Note: throughout this class, the terminology "marginal benefit" and "marginal value" are meant to be synonymous. For various reasons, it is appropriate to use one term in some situations and vice versa. They are the same thing.

Economic Efficiency – so far

Economic efficiency – two conditions must occur to maximize gains from trade.

1. Total benefits ≥ total costs (this conditions boils down to having GFT ≥ 0)
2. Marginal benefits = marginal costs

In general, we found that price taker markets are efficient, that is, the standard intersection of supply and demand was efficient. At this quantity, MC, given by the supply curve, and MB (MV), given by the demand curve, are equal.

We have already looked at several policies that have created inefficiencies.
Taxes – by restricting output below the efficient level
Subsidies – by expanding output beyond the efficient level
Price Controls – both price ceilings and price floors ended up restricting output below the efficient level
Price Searchers – by restricting output below the efficient level

We have made an implicit assumption thus far – what is it?

Thus far, throughout all of the analysis we have done, we have implicitly assumed that all of the costs and benefits are borne by the decision makers. Below, the assumption is made more explicit.

On demand side – all benefits of consumption go to the buyer of the good. Or on the other hand, there are no benefits enjoyed by other people (not the buyer).

On the supply side – all costs of production are borne by producers. Or on the other hand, there are no costs incurred by other people (not the producers)

If our assumption is erroneous, that is, if not all costs and benefits are borne by the decision makers, we will have to modify our analysis.

In fact, when this assumption is not true, that is, when people do not bear all of the costs of their actions, we have a situation that is generally termed an "externality". We will talk about two cases, external costs and external benefits.

Clearly, we can think up examples of situations where this assumption is violated. What we will do next is to look at examples of cases with external costs. These, I repeat, are cases where there are costs incurred by others who are not the original producer. (We'll look at external benefits later).

Before this, some terminology

Private costs – the costs paid by the firm or person that produces the good (the decision maker)

External costs – the costs incurred by those people other than the firm or person that produces the good

Social costs – the total costs to all members of society, including those who didn't produce the good.
Social costs = private costs + external costs.

Examples of situations with external costs

Consider driving an automobile. You, the driver (decision maker) consider the cost of driving the car. This includes gasoline, car insurance, your time, etc. These are the private costs, and these costs would be

reflected in your supply curve of "driving". However, there is an additional cost that is borne by others, this is the smoke that comes out of your muffler. This affects the people walking down the street and others living in your community causing them discomfort, lower life expectancy, more health problems etc. These are the external costs, costs incurred by those who weren't the decision maker.

Consider smoking a cigarette in a crowded bar. Your private costs include the pack of cigarettes, matches, and the increased chance of getting lung cancer. The external costs are the discomfort, unhappiness, and increased change of getting cancer incurred by the people around you who don't like the smell of second hand smoke.

Consider painting your house day-glow yellow. Your private costs include paying the painter and the costs of the paint. The external costs are the unhappiness that your neighbors have to incur looking at your eyesore of a house.

More examples: Hog farms (external cost is smell), Sauerkraut factories (ditto), Farmers using fertilizer (dead fish down stream).

When we have external costs, is the private outcome efficient?

Answer: No.

The general conditions for efficiency are:

1. Total social benefits ≥ total social costs
2. Marginal social benefits = marginal socials costs

(Note: Don't worry about this unless you want to. The previous conditions (MC = MB) were a special case of these more general conditions. Talk to me if you want to hear why.)

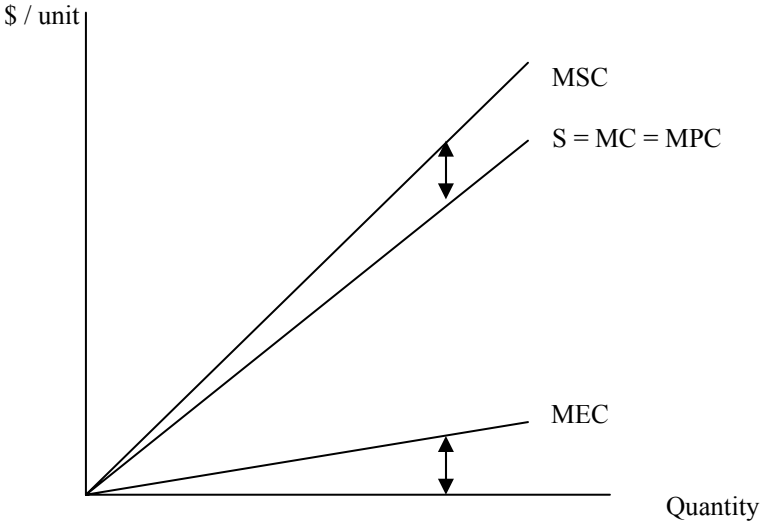
The first thing to keep in mind is that decisions are always made on the basis of private costs. Thus, without any intervention, people will make decisions based on their marginal costs (supply curve) and will not consider the external costs. Let's look at a picture.

