fields contain a collection of algorithmic tools for finding the most efficient use of limited human and material resources. (We will not be studying these fields in this course, though they are available as Directed Studies.)

Economics itself can be divided into Macroeconomics and microeconomics, which is to say, `big economics' and `little economics'. Big economics is economics on the national or international scale, and is concerned with such questions as, ``What is the effect of the money supply on employment?''. Little economics, which is what we'll be doing, operates on the personal or corporate scale.

Macroeconomics has been described as `the dismal science'. This description is unduly optimistic, as it can't really be considered a science at all. In particular, it offers no opportunity to do repeatable experiments -- having instituted a policy of tight money controls in 1970, a government cannot in 1975 go back and try the effect of looser controls on the 1970 economy. The questions it deals with -- for example, how particular measures affect the distribution of incomes within the society -- are inextricably linked with questions of policy -- for example, how incomes *should* be distributed within a society. Hence, particular economic theories tend to be offered more as programs for political change than as rival accounts of how social mechanisms operate.

Against this background, how is it possible to do microeconomics in a disciplined and scientific manner? Fortunately, this *is* possible. The variable parameters of macroeconomics become the givens of microeconomics: the individual, or the corporation, take the state of the macroeconomy as determined, and plan to reach their goals against its background. We could thus compare macroeconomics with the (non-existent) science of predicting and controlling the weather, whereas microeconomics may be compared with the art of making umbrellas.

Since we cannot control or predict all aspects of the macroeconomy, microeconomic planning must take into account the consequent uncertainties in the economic climate. We will review techniques for dealing with uncertainty later in the course.

We now come to the new idea I warned you about. Suppose I want to borrow $1,000 from you, to be paid back in one year. How much should I pay you back?

There are a large number of things you will want to consider: how much do I want the money? What else could you do with the money if you didn't lend it to me? How reliable do you think I am? Am I offering you any collateral on the loan? By considering these factors, we may be able to come to an agreement. That agreement will almost certainly say that, if you're going to lend me the money, I'll have to pay you back more than I borrowed. We could think of the extra amount I pay back as a rental that you're charging for the use of your money. And this idea, that a rental must be paid for the use of money, is the one idea whose implications we will spend much of this course exploring.

The idea that money can, of itself, earn money seems paradoxical, and perhaps undesirable. It implies, for example, that a person who has inherited sufficient money can go through life in perfect idleness, living on the proceeds from renting out some fraction of their inheritance. But if we consider a society in which *everyone* has sufficient money to do this, we seem to have a situation where everyone has an income, yet no-one is doing any work.

We can resolve this paradox by considering a small, model society. For example, suppose a society comprising ten farmers. One farmer borrows sufficient grain from his neighbours to support him for a year, and during that year, he studies enough engineering to design a more efficient plough. Using this plough, he is able to harvest enough grain to repay his loans with interest. The underlying equation is that capital + new ideas + labour can give rise to more efficient means of production, hence generating a surplus which can pay for the use of each contributing factor. If one or more of the factors is absent, no surplus can be generated, so no interest can be earned.

Now we've established the principle that $100 this time next year is worth less than $100 now, let's go back to the cost of human life. We've established that a human life is worth less than $10,000,000. What's the life of a person born in the year 3000 worth now? Well, in the year 3000 it's worth $10,000,000. What amount of money in the year 2000 is equivalent to $10,000,000 in the year 3000? Suppose we set aside X dollars now, at 5% interest. Then we have to solve the equation

$$X(1.05)^{1000}=\$10,000,000$$

We can solve this to get $X = 6 * 10^{-13}$ cents. So to save the entire global population of 10 billion in the year 3000, it's worth spending at most 0.006 cents now. For example, if you were an astronomer and detected a comet that would impact the earth in 1000 years, and if we had the technology to stop the comet at zero cost, it wouldn't even be worth making a phone call to recommend using that technology.

Power Point Presentation

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