

Design Reviews

Bob Colwell

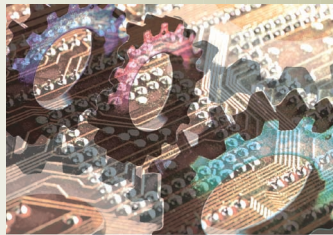
It was Monday, my first day as a hardware designer at a startup. After leaving my wife and baby daughter in another city the day before, I had driven for many hours and had temporarily moved into a hotel room. Like a meteor shower, random concerns were blazing across my consciousness. Focusing on technical things was (at best) statistically unlikely.

Then my new boss walked in and said, “Oh, hi. I see you made it okay, and you have The Albatross’s old desk.” When I asked him who The Albatross was, he replied, “He’s the guy we fired last Friday for taking too long to design the floating-point unit we’re now commissioning you to design.”

If his intention was to boost my morale and make me feel welcome, this opening gambit was decidedly ineffective. In fact, I surreptitiously glanced down to see if there was a little red laser target-sighting dot somewhere on my torso.

I asked why he called my predecessor The Albatross. He replied, “Well, we had become concerned that he was in over his head on this design, so we held a design review on his unit last week, and it did not allay our fears even a little bit. Fortunately, the process of doing the design review was sufficiently unpleasant for him that he decided to quit without further intervention from us.”

As my boss was waxing eloquent on my predecessor’s defects, a series of thoughts were scrolling across my overloaded brain:



The best design engineers are adept at accepting valid criticisms of their ideas and proposals.

- I could call my wife, say the job was filled when I got here, and just go back home. Yeah, that’s the ticket.
- Perhaps this isn’t the best time to mention that floating-point design wasn’t my strong suit in school.
- I wonder if the Marquis de Sade School of Scorched Earth Management has any other graduates besides this guy?
- Somebody please tell me the whole company isn’t like this.
- Where’s the bathroom? Throwing up is beginning to seem a reasonable course of action.

However, this conversation induced a defensiveness that had the salutary effect of making me focus on my immediate survival. It also revealed several

important things. First, my new company did not know how to conduct a design review. Second, the company was willing to let its engineers run open-loop long enough for them to get into trouble, at which point the corrective action plan appeared to be to have someone hold the front door open while someone else booted them out. Third, points 1 and 2 suggested a substantial lack of project management.

To be clear, I don’t necessarily intend point 3 to be a condemnation. At a startup company with only a few engineers, the best course of action could be to let those engineers drive the project on their own terms. Management could watch closely to make sure the engineers are taking the company to a place it really wants to go, but give them some latitude in finding the best route. For any but very small teams, however, competent project management is essential, and for very large teams, the management must border on inspired.

HALLMARKS OF A GOOD DESIGN REVIEW

Telephone systems are an important part of a society’s infrastructure. Telephones must work. They are the means by which people report fires or crimes, summon ambulances, and accomplish general interpersonal synchronization. The Bell System had an official target of no more than two hours of accumulated downtime in 40 years of service. I don’t know if they have continued to accomplish that goal over the past couple of decades of computer-based service, but even aspiring to it forces special measures in designing hardware and software.

Bell’s software design review process required that the presenter make all relevant materials available to the reviewers about two weeks before the review. In addition to the source code under review, these materials included background information, the relevant parts of the design spec itself, testing plans and status, and anything else a reviewer might need to make a pene-

trating analysis of a design. Reviewers were expected to have thoroughly studied these materials before arriving to conduct the review.

Just as important as the reviewer preparation aspects of the design review was the corporate culture reinforcing the idea that these reviews were to be taken seriously and not just endured or subverted. Sending the preparation materials out late was bad form—it was considered to be disrespectful of the reviewers' time. Reviewers had the right to ask that the review be delayed, rather than attend one without being properly prepared.

A truism at Intel was that when we prepared a design review, we reaped 90 percent of the benefit before the executive ever appeared to conduct the review because preparing the materials forced us to confront issues that otherwise fell between the cracks of the everyday engineering process.

There isn't enough space in this column to do justice to the mechanics of the review itself. There are times when a line-by-line code walkthrough is the right course and others when a higher or lower focus is more expedient. In any case, you know the review is working well if it raises lots of issues and concerns, challenges questionable assumptions, identifies outright mistakes, and generates follow-on items. Collect these assiduously, send them around to the meeting attendees, and resolve them afterwards. Don't mark an item as having been resolved until the person who raised the question at the review considers it to have been resolved.

ATTITUDE DETERMINES GRATITUDE

For a design review to be beneficial, both the reviewer and the designer must have the right attitude. Both must distance themselves emotionally from the design under review, a task that is usually much easier for the reviewer than for the designer. After all, the designer has invested many days, nights, and weekends, and a great deal of professional pride in this creation. Designers believe their design is cor-

rect, complete, and elegant. Like parents who delight in having others tell them how cute their babies are but do not want to hear about flaws, an objective, balanced perspective is not what designers naturally seek. Handling professional criticism is a learned behavior.

The designer arrives at the design review with a lot of emotional baggage that must be left at the door; otherwise the review process won't work, and it can even be actively counterproductive. Easy to say, hard to do. The audience at a design review isn't a bunch of computers—it's your coworkers.

The reviewers are seeking flaws in your design—not in you.

In most cases, you and your colleagues work together on a project, and all of you succeed or all of you fail. While some of them are your personal friends outside work, others personify the saying "it takes all kinds." As a design engineer leading a design review, your job is to set all that aside, put your ego in your desk drawer, and present your design for review by smart people who are motivated to find things wrong with it.