Suppose the scenario is as follows. Farmer John grows corn. To grow the corn he uses seeds, tractors, land, labor, and importantly, fertilizer. Unfortunately, when it rains, some of the fertilizer runs off into the stream, and kills some fish downstream. This makes the downstream fisherman worse off. The external cost is the pollution of the water, and is incurred by the fisherman (perhaps they can catch fewer fish).

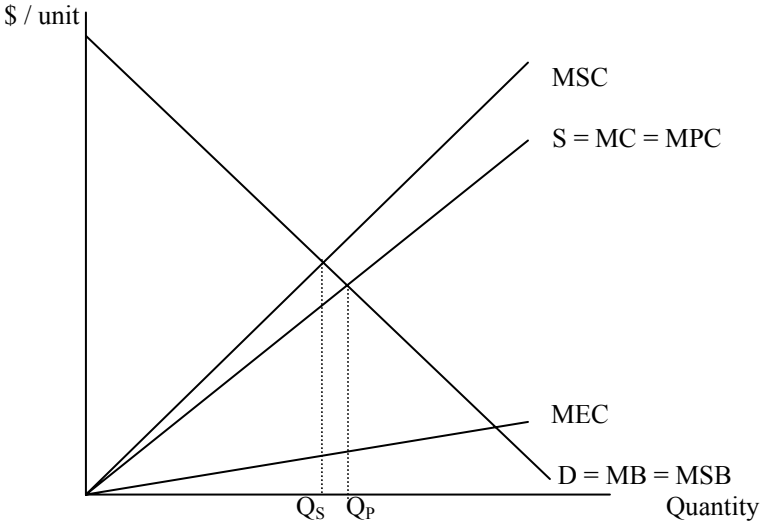
We start by drawing in the supply curve of corn. It is labeled, S, but you are reminded that this is the MC of producing the corn. Since these are the private costs of corn production, we will label it **MPC**, for **marginal private costs**.

Next, we want to consider the damage done to the fisherman downstream. Suppose for each unit of corn production, we can figure out how much marginal damage is done by the fertilizer killing fish. Let us graph this, and label it **MEC**, for **marginal external costs**. (Of course, if we could figure out what the total external costs were for each level of output, we could have calculated the marginal external costs. See example below). These are the costs incurred by people who are not the decision maker.

Last, we need to figure out what **MSC**, **marginal social costs** looks like. Recollect that social costs = private costs + external costs. It thus follows that that **MSC = MPC + MEC**. Here we add these curves using what's called "vertical summation" (as opposed to horizontal summation as we did before). The idea is we pick any old quantity, add up the private costs at this quantity, and then add up the external costs as this quantity, and call the result social costs. So, if at Q = 3, MPC = $5, and MEC = $2, then MSC = $7. See the picture below. Graphically, we just shift up the MPC curve vertically by the amount of the MEC. The result is MSC.



Finally, we draw in a demand curve, and we can see what happens. Since D = MB, and because we are assuming the demand curve reflects all the benefits to society, we can label it MSB for marginal social benefit (we are assuming that there are no external benefits). If the farmer only considers his private costs, he will choose the level of output where MPC intersects with demand, thus resulting in Q_P (where the P refers to the private solution). However, this is inefficient. At Q_P, MSC > MSB. The gains from trade for society are falling. There is too much corn being produced. The reason is that the farmer is not considering the additional cost that his fertilizer is imposing on the fisherman. He is ignoring the external costs. There is a DWL.



Can you shade in the DWL?

It is the area between Q_S and Q_P, and between MPC and MSC. This is one of those two instances I said where society is producing too much output.

