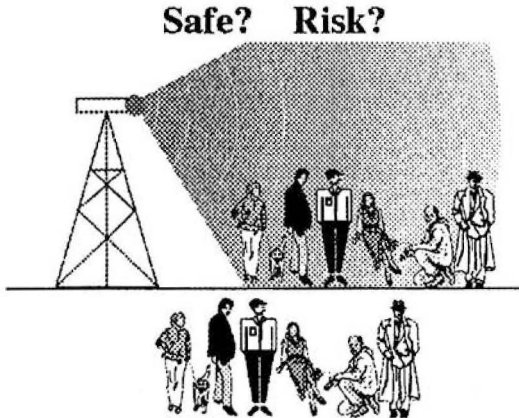


## Chapter 5

### Assessing Health Risks of Cell Towers\*

By: Andrew A. Marino, Ph.D., J.D.

I'm going to discuss the health consequences of being exposed to electromagnetic fields from cell towers. Are they safe, or is there a risk? I'm not going to answer the question. This is not the time or place for me to do that. I want to be very clear about what I mean by "risk." People who live beside the cell towers are going to get sick, just like anybody else. They may get cancer; they may have heart attacks; or get other kinds of diseases, because that's what can happen to people — eventually. If it were the case that we could take even one such sick person, and make no change whatsoever in his life except to erase exposure to the electromagnetic field, and it turned out that this change delayed the onset of his disease — then that is what it means to say that exposure to the fields is a risk.

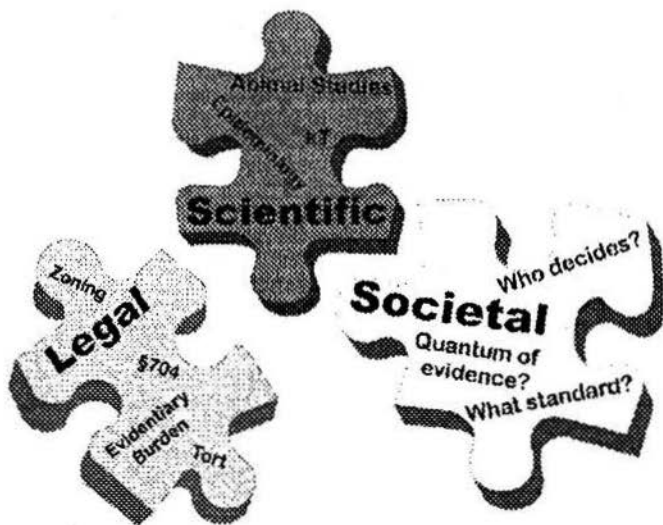


- Risk?/Safe? Is not purely or even mostly a scientific question.
- It is impossible to get an answer from science, and it is unwise to accept any answer from scientists.

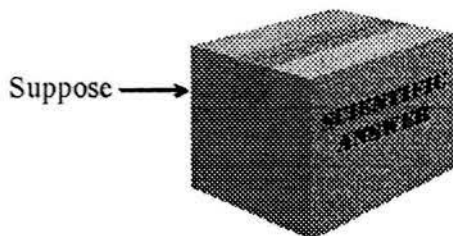
\*Presented at Cell Towers Forum; State of the Science, State of the Law; Litchfield, Connecticut, December 2, 2000.

I'm going to make two basic points. The first is that the question of whether something is a risk, or is it safe, is not a scientific question. Second, I'm going to conclude that it is exceedingly unwise for you to put your faith in scientists because they're no better than you. They're no worse than you. They're just like you. It makes no sense for you to let scientists do your thinking for you.

This question that I intend to talk about —“risk? or safe?”— is a complex one, but we can group the issues into three separate areas. I will talk about all three pieces of the puzzle.



Let's suppose the answer to the question — "risk? or safe?" — is actually scientific. Consider two questions. First, what would the answer look like? It's clear that we have to have some concept of what it would look like because that's the only way we're going to know it when we see it. So, what would it look like? Second, how would we get the answer? Bear in mind that if there is no agreeable and acceptable way to do that, then the situation would be truly hopeless.