The key idea is for you to keep reminding yourself that the reviewers are seeking flaws in your design—not flaws in you—and to remember that the two are not the same. If your design has flaws, it's better to find them now than after the project has gone into production. Some day you will have occasion to return the favor of looking at the reviewers' work through fresh eyes, and you may find that their designs have flaws too.

I once participated in a memory controller design review, held on a Friday. We gave the design a thorough going over, found some things that could be improved, wrote up some notes so nothing would be forgotten, and felt pretty good about the whole thing.

Until Monday, when we discovered that the designer had come in over the weekend and cleared out his things because he felt so badly abused by the design review process. None of us ever understood why he did that because, as far as we could tell, the design was pretty competent and needed only relatively minor improvements. We had not called him an albatross—or even a turkey or any other kind of animal.

The best design engineers are not just the most likely to come up with great designs—they're also adept at accepting valid criticisms of their ideas and proposals. They've learned to focus on the final product and their role in developing it, not on how silly they may feel if a review early in the project reveals a dumb design error.

HOW NOT TO DO A DESIGN REVIEW

If designers approach a review as a scourge to be endured and survived, or even subverted, the focus on finding flaws in the design is lost, and the review becomes a defensive contest. I attended a validation plan design review once in which the validation manager had adopted this attitude.

The review was a disaster. Because his intent was to make it extremely difficult to spot potential flaws, this manager had intentionally not given the reviewers enough information to make sense of the plans being sketched. After the meeting, the manager was chortling about how he had survived the review "without a scratch." When I asked him if he believed that his plans were complete, correct, and without any holes, he said, "Of course not." I responded by saying that he had just wasted his single biggest chance to find what was wrong with them. Actually, I'm paraphrasing. I can't repeat here what we really said to each other, but we said it rather loudly.

Another memorable Bad Design Review occurred when I noticed some subtle issues during a CPU design project. The CPU/bus engineers kept fielding odd questions from the chipset group, a different design group within

the company that reported to a different manager. Finally, I got worried enough to start agitating for a design review of the chipset to make sure we weren't about to mutually embarrass ourselves.

The chipset manager didn't like that idea. He felt that the CPU guys were altogether too full of themselves and that the chipset designers weren't some B-team for us to be ordering around. He was right about that, of course. There is always a pecking order, and it is profoundly uncomfortable, and sometimes enraging, to find that there is disagreement about your place in it. Looking back on the event, I think this particular problem was part jealousy on their side and part arrogance on ours. Engineering teams aren't machines—they're collections of people with the same amazing breadth of egos, attitudes, motivations, and beliefs as any other group of humans.

Eventually, the chipset manager and I reached a compromise. I would label this a design review for the CPU/bus engineers in the audience. But he would call it a tutorial, to salve the egos of the chipset designers.

The meeting was a fiasco. The chipset designers didn't come prepared to look for flaws in their designs; they came prepared to show a rival group how clever they were. As the meeting progressed, the reviewers and the designers became increasingly angry with each other, to the point where I eventually had to stand up at the board between two would-be combatants.

Both of those guys owe me for that intervention: The reviewer half of this pair had a black belt in karate, and I really believe that without my intervention, one of them would have ended up in the hospital and the other in jail. But I only deserve limited credit, because my naiveté in having set up a meeting with a matter/antimatter agenda was largely to blame in the first place. Later, I discovered that the flaws I was worried about were really there. That cost us some expensive debug time before full production could be reached.

A senior manager frequently reviewed our CPU design project—at his insistence, not ours. Although the preparation for his design reviews was valuable to us, the review itself was often counterproductive because he used it as a management tool. He would tell the validation manager that he needed to find more bugs faster. He would tell the power engineer that the chip was too hot. He would tell the design manager that the schedule was too late. He would tell the layout expert that the die was too big. And he would tell the architects that the performance was too low.

The more a project progresses, the more difficult the remaining design choices become.

The more a project progresses, the more difficult the remaining design choices become. This is because all the easy decisions have already been made—all that's left are difficult and painful compromises between important project goals. So when a senior manager says, "You don't have a viable product here unless you fix the power dissipation," the power engineer believes this is a mandate to sacrifice anything necessary to drive the power down, including performance, schedule, and die size. The layout person, on the other hand, hears that unless the die size is reduced, nothing else matters. So he tries to convince the various unit owners to redo their designs to make them smaller, no matter what that does to schedule.

The design manager, who has heard all this before, realizes that in the end, the senior executive will ignore everything else but schedule, and actively works to improve it at the expense of a bigger die, higher power dissipation, and lower performance.

In effect, this senior executive's design reviews caused many of the project leaders to begin working against

one another without even realizing it. I eventually had to tell this executive that he wasn't welcome to visit our team any more because every time he did, it took three days to straighten out the mess he made. He would then look somewhat chastened, but he always came back and did it again.

LET'S REVIEW

A design review is a powerful tool. With proper direction, many heads really are better than one. Having a common understanding of a project's priorities between the reviewers and the designers is crucial.

Make it clear that reviews are officially sanctioned and required by upper management, observe proper procedures regarding note taking and action-item follow-through, and cultivate a team of A-players who know that ultimately only the success of the overall product matters.

Don't let the review become a defensive charade. Remember, the people doing the designing eventually will do a design review themselves, and they'll be watching this one to see how it's done.

The designer succeeds only if the product is a success. When everyone on the design team understands that one simple fact, they will wield the design review process properly and make the chances of product success much better. The bonus: A higher percentage of them will return to work on Monday. ■

Bob Colwell was Intel's chief IA32 architect through the Pentium II, III, and 4 microprocessors. He is now an independent consultant. Contact him at bob.colwell@comcast.net.