How about shading in the total damage done by pollution? (Under MEC out to the quantity)

The efficient level of output is where MSC = MSB. In this case, this occurs at the intersection on the MSC curve and the demand curve. This level of output is labeled Q_S (where the S refers to the socially optimal solution).

Notice, even at the economically efficient level of output (Q_S), there is some pollution. At Q_S, we can see that there is some amount of MEC. In fact, if you wanted to add up the total damage done by pollution, we would add up all of the area underneath the MEC curve out to Q_S. <u>The efficient level of pollution is not zero</u>. Do not tell me on the test that the efficient level of pollution is 0. I will get very angry.

Think of the world we would live in with zero pollution? Do you like driving? I hope not, it's out. You like flushing your toilet? Better not.

What can we do to get to the socially efficient level of output? How do we get from Q_P to Q_S?

1. Tax
2. Regulate
3. Property rights / Coase Theorem / Side payments.

1. Taxes. If somehow the government new exactly the shape of the MEC curve, the government could levy the perfect tax that would result in the efficient level of output. Consider a tax that was the exact shape of the MEC curve. We know that putting a tax on suppliers shifts up the supply curve by the amount of the tax. If we could tinker it so that the tax looked just like the MEC curve, this would shift up the supply curve exactly to coincide with the MSC. The firm would pick the socially efficient level of output. We could even use the tax revenue to pay off the damaged fisherman (if we didn't spend the money on rockets or cheese). The trouble is that it might be tough for the government bureaucrat to figure out what the MEC curves look like. There are additional problems that are beyond the scope of this class. This will be easy to do in the numerical example later in these notes.

2. Regulate. We could just mandate that Farmer John produce no more than Q_S units. Again, the government needs to know what the curves look like. What if demand increases? We need a new regulation? It can get messy.

3. Define property rights / Coase Theorem / Side payments. More later.

Ok – I know what an external costs is and what happens when they exist. Why are there external costs?

To figure this out, we have to backtrack a bit and define some more stuff

Perhaps the most important role or function for government in to define and enforce **property rights**. What are property rights? They are fairly nebulous but extremely important. Consider an example. You own a bicycle. We say that you have a property right for that bicycle. You have the right to do whatever you want with that bicycle. You can ride it, you can paint it blue, you put baseball cards in the spokes, you can crush it, and you can leave it out in the rain and let it rust. No one else can do anything to your bicycle without your permission. If someone violates this right, you can take action accordingly.

Of course, there are limits to property rights. You may have the property rights to a knife in your kitchen, but you can't stab your next-door neighbor with it. The idea is that you have the right to do whatever you want with your property (within some limits). Importantly, other people are not allowed to take your property. You can also **transfer** your property right to the bike (by selling it to others). The government is responsible for protecting (**enforcing**) and defining (setting the limits) on your property rights, hence the police, military, court system, etc. If someone violates the property right to your bike, you can call up the government, and they'll do something about it.

In every situation where we find an externality, the fundamental problem is that property rights of some resources are either not defined, transferable, or enforceable. The government has not done a good job defining and enforcing the property rights.

Consider again, Farmer John. What's the property right that is not defined? Why? Who's fault?

Farmer John uses seeds to produce corn, and pays for the seeds.
Farmer John uses a tractor to produce corn, and pays for the tractor.
Farmer John uses labor to produce corn, and pays for the labor.
Farmer John uses clean water to produce corn, but does not pay for the clean water.
A hog farmer uses clean air to produce hogs, but does not pay for the clean air.

In the last two cases, the problem is that a scare resource is being used and not being paid for. No one can use your bicycle or car without compensating you, why is it that Farmer John can use clean water without paying for it? The answer is that no one owns the property right to the clean water. In fact, the property right to clean water, a scarce resource, is not defined. Externalities exist where property rights to scarce resources are not well defined.

Since the government is responsible for defining property rights, excess pollution is the fault of the government. Of course, the resources for which property rights tend to be ill defined are certainly resources for which it is more difficult to define them. We keep coming back to water and air. The problem is that these things tend to move around. Suppose you bought the 18 cubic yards of air directly around you. What's keeping the air you bought to run off and hang out with the air on the other side of the room? Read the chapter on bison in MB&N (they run around) and forests (sometimes people chop them down and drive them away). Seriously, it may help you out to read this sooner than later.