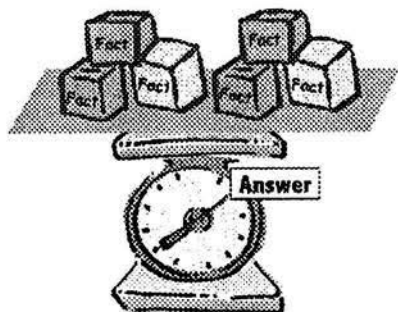


Q1: What would it look like?

Q2: How would we get it?

The orthodox answer to the first question is that the facts answer the question, and that when we have enough of the facts the answer will be obvious. Is that true? Well, let's see.

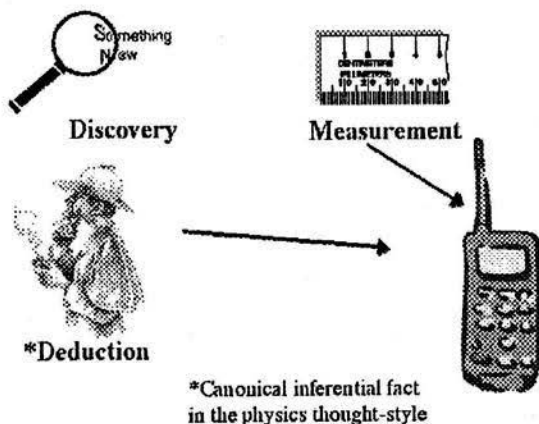
Orthodox Answer to Q1



If you're educated as a physicist or engineer in this country you are taught that there are three kinds of facts that you will use in your career. We can find something, we can measure something, and — because of the intellectual achievements of our forefathers, we have all of the deep, deep laws of nature in the form of mathematical equations — we can deduce things.

There are four sets of laws. From those laws we can deduce things. What things? Everything you can think of. For example, one of those four laws, in conjunction with measurement facts, completely explains how cell phones work. There's no mystery about them. Their behavior is entirely predictable — that is, it can be deduced.

## OK - Then What's a Fact?



The simple truth is that there are no deductive facts that can be summed to answer the question of risk — not even one. Thus, all of the special expertise of the physicists is simply unavailing. It doesn't matter. Physicists can give no more of an authoritative answer to the question than Groucho can.

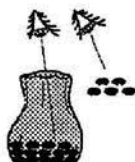
**\*Risk?/Safe? = Nonquestion  
in Physics**



*\*Don't confuse this question with the relatively trivial kind of question that can be answered by a measurement*

Well how are we going to get a scientific answer to the question — “risk? or safe?” This task begins with recognition that there is plainly and obviously another kind of inferential fact, and it is obtained by a reasoning process that is totally different from the deductive reasoning process.

**\*Abduction  
(the other kind of inferential fact)**

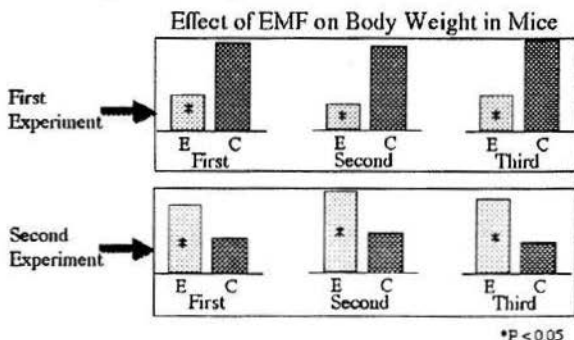


“The evidence suggests that the beans came from the bag.”

*\*The canonical reasoning form in biology and medicine*

Now, in a sense, the abductive fact is a poor country cousin of a deductive fact. A deductive fact pounds the table. It says, "This is the way it is. Exactly. Certainly." It's the nearest thing to infallibility that you'll ever see on earth. The abductive fact, in contrast, says, "It looks like this is the case. The data suggests that such-and-such is true. But of course, I could be wrong."

