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By Clifton E. Meloan

Presenting chemistry to consumers

DURING FIFTEEN YEARS as a practicing analytical chemist and eight years as a science adviser for the FDA, I have encountered many consumer-related problems the solutions to which required the application of a wide variety of analytical chemistry techniques. In talks before students, civic and social groups, legislators, administrators, and other nonchemists I try to present chemistry and chemicals as logical, attractive ways of dealing with many kinds of problems. I learned very quickly, however, that as chemists we too often overkill with technical facts and jargon, and with a bit of arrogance help to alienate from science consumers, students, law-makers, voters, and taxpayers. When chemistry, indeed all science, is made mysterious and miraculous, its practitioners sometimes come to be blamed as devils for carrying out the tasks society seemed to be requesting.

Seeking to avoid mystifying or alienating nonscientists, I present case histories and involve the audience in setting up problems and moving toward solutions. Cited in this paper as examples are the histories of cases that required determining the substitution of carp for red snapper, the addition of cider vinegar to wine vinegar, the presence of polychlorinated biphenyl (PCB) in cereal, and the source of insects found in flour (the case I lost). What I have found to be the wrong way to present information is to be perfectly factual (and dull)—to state simply that disc electrophoresis is used to detect the carp proteins in the presence of the red snapper proteins, that gas chromatography is used to determine sorbitol (from the cider vinegar) in the wine vinegar and also to detect PCB in the cereal. Analytical chemists would immediately know what was done; we are accustomed to brief and straightforward explanations. To others, however, such explanations mean little if they did not even realize these analyses were problems and do not understand how the problems were solved. Certainly laymen know little if anything about the instruments used.

The basic precepts I try to work under are as follows:

1) Make a detective story, if possible, out of any analytical problem you must present to an audience of nonchemists. This keeps audience members with you and encourages them all to try to see if they can solve the problem before you reveal the answer.
2) Set up the problem carefully, in clear, logical steps, so that laymen can understand it.
3) Minimize the details of instrumentation.
4) Show how the application of science solved the problem.
5) Do a soft sell for fundamental research and chemicals.
6) Make a straightforward pitch for the application of reason and common sense when discussing chemicals.

I do not try to cover all of these points in each example, but I do cover them all in the course of the talk. The case histories that follow are typical presentations of problems and the reasoning behind their solutions.

The substitution of a cheap grade of fish for a more expensive grade

Red snapper, found off the coast of Florida, is a fine-tasting fish but in limited supply, so it is more expensive than many other kinds of fish. Now, if I wanted to cheat you I could look for something much in demand and find some way to provide a cheap substitute. There always are a lot of rough fish caught along with the desired ones. If you had caught them would you throw them back? It took a lot of work to catch them, so let's see what the possibilities are for putting them to profitable use. One possibility is fish meal, another is pet food; but there are no big profits here. What about substituting something like a carp for a red snapper? A direct substitution probably would not work because it would be noticed, but what about a breaded fillet or a breaded fish stick? It would take something of a gourmet to recognize the difference, and the profit picture is more appealing with the inferior fish.

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composed of college students, parents, or legislators, I also mention that IIT found that 85% of the fundamental work was done at universities.

PCB in cereal

I use this example to combat the popular idea that chemicals are always bad and to appeal for the application of common sense and reason by consumers alarmed about what they are consuming. I start out by reminding them that several months ago a class of compounds called PCB (polychlorinated biphenyl) was found to be a problem in the environment. Immediately the cry was out to ban these compounds entirely. Let's take a closer look at the situation.

> Several months ago 27 ppm of polychlorinated biphenyl was found in cereals. This is far more than the recommended tolerance of 0.2 ppm for baby food. How did we find these PCB's when they were mixed in with hundreds of other compounds that make up cereal? The technique is called gas chromatography and it works as follows.

Don't give your listeners retention time, type of detection loading, flow rates—they know you're an expert, don't bore them with details. Use an analogy that they can all follow.

