The Oil Drum
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Arrogance and Scientific Rules of Thumb

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This is a guest post by Cheryl Rofer. Cheryl worked at Los Alamos National Laboratory for 37 years on topics including the nuclear fuel cycle, fossil fuels, lasers, technologies for destruction of hazardous wastes and decommissioning of nuclear weapons, and management of environmental cleanups. Cheryl has been a visitor to The OIl Drum for a long time, but has only recently registered. Her blog is Phronesisaical.

I often get irritated when I read poorly informed discussions of scientific and engineering issues. Why? I think it's the arrogance. That arrogance comes in several forms:

Hey, you science guys! You've got something wrong!

I've figured out a solution for a problem that other people seem to find difficult.

No, I didn't have to check what's been done before.

And there are more.

These assertions are indicators that the person behind them doesn't know what s/he is talking about.

That's one of my rules of thumb. Scientists have a lot of rules of thumb, which sometimes makes them seem arrogant.

"I've found a way to run your car on water instead of gasoline."

"Bosh."

One of my favorite sources of rules of thumb is thermodynamics. It doesn't tell you how to do things, or how fast you can do them, but it tells you whether something, like running your car on water, is impossible.

Most people know that there are three laws of thermodynamics: energy can neither be created nor destroyed; you can't break even except at absolute zero, but you can't reach absolute zero. Adding some chemical specifics gives very useful rules of thumb. Engineers have other rules of thumb, from thermodynamics and practical experience.

I'll give a few examples of those rules. They become so engrained if you do science or engineering for a while that you don't think of them--they become a sort of common sense, different from everyday common sense. So when someone says something that contravenes them, a scientist is likely to reply sharply that that's wrong.

Rule #1 (no significance to the numbers): If it's an obvious idea, chances are that someone's thought of it before, and there's a good reason why it won't work. This is not a reason to give up, but rather a guide to checking the idea out.

This rule doesn't flow directly from thermodynamics. It's more in the realm of how science works. One of the most basic things that a scientist learns is that his/her own mind is the first place that mistakes will be made. It's too easy to bend facts in your mind toward what you want, to determine a conclusion and then figure out how it has to be done. So when a scientist has a great idea, the first reaction is to ask whether it fits with the rules of thumb and whether it's been done before. If it goes against any of these, a scientist's reaction is, "What did I get wrong?" not "That's the way it ought to be."

I had a boss once – a physicist in a project that was mostly chemistry – who believed that creativity depended on not knowing too much about a subject. This is a view taken by many physicists and too many of those proffering solutions to the Deepwater Horizon blowout. My boss would come around with a great idea; we would tell him what was wrong with it; and then he'd let it go. It wasted time, which is why I prefer some base of subject knowledge as a takeoff point for creativity, but he put the process of science into play and lived by it: peer review. There are a lot of ways to check out a new idea: ask other people; repeat the experiment; check the literature. You can't get creative if you stick with a loser idea. The important thing is to give it up once someone shows you it's foolish.

BP's blowout at Deepwater Horizon is particularly difficult to comprehend because of its scale. Most of us are not accustomed to thinking of the pressures under a mile of water, nor gases flashing out of the liquid as the petroleum bursts from the pipe, the enormous pressure behind it, the five-story blowout preventer. The construction of the well is not easily visualized, particularly if you've never learned how a well is constructed, now with an unknown degree of damage. I've dealt with drillers, had the business of mud described to me, and I can't describe it now in any detail myself.

So extrapolations from experience in watering the garden are unlikely to provide solutions. Heck, if you think that the well can just be buried, plant a hose in the ground shooting full force upward and try to cover it with dirt. Nor are computer games or action movies a good guide to what can be done.

Rule #2: Input for a product should be water and air; other things cost more. KISS: Keep it simple, stupid. Also: Occam's razor. Basically, the simplest explanations and the cheapest inputs, are usually best.

These are three statements of a similar principle. I learned the first from a chemical engineer. The others are more general. They are nice tests of an idea: how cheap and easy is it? How could it be cheaper and easier? This can lead to cutting corners, but it doesn't have to.

Those rules are directly applicable to the solutions being offered for the BP blowout, but there are other rules that have more general application.

Rule #3: Carbon dioxide and water are products, not reactants. The system hydrocarbon plus oxygen has more energy (enthalpy) in it than water plus carbon dioxide. This is mostly a consequence of thermodynamics' First Law. If you get energy out of a system, as in an automobile engine, you can't get much more energy out of the products. So all the schemes to run your car on water are bosh. No, you can't use a catalyst to turn it around; catalysts only speed up reactions that are allowed thermodynamically. You have to add energy to do anything chemically with carbon dioxide and water.

Rule #4: Stuff mixes. I've recently been engaged in a discussion with a person who has convinced himself that the science on the CFC ban was wrong. His reasoning is that you can pour out gaseous CFCs in a stream because they are heavier than air; therefore they must fall out of the atmosphere and never reach the ozone layer. The Second Law says that things tend toward maximum disorder, which means they mix. Once mixed, stuff doesn't unmix. Have you ever seen the sugar jump out of a cup of tea and form one of those nice little cubes? Gases mix even more easily.

Rule #5: Everything takes more energy than you think. I've seen, far too many times, the lament that our current electrical generating plants "waste" one-third of the energy in their fuels. Welcome to the Carnot cycle! It's one of the first things thermodynamics students calculate, a sequence of energy generation and use. And the result that those students get, largely a consequence of the Second Law, is that about a third of the input energy goes to entropy, not usable. There are other cycles and other ways to use energy that are more efficient, but if you've got a Carnot cycle, the most common cycle for power plants, you're stuck with that one-third entropy. The Second Law says that there's always going to be some left-over, not-usable energy, and that there will be even more when you try to reverse a process, like turning carbon dioxide into something else.

There are more. Maybe the ongoing nature of the BP blowout, leading to repeated rebuffs of all those suggestions that aren't likely to work, will teach some of the public that such rules of thumb exist and are useful.