## Subjectivity in Abductive Facts

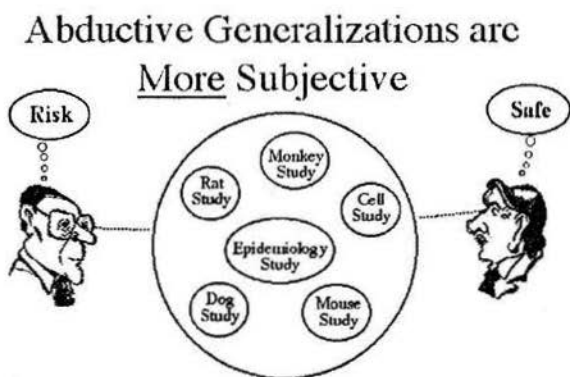


Okay? So let's decide the question using abductive facts since that's the only kind of fact open to us. Well, it turns out there are basic problems with that approach to answering the question. This illustration depicts one of the more fundamental difficulties, namely, that abductive facts are at least partially subjective. I want to illustrate this point using real data. I've shown it in qualitative form because the numbers themselves aren't important. These experiments were performed at a private research institute in Richland, Washington, on behalf of the electric power industry. These are folks who are keen for you to understand that the electromagnetic field from powerlines are safe.

The investigators exposed three successive generations of mice to electromagnetic fields, and then repeated the entire experiment. The first time they did it they found that the mice in the exposed group were always smaller than the controls, and the second time they did the experiment they found that the mice were always larger than the controls.

What is the overall conclusion of this work? Incidentally, when I present this question to my students, a fair number of them say that no conclusion is possible, and that it's necessary to repeat the experiment. Well, that's an unacceptable answer. That's simply not an option. Why? Because, these two experiments cost several million dollars. Not even the power companies can continue to fund studies of that magnitude without an answer. This is the real world, imperfect as it is, and we need an answer.

Well, there are two possibilities. The investigators argued this way: They said in the first experiment the mice were smaller than the controls and in the second experiment they were larger than the controls. Therefore, on average, they were identical to the controls, suggesting there was no effect due to the EMF. The alternative view is this: Both experiments clearly showed that fields could affect the growth rate of mice, but the direction of the effect was affected by factors that were not controlled in the experiments. Note that depending on the interpretation one accepts or adopts, the experiment is or is not evidence that being exposed to power-line fields is a health risk. The point of this example is to show you that abductive facts have a significant subjective component.



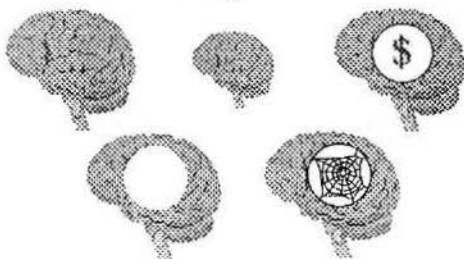
I think that you can easily see that because individual studies in biology do not speak for themselves but rather must be interpreted, for an even greater reason generalizations based on biological studies also depend on human interpretation. This is an important illustration. If you understand my point here, then you'll understand my further and deeper

point, which is that I really don't care what either one of these guys says is the conclusion. What I really want to know is *why* they are saying what they are saying, and how they got to that conclusion.

Why is there subjectivity in biological facts? For the reason that I mentioned earlier, namely — that scientists are no better than you. Their brains are no better than your brains. Brains of some scientists are robust and work well. Other scientists have teeny little brains. Some brains work only in response to financial inducements, irrespective of facts. Other brains have big wormholes. They used to work well, but worms got in there. Finally, there are a lot of present-day scientists who put a lot of stuff in their brains and then walled it all off a generation ago. Nothing new has entered since Gerald Ford was President.

Because of the properties of abductive reasoning, which I mentioned previously, use of a blue-ribbon panel to decide the question of — risk? or safe? — never works. It can't. The best it can ever do is give you a consensus of the people who the guy who picked the panel liked. It would be far more honest intellectually to skip the blue-ribbon panel and go directly to the guy who appointed it and ask for a ruling.

### Why Biomedical Facts Are Subjective to the Extent That They Are



### The Blue-Ribbon Panel Process Doesn't Work



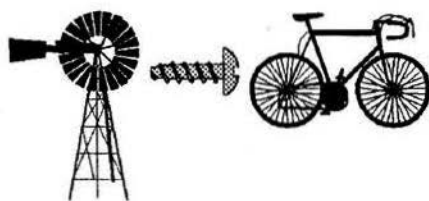


For the rest of this chapter, I would like to do two things. First, I want to revisit the domain of physical science to show you that a judgment that cell tower fields are a health risk is entirely consistent with physical reasoning. Then I will say some things about the legal issues associated with cell towers and their fields. First, the

matter of physical reasoning... A “linear system” is a system that has the following property: when the input is small, the output is small. But if the input is large, then the output is large. It’s that simple. If the wind is blowing at a certain velocity, then the windmill turns at a certain rate. If the wind goes up a little, or down a little, then the speed of the windmill changes accordingly. In proportion to how much you turn the screw, that’s how far it advances. In proportion to how fast you pedal the bike, that’s how fast you go.