Why is it that Lake Erie is dirty and your backyard swimming pool clean? I would argue that someone has clearly defined ownership (property rights) to the swimming pool, where as no one has clearly defined property rights to Lake Erie. You have an incentive to keep your swimming pool clean, and thus will not tolerate people dumping trash into it, but who has the incentive to do the same for Lake Erie? Ever see the Chicago River on Saint Patrick's Day? They claim they die it green for the parade, but I am not so sure that's not just the normal color of sludge.

A numerical example of the private solution and the external solution

Same as above, only with some numbers. A great deal of this will be a bit of review, but it will be useful to put numbers on these curves to help explain the Coase Theorem result. Essentially, the same story told above with a more simplified picture to help illustrate the point. You should draw this picture (you did in class on Thursday if you made it).

Q	P	MPC	MEC	MSC
1	$10	$2	$6	$8
2	$10	$4	$6	$10
3	$10	$6	$6	$12
4	$10	$8	$6	$14
5	$10	$10	$6	$16
6	$10	$12	$6	$18

Graphically, this will be similar to the last picture we have drawn only the MEC curve will be horizontal, and also the demand curve is horizontal at a price of $10. This makes it easier to calculate stuff, and makes it easier to see the optimal tax (later).

We have assumed a perfectly elastic demand curve at a price of $10. Given the MPC, and the MEC, we can calculate the MSC.

Private solution

If Farmer John considers only his private costs, he looks for the intersection of MPC and MSB. This is just him looking for where his supply curve (MPC) intersects the demand curve (MSB). This occurs at Q = 5. Thus, the private solution is Q =5.

CS = $0 (It turns out in this example, due to the demand curve's shape, that CS = $0).
PS = $20 PS = TR – TC = $50 - $30 = $20 or ($8 + $6 + $4 + $2 + $0 – by unit)
Pollution damage = $30

GFT = CS + PS – damage = $0 + $20 - $30 = $-10.

Socially efficient solution

The socially efficient solution occurs at the intersection where MSC = MSB. Thus, we are looking for the intersection on MSC and Demand (MSB). This occurs at Q = 2. The efficient solution is where Q = 2.

CS = $0
PS = $14 PS = TR - TC = $20 - $6 = $14 or ($8 + $6 – by unit)
Pollution damage = $12

GFT = CS + PS – damage = $0 + $14 - $12 = $2.

A couple of things to notice...

The amount of damage caused by pollution is reduced from $30 to $12.
Farmer John's profits have fallen from $20 to $14.
Society is $12 better off (-$10 compared to $2). That is, society is better of by $12 worth of GFT.

Now, let's solve this numerical example using taxes and regulations

We know that the left on his own, Farmer John will produce Q = 5, the private solution. Somehow we would like to get him to produce Q = 2. How can we do this?

1. Tax – Suppose we put a $6 per unit tax on Farmer John. This would cause his supply curve to shift up by $6. It's as though his new supply curve now reflects both the private costs and the external costs (that he "pays" by way of the $6 per unit tax). Now, in essence, Farmer John must "pay" the amount of damage he does on the fisherman. This is called "internalizing" the externality. We have forced him to consider the external costs by making them part of his private costs (by way of the tax). The government collects some revenue, which it could give to the fishermen (if it doesn't build a new highway in Ted Kennedy's district)

2. Regulate – not much to say here. New law, you can only produce 2 units.

3. Coase Theorem / Property Rights / Side Payments – coming soon

Enough already – tell me about the Coase Theorem

Recollect that we said earlier that the reason an externality exists is because property rights are not defined for some resource. Ronald Coase comes up with a devilishly simple answer to the problem. He says don't tax, don't regulate, just define the stinking property rights to the resource. Let someone own the resource.

So in this case, he would suggest letting someone own the stream, or own the right to having clean water. He claims this would solve the problem.

Coase Theorem: If property rights are fully defined, cheaply enforceable, and transferable, then the ultimate utilization of productive resources is independent of the initial allocation of those resources.

What does this mean? First off, he says define all of the property rights to the resources. Then, if these conditions are met, this means that in the end, productive resources will be used in the highest valued way, independent of where they started.

So for example – shake up all the CEOs of all the fortune 500 companies, and in the end, they'll all end up working for the same companies. Say Bill Gates gets assigned to be IBM's CEO. The Coase Theorem says that Bill Gates is most valuable to Microsoft. So no matter what happens, he'll end up being hired away to Microsoft, where he is most valuable. Likewise with the others.