> Suppose we were going to take all of the people in this room and have a jogging contest out on the golf course. The rules will be quite simple. We will all start at the same time and we must each touch each flag in order. The actual route you use to get to each flag is your choice. Because some people are in condition and others are not, some are fat while others are thin, and some either fast or slow, we see that if such a contest were held, by the time we get to the eighteenth hole we would be all spread out and separated from one another. The same thing can be made to happen with molecules because of their different sizes and shapes. Maybe the PCB molecules arrive tenth in line. We can focus our attention in that area and see what we find.
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> Polychlorinated biphenyl compounds were synthesized many years ago (in 1881) and were found to have some interesting properties. They conducted heat very well, were nonflammable, and were good electrical insulators. Because they transferred heat so well and were nonflammable, they were used in boilers in factories as heat transfer fluids, thus saving energy and being quite fire-safe should a leak occur. Their heat transfer property combined with their electrical insulating ability made PCB's ideal for use in transformers. Many of you have noticed the transformer on the utility pole behind your homes. It is about one foot in diameter and about two and one-half feet tall. One of the reasons the transformer is as small as it is for the job it does is PCB compounds. They remove heat rapidly yet provide excellent electrical insulation. If we are not permitted to use chemicals for this purpose, we must rely on air-cooled transformers which require much more space. This space may be available in my back yard and maybe yours, but what about the downtown section of a large city? There just is not enough space, so to cry for a total ban on this chemical just is not common sense. About the only problem I am aware of in the use of PCB's is that once someone shot into a transformer on a dairy farm, the PCB's dropped to the ground and we then found traces of them in the milk from cows that ate the grass. I have heard that some factories that switched from PCB's to other boiler fluids have had serious fires. The benefit-to-risk ratio for these applications seems to be far in favor of benefits.
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> Boilers and transformers are still a long way from cereal. How did PCB's get into the cereal? Well, PCB compounds have other properties as well, one of these being that they make good plasticizers. Plasticizers are among the ingredients that make plastic flexible. A child can run a tricycle over a new plastic car and nothing much will happen, yet after a few months the car will break apart if it gets the same treatment, because the plasticizers have left.
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> It may seem as if we're getting further off the track, but let us now shift our attention to carbonless carbon paper. Anyone who has gotten black fingers and clothes from using regular carbon paper can fully appreciate carbonless carbon paper. This is a very clever idea made possible by a technique called microencapsulation. A chemical is enclosed in a very small ball of plastic and attached to the bottom of one sheet of paper and to the top of the sheet below it. When you write over the top sheet the plastic balls break, the chemicals mix and "ink" is produced. In order to keep the plastic balls flexible, PCB's are used. There is a lot of carbonless carbon paper made and since much of it is used to make copies that no one really wants or needs, there is a lot of waste paper. Now, this waste paper is recycled, as it should be. However, it costs a considerable amount of money to recycle paper, so a cheaper form

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of paper is desired. One such form is called gray-board; it is used for egg carton dividers, cereal boxes, etc.

Now we can see how the PCB's got into the cereal. They came from recycled carbonless carbon paper from which the box was made. The prevention was easy. Simply put a liner between the cereal and the box. This has been done.

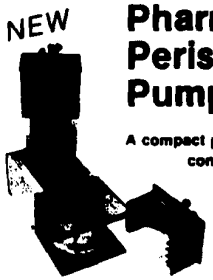
We can see that by not panicking and by applying a bit of chemical investigative work, chemists were able to solve a problem so that we can continue to take advantage of the chemical properties of these compounds to provide a better life.

The direction an insect travels

If you can make fun of yourself you can usually win over even the toughest audience. I use the following case history to do that, to show that chemists can be humbled like anyone else, and also to reinforce my plea for the application of common sense.

> Here is a problem I simply failed to solve although the final solution was quite easy. There were packages of flour containing insects. The question was: did the insects get into the flour when it was packaged, or did they crawl in later? FDA inspectors were all set to inspect either the factory or the warehouse, but which one? I had until noon to find out. I used my normal approach. I mentally examined each instrument I knew of, what it could do, the type of samples it handled, and I made a mental list of those instruments that could solve the problem. Usually there are three or four possibilities for any problem. You then eliminate the instruments you do not have and the instruments that you do have but that do not work and hopefully you have at least one possibility left. The same approach is used for wet chemical methods. However, in this case I found nothing I could really use. If I could have tagged them earlier it would have been easy, but this was out of the question now. At about 11:45 AM I went to the chief chemist and reported that I was unable to solve the problem and that we would probably have to spend the extra time and inspect both the factory and the warehouses.
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> He said not to worry because they had solved the problem ten minutes after I had arrived, but they just wanted to see what I would do. He had a funny grin on his face. They often like to play "fool the professor" and this time I knew I had been had. The only question was, how bad? They told me that while I knew something about chemistry, I knew nothing about insects.
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> Consider yourself as an insect and the room you're in as a package. If you want to chew your way out you go to the package material. Now Mother Nature has provided you with some very sharp teeth but the packaging industry has provided a tough package so you can't chew through just anywhere; you have to chew a lot to find a soft place. While you are chewing, trying to find a soft place to get started, you are making teeth marks on the package wall. Once you find the soft place you can chew right through and there will be no teeth marks on the opposite side.
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> The solution then is to place the package material under a microscope and look for teeth marks around the hole. In this case it was quite easy to show that the insects chewed their way into the packages of flour and the warehouse was the place to inspect.

After ten or twelve such case histories, I finish the talk by mentioning again that most industries work hard to provide a quality product and that the food we eat is probably the best bargain on the market today. My daughter's favorite book is the greatest story ever told—the Bible. As chemists, we have the greatest story yet to tell and we ought to get started.



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