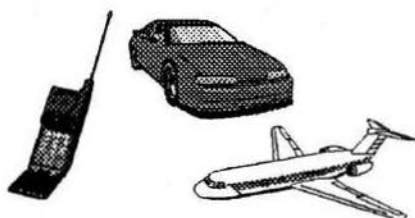
### Man-Made Linear Systems

#### Simple Linear Systems



### Man-Made Linear Systems

#### Complex Linear Systems



predictable. Having a cell phone that might work sometimes, but might not work other times is hardly a desirable situation.

There are many linear systems that are quite complex. A cell phone is a good example. A cell phone follows simple linear laws — that is the reason it is so dependable. Linearity is a codeword for reliability or predictability. All of man’s machines, essentially, are linear in nature because man has little use for machines that aren’t

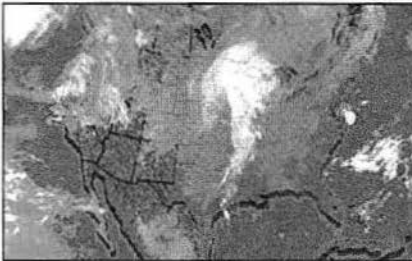
## Man-Made Nonlinear System

Man sometimes makes nonlinear systems — like this Lava Lamp — for fun, but they're not predictable, so they're generally not useful.



Nature, on the other hand, is loaded with nonlinear systems. That is, systems that do not have the property that I mentioned earlier that defines a linear system. The weather is a classic example. Because

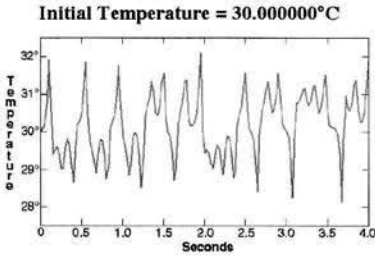
## Natural Nonlinear System



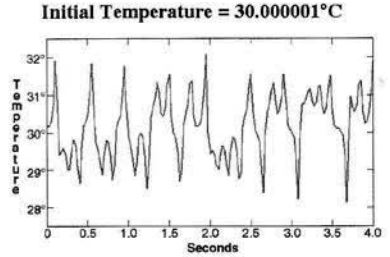
weather systems are nonlinear, it is impossible now — and will forever remain impossible — to have long-range weather predictions. It's the non-linearity that is the source of the long-range unpredictability.

I want to illustrate for you the dimension or significance of this unpredictability in nonlinear systems. To do that I have taken some equations that are used to mathematically model the weather. They are nonlinear equations and I used them to calculate, in this model, how the temperature would evolve over time. As you can see in the illustration to the left, beginning at  $30^\circ$ , the temperature bounces around between  $28^\circ$  and  $32^\circ$  over four seconds.

### Sensitivity to Initial Conditions

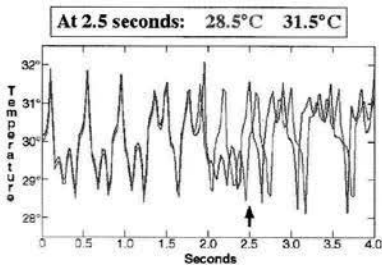


### Sensitivity to Initial Conditions



In the illustration to the right, I have used exactly the same equations, made no changes whatsoever except that the initial temperature was now immeasurably and imperceptibly greater than was the temperature that started the previous pattern that I showed. One millionth of a degree different. A difference so small that for all practical purposes it is unmeasurable and not able to be regulated. This is the pattern of evolution of the system starting with this initial condition.