Think of the example with the Superbowl in the Superdome in New Orleans. The car dealers had reserved the Superdome on the Sunday that the NFL wanted to play the Superbowl. I surmise that it is more valuable to use the Superdome for the Superbowl than the car dealers. The Coase Theorem says that even though the car dealers have the initial right to use the Superdome that day, since it is more valuable to use the Superdome for the Superbowl, that the Superdome will be used for the Superbowl. This is, of course,

just what happened. The NFL made a $6 million payment to the car dealers for the right to have the dome that day. Here, property rights (to use the Superdome that day) were transferred. But in the end, the Superdome was used in the way that it was most valuable.

What does it mean in for Farmer John? It says that if you just give the property rights of the stream to someone (fully defined, cheaply enforceable, and transferable), the water will be used in the highest valued way. Further, the outcome will be no different even if we change whom we give the rights to initially. That is, allow the Farmer to pollute, or give the fisherman the right to clean water, and we'll still end up with the same result. You will hopefully be convinced of this below.

So finally, three cases of Farmer John

Case 1 – Someone is polluting, but no one can identify the source. What do we get? The private solution. Farmer John will consider only his private costs. Q = 5. This is inefficient. What if we define the rights…

Case 2A– The source of the pollution is again identifiable (Farmer John). The property right to the stream is given to Farmer John. He has the right to pollute all he wants.

The property right to the stream is given to Farmer John. That is, he is allowed to pollute all he wants, without having to compensate the fishers down stream. You might be inclined to think there will lots of pollution here, but the Coase Theorem says just the opposite.

Here, the Farmer has the right to pollute as much as he wants. But, since property rights are defined, the fisherman can pay the farmer to not to produce, and hence not pollute. How much are fisherman willing to pay? The will pay $6 for each unit of output not produced, as it will cause $6 worth of damage to them if he pollutes. (Each unit of corn not produced will save them $6 in damages)

Consider what Farmer John now faces

	Profit from producing		Accept $6 not to produce
Q = 1	$10 - $2 = **$8**	or	$6
Q = 2	$10 - $4 = **$6**	or	$6
Q = 3	$10 - $6 = $4	or	**$6**
Q = 4	$10 - $8 = $2	or	**$6**
Q = 5	$10 - $10 = $0	or	**$6**

So, he can earn $8 worth of profit on the first unit. If he is offered $6 not to produce, he will turn this down and produce the 1st unit. On the 2nd unit, he's indifferent between producing and not producing, but let's say he does produce. Consider the 3rd unit. He could produce it, earn $4 in profits or could accept $6 from the fisherman not to produce that unit. Farmer John will choose not produce the third unit. Likewise, for the 4th and 5th unit. It turns out then Q = 2. The fisherman will pay $6 each so that the third, fourth, and fifth units are not produced, for a total of $18. (The wise fishermen knew that Farmer John would not have produced the 6th unit, so they don't offer him any money not to produce the 6th unit).

Again, the externality has been "internalized". When the farmer decides to produce one more unit now, he includes the $6 he could get from the fishermen if he decided not to produce.

Case 2B – The source of the pollution is identifiable (Farmer John). The property right to the stream is given to the fishermen. They have the right to a clean stream.

Here again, you might think since the fishermen have the right to clean water, there might be less pollution that in the previous case. Not so, says the Coase Theorem.

The fishermen have the right to clean water. However, they will be willing to sell this right to Farmer John for the right price. In fact, since it does $6 worth of damage for each unit of output produced, we know the

price. If Farmer John will pay them $6 per unit of output, they will allow Farmer John to produce and hence pollute. So now, in order to produce a unit of corn, Farmer John must now pay his MPC and must also pay $6 per unit in addition to pay for the damage done to the fisherman. His MPC curve shifts up by $6. In fact, now it coincides with the MSC curve we had before. He will choose Q =2, the efficient level of output. See the chart below.

Q	MPC	Damage Payment (if he produces)	MPC'	MSC (from before for comparison)
1	$2	$6	$8	$8
2	$4	$6	$10	$10
3	$6	$6	$12	$12
4	$8	$6	$14	$14
5	$10	$6	$16	$16
6	$12	$6	$18	$18

In contrast to case 1 (where he didn't have to pay for the pollution), he must now pay to use the scarce resource (clean water), and cuts back on it use accordingly. Now his new private costs are equal to the social costs. He chooses Q = 2. This is internalizing the externality again. The damage, which previously was an external costs, is now internalized.

