The Art of Questioning

Researchers did a study where they put monkeys in a cage with a pole running up the center, and a bunch of bananas attached to the top. Whenever one of the monkeys would climb the pole to get the bananas, the other monkeys would get sprayed with cold water. Very quickly the monkeys associated climbing the pole with the cold water, so whenever one of the monkeys would try to climb the pole, the others would pull him down and beat him. Then the researchers stopped spraying the water, and replaced one of the "trained" monkeys with a new one. The new monkey tried to climb the pole and the other monkeys pulled him down and beat him. Slowly the researchers replaced the monkeys one by one, and as each new monkey would try to climb the pole, and the other monkeys would beat him. Eventually, all the original monkeys who had been sprayed with cold water were replaced with new monkeys who had never been sprayed with cold water. However, all of the monkeys had learned to pull any monkey down from the pole and beat him whenever he tried to climb the pole to get the bananas, never knowing WHY.

That might seem like a strange story to publish in a technical magazine, but I wanted to spend a few paragraphs on the topic of learning and questioning. One of the things I have learned after twenty years of design work is that questioning is an art. Whatever situation you find yourself in, you will eventually be given instructions that seem contrary to what you have learned. Should you follow the instruction without question?

I remember starting a new job designing cell phone amplifiers, and the pre-amp was a 1.67GHz circuit on a Teflon board. The circuit was entirely on layer one, and layer two was a back-side ground plane. When I showed the engineer my preliminary layout, he instructed me to move the components so close to the main signal line that the component pads were sitting directly on top of the wide trace! I proceeded to tell him how we frown on this practice, because the pads would have no thermal relief, and without soldermask on this design we wouldn't even have the advantage of having soldermask-defined pads. I was quite proud of myself for pointing this out, having just recently learned about these things from a seminar. With great patience he explained how he was very aware of good soldering practices, but had technical concerns that far outweighed my guidelines. I was embarrassed, but learned an important lesson. In certain cases engineers will consciously break guidelines to get the results they need.

At another company I worked for, every circuit board was required to have yellow silkscreen. When I asked my fellow employees about the reason for yellow, some speculated that reflections from the traditional white silkscreen could confuse the cameras during assembly. The subject came up a few more times, but after about five years I discovered that the person who originally asked for it was now a vice president of the company. When I asked him why he specified yellow over white, his response was… Are you ready for this? He did it because he thought it "looked cool". I had a good laugh, but it illustrates the fact that some decisions are relatively harmless, but shouldn't be universal. Discovering the truth behind the origin of yellow silkscreen will prevent me from trying to blindly implement it at the next company I work for. Every group you work for will have its own way of doing things, and if you can question these variations without putting people on the defensive, you can build a better foundation for the future.

Have you heard the term "Rule of Thumb"? A rule of thumb isn't really a rule, it's more like a summary that is easy to remember. But what happens if people learn the rule and repeat the rule to others who then pass it on to others who have no idea where it came from? Well, just like the new monkeys or the yellow silkscreen in the stories above, they will be making decisions without understanding what foundation the rule was built upon, what the decision means, or when it should be changed. The value of a rule of thumb is that it makes it easier to remember something, but to be a good designer you have to know what is behind it. The best designers will know when the rule of thumb should be abandoned or modified to get more desirable results.

When you hear something that conflicts with your own understanding of good design practices, first try to determine if the difference is important enough to question. If so, try to determine if the person providing the conflicting rule is merely repeating something without understanding the basis for it, or if it is someone who truly has a deeper understanding and is making a conscious decision to veer away from the guideline. Not that it matters who is "right", but if it helps you initiate a discussion without making the other person defensive, it may result in a better product and in gaining valuable knowledge for future designs.

It's important to make a distinction between guidelines and rules. Guidelines provide a place to start in the absence of any other factors, a foundation to build on. Rules are often legal requirements, and should not be ignored. For example, UL may require a certain distance between high-voltage conductors. This rule is probably not negotiable. If someone is asking you to bend a rule that will affect safety or could cause legal trouble, you are obligated to question it. We'll talk more about constraints later.

Ask questions! We all have a natural desire to appear competent, and admitting that you don't understand something seems contrary to building other's confidence in you. But trust me, people respect someone who has the courage to say "I'm not sure about that subject, but I'm willing to research it and get back to you as soon as possible."

Sometimes it is helpful to be able to ask questions outside of your organization. I have three suggestions for appropriate public venues for questions. First, find out if the software you are using supports a User Group. If so, you can present your situation to a focused group of people who will be more familiar to your situation. Secondly, the IPC supports free email-based forums (sometimes called "listservers") for many different areas of our industry. Find out about them at http://ipc.org under the "Knowledge" tab. Finally, attend conferences like PCB East, PCB West or several sponsored by the IPC. In any of these you will find knowledgeable people willing to help.

My last bit of advice to you is this: Before you ask for help on a public forum like a web-based user group or a listserver, try to find out what has already been written about the subject, and be specific. If you ask a general question, people wonder if you're just writing a term paper or are trying to get others to do your work for you. On the other hand, something like, "I searched the archives for this subject, and found a post I don't understand", or "I'm being told this from one source, and another source seems to contradict it" you will probably get a better response.

Don't be afraid to ask, none of us was born knowing this stuff.

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