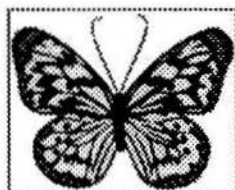
### Sensitivity to Initial Conditions



Here I have superimposed the two patterns on one another. What you see is that the patterns were, initially, identical. But after a few seconds, the evolution of the two systems differing by a millionth of a degree, differed markedly. For example, after 2.5 seconds, there was a difference of about  $3^\circ$  in the two cases.

Remember that initially the systems differed only by a millionth of a degree and after a few seconds they now differ by  $3^\circ$ . This phenomenon is called sensitivity to initial conditions. It is exhibited only by nonlinear systems. And it is inconsistent with the idea of trying to predict the exact behavior of the system. You could say some things about the future behavior, but you can't predict things in anything like the way you can in linear systems.

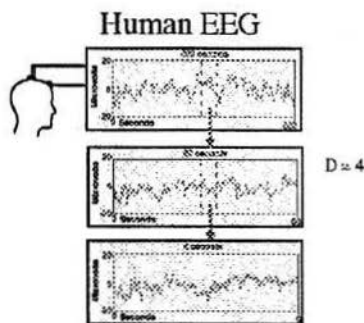
Chaos  
is  
Sensitivity to Initial Conditions



**Butterfly Effect**

Another name for this phenomenon is 'deterministic chaos', also called the 'butterfly effect', based on an observation that a butterfly flapping its wings in the southern hemisphere could affect the weather in the northern hemisphere. As counter-intuitive as that notion may be, it is true. Small changes can be amplified enormously in nonlinear systems.

So what? Well, the human brain is a nonlinear system. Here is some evidence... In the top panel, I show you 600 sections of a human



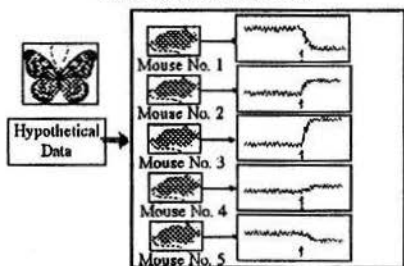
EEG recording. In the middle panel I've taken a small slice of the top panel and expanded it so that now I show sixty seconds of data. The bottom panel shows the further expansion so that only six seconds of data can be seen. The thing to notice here is that the pattern of the EEG looks the same across all the time scales. This is a signature

property of a geometrical entity known as a fractal. Fractal behavior suggests that the underlying electrical activity was nonlinear in nature.

So what? Here's what. If a living thing is governed by nonlinear laws, and you take a collection of those things — say, five mice — and you expose them all to the same environment, the expected behavior if —

and only if — the environmental stimulus can affect the mouse, is that every parameter you're measuring will change differently in different mice. In a linear model, all the changes would be of about the same amount and would go in the same direction. In a nonlinear model this is what happens... Now you can see what would happen if you averaged the results. If you

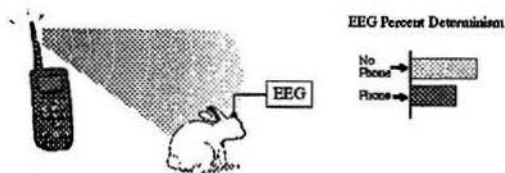
### Nonlinear Model



had a linear effect then the more animals you averaged, the clearer the result would appear. If the underlying law is nonlinear in nature, however, when you average the results you wind up concluding that there is no effect. The 'ups' balance out the 'downs'. The choice to approach the data by invoking the statistical process of averaging is equivalent to the choice of ignoring the stimulus-response relationship which, given the assumptions in this slide, actually exists.

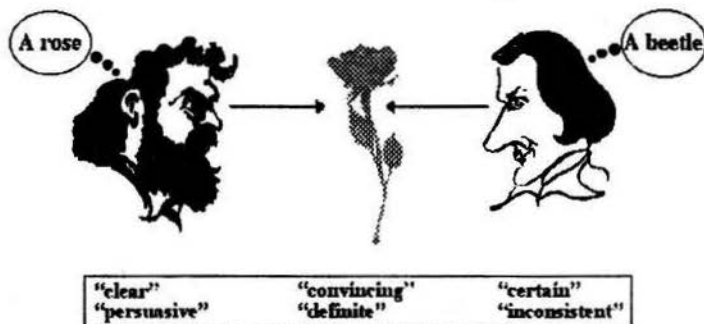
What direct evidence is there that cell phones cause changes in the human EEG? Published right now? None. Coming in the future? Stay tuned.