Wrap – up on the main points of the Coase Theorem

We defined the property right to the stream, and then gave it to each of the parties (in cases 2A and 2B). We found it in **both** cases, we ended up with the **same** level of output, Q = 2, which in fact was the **efficient** level of output.

In fact, we found out that the water was **used in its most valued use**. For units 1 and 2, it was more valuable to use the water for farming. The profits earned by the farmer on these units ($8 and $6) exceeded the damage done to the fisherman ($6). For units 3, 4, and 5 it was more valuable to the fisherman for fishing. The damages done to the fishermen ($6) exceeded the profits that could have been earned by the farmer ($4, $2, $0). Again, ultimate usage of the resources **was not changed by who initially had the right** to the water. This is what Coase says. Resources will ultimately be used in their most productive way, regardless if who owns them initially (if property rights are well-defined, etc, etc…)

Are there any other important differences between cases 2A and 2B?

There is one important difference between cases 2A and 2B. While the initial allocation of the property right does not matter in determining the ultimate use of the resources, it most definitely determines the **direction of the side payments**. We define side payments as the payments that are made from party to party.

In Case 2A –
Side payments = $18 (from fisherman to Farmer John so he doesn't pollute)
In Case 2B –
Side payments = $12 (from Farmer John to fisherman for damages or right to pollute)

In Case 2A, Farmer John earned $14 worth of profits, but also received $18 in payments from the fishermen, leaving him with $32.

In Case 2B, Farmer John earned $14 worth of profits, but had to pay $12 to the Fishermen, leaving him with $2.

So, while it doesn't matter from a societal point of view that gets the initial rights, it certainly affects the parties involved. Which does Farmer John prefer? You better believe he'd rather have the right to pollute (as he does in 2A). Everyone will want to have the initial right, as they will then receive side payments.

What if property rights are nut fully defined, cheaply enforceable, and transferable? What if it's not easy to get the parties together to make these side payments and bargain? That is, what if all those Coase Theorem conditions don't hold? Two more easy cases…

Then, the Coase Theorem doesn't work, and we'll get something inefficient.

Case 3A – Farmer John can pollute again, but Farmer John and fisherman have some impediment to keep them from bargaining, and agreeing to make side payments. (This is really case 1 all over again).

Q = 5. The private solution once again. Fisherman can't pay him not to produce.

Case 3B – Fisherman have right to clean water, but Farmer John and fisherman have some impediment to keep them from bargaining, and agreeing to making side payments.

Q =0. Farmer John is not allowed to pollute at all, and can't pay off the fisherman to allow him to.

Both cases 3A and 3B are inefficient. These are examples of situations where all those conditions on the Coase Theorem aren't met and the Coase Theorem doesn't work.

The Coase Theorem has its pitfalls (as do taxing and regulation) as well, as illustrated in case 3A and case 3B. When it is difficult to identify the source of the pollution, or if there are large costs to get together and make an agreement, divvy up the side payments, enforce the agreement, etc, the Coase theorem's conditions will not apply. However, Coase is a pretty powerful idea, nonetheless. Anyone want to buy Lake Erie?

I am bewildered. How about a quick summary?

- People make decisions based on private costs. In situations where there are external costs, people will not consider the external costs (they will consider only their private costs) when making their decision, and thus will produce too much output. This will be economically inefficient, and will result in a DWL. There will be too much output, too much pollution (damage).

- The socially efficient solution is found at the rate of output where MSC = MSB. Here the gains to trade from society are at their maximum level.

- We must alter people's incentives to get them to produce the efficient solution. We will need to attempt to make them consider the external costs. Three such ways are to tax, regulate, or define property rights (Coase).

- The optimal tax on pollution would mirror the shape of the MEC curve.

- If all of the conditions of the Coase Theorem are met, we will always see the socially efficient level of output, and thus resources will be used in their highest valued way. This does not depend on who owns the initial rights to the resources. The direction of the side payments (whom is making payments to whom) of course will depend on who receives the initial rights.

Did you know that when you type in Superbowl in Microsoft Word, the spellchecker spits it out and suggests "superb owl"

Don't Freak Out, yet….

We'll go over some problems on Monday. You're not be required to regurgitate with so much detail on the test.