### Cell Phones Cause Nonlinear Change in EEG



I now want to make a series of legal points. First, it is a basic principle of statutory and common law that the burden of showing safety for a new device or technology is on the proponent of the device or technology, and not on the potential victims. Nothing, absolutely nothing about Section 704 of the Telecommunications Act, in my opinion, changed that burden. If a particular litigant or zoning board decided to conduct itself as if that were the case, then that's their mistake.

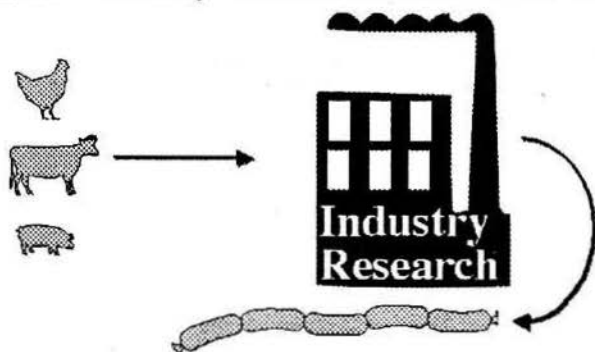
## Terminology



- It is essential to understand what particular words mean

In trying to ferret out who is saying what, and on what basis, as banal as it may sound, pay attention to what the words may mean in the assertion of claimed fact. It is my experience that the only way a proponent of safety succeeds is if the words in which his argument is cast are undefined, and you fill the need for him with your own idiosyncratic notion of what they mean. I have listed several examples on this illustration. Ask yourself when you see these terms in cell-phone literature, what exactly do they mean? I think this much is true: If there is no clear meaning assigned, then it is impossible to answer the question.

## All Industry Research is Dubious



- Unless you know what goes on inside the factory, you can't trust the product

One of the most foolish things someone who suspects that cell phone towers might be health risks could do is accept evidence provided by the industry. Everything it says must be challenged. The industry isn't going to shoot itself in its foot. Don't you know that from your own experience in life?

If I had available to me the amount of money available to pro-industry spinners, I could fill an auditorium room with medical school department chairmen who would swear on a stack of Bibles that there is no substantial evidence that there isn't green cheese on the far side of the moon. I return to the point I made earlier. You don't want a conclusionary statement from any expert. You want to regard him as a paid spokesman for the company. What you want to ask is why he says that, and how he reaches that conclusion.

## Scientists Are Only People



- All industry spokesmen (especially M.D.'s and Ph.D.'s) should be regarded as compensated endorsers

## Examination of Witness



"May I remind the witness that he is under oath."

- Effective cross-examination is as rare as it is important

The greatest vehicle for finding truth is cross-examination. I have been cross-examined for hundreds of hours, and I can tell you it is never a comfortable position. The rules are all in favor of the cross-examiner. Never believe anybody who hasn't been thoroughly cross-examined.



"It doesn't look to me like it could do any chromosomal damage."

Decide beforehand what acceptable evidence IS.



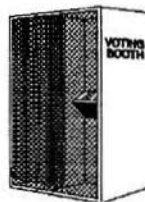
Before you go into a contest aimed at assessing whether cell tower fields are safe or a health risk, you must decide in advance what you consider to be acceptable evidence of one or the other inference. If you can't do that, you're wasting everybody's time.

Finally, I want to make it clear that I do not want to be understood as somehow advocating some kind of massive governmental rule-making intervention in the cell phone area. I think that would be the worst possible thing that could happen. It would be a disaster. The EPA and the FCC are woefully inadequate to deal with this issue. So is,

in my view, the NIH and the World Health Organization. All these groups are hamstrung by traditions, constituencies, rules and laws. Perhaps the best you can hope for is that research is done, that it is not rigged, that all the results are made available to you if you want them, that all the issues are evaluated on a level playing field where both sides have equal resources and are able to confront the experts on the other side. That's as good as it gets.

Then, you have to make a choice...

### Risk?/Safe? A Basic Societal Issue



- Should you or the government decide?

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