EMBEDDED IN THIN SLICES

Build an Embedded Systems Consulting Company (Part 5)

Axiom Wrap-Up

COLUMNS

This month, Bob wraps up his series on starting and running a successful embedded systems design firm that can last.

By
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Sixty-two years ago this month, the U-2 made its maiden flight. Some of you, when you hear U-2, think of Bono and his rock group. But some of us remember that this was a plane that was initially used for ultra-high altitude reconnaissance of the former Soviet Union. You may have seen the 2015 movie with Tom Hanks called *Bridge of Spies*, which tells the story of the release of Gary Powers, one of the pilots of the U-2, who was shot down over the Soviet Union during the height of the cold war. What you may not know is that, amazingly, some of the 104 U-2 planes are still being used today. Now that is something that was designed to last.

In this article series, we are discussing some things that we learned over the years that helped us build an embedded systems consulting firm that can last. I don't know that we will last 62 years, but we are working on it. We have found that succinct, practical, portable leadership proverbs have helped us to lead such a company. "Kelly" Johnson has been widely recognized as the designer of the U-2. Kelly had many of his own axioms that helped him create a successful organization at Lockheed Martin called the Skunk Works. One axiom was: "Be quick; be quiet; and be on-time." Another axiom often attributed to him was: "Keep it simple stupid." His axioms and principles were so good and long lasting that Lockheed Martin still has them on their website 42 years after he retired!

Each organization has its own unique DNA and culture and requires its own set of axioms. I, for one, would not use "Keep it simple stupid" for a number of reasons. I like Albert Einstein's axiom a little better when he said that a scientific theory should be as simple as possible but no simpler. However, not many embedded systems that we design can be called simple. The devices that we develop are incredibly complex. Perhaps a better axiom for our business would be: Make it only as complex as necessary and no more. My point is that the axioms we developed are unique to us. There are many more good ones out there that will fit you and your embedded systems consulting company better than the ones we developed. Axioms are developed in part out of your core values. Your core values and mine are different. And I want to encourage you to develop your own axioms for your company that fit your DNA. That said, let's look at some more axioms that we have used.

TOOLS NOT TOYS

Focus your efforts on tools, not toys. As engineers, we love to invent and create. Many of us just love everything dealing with technology. The latest, the better. Early in

my career, I was leading a team of engineers to develop an avionics system. The systems group had chosen the processor and we needed to procure the tools to develop the software. We were going to be using a non-Intel processor for the first time. At that time, the company was using the first Intel In-Circuit-Emulator (ICE) called the Intellec MDS 80 for their software development. Some of you may remember these big blue boxes (see **Photo 1**). Hewlett-Packard had developed a new and more powerful ICE called the HP-64000 that worked with our new processor (see **Photo 2**). I was smitten by the things we could do with the HP. But it was very costly. When I submitted the requisition to our vice president to buy six of these, he almost went through the roof. "Will this tool actually save time and money? Will it shorten the schedule?" Uh, I never thought about it that way before. It is so cool and it does so much. Does he want us to hand code the software and debug it by hand? Even though I railed at the question at the time, I realized that he was right. I had not done my homework on such a large purchase. I was looking at it as a toy not a tool that requires a cost justification. I had not done the cost comparison of the options nor analyzed the return-on-investment (ROI). But I walked away from that experience recognizing that I had a tendency to jump at every new gadget and tool and wanted to buy it. I needed to think tools not toys. And any tool should be subjected to an ROI analysis. It has proven to be a worthwhile axiom over the years. So this axiom encourages our team members to ask: "Will this tool actually save time and money? Will it shorten the schedule?"

PHOTO 1
Intel's Intellec MDS boxes (middle box) provided In-Circuit Emulation functionallity for developing Intel microcomputer-based products.

WAIT TO BUY HARDWARE

Don't buy electronics hardware until you need it. Moore's Law states that the number of transistors in an integrated circuit will double every two years. This "law" has driven the cost of electronics down in an extraordinary fashion. My first software development station was a PDP-11/40. It had 16,000 bytes of memory. It cost over $30,000. Need I say more. The price and performance of electronic equipment changes so rapidly that, in order to have the latest version or model, this axiom tells us to schedule hardware acquisitions as late as possible in a project and no later.

CREATE VALUE

Create value for our customers. Developing software and hardware systems can cost a tremendous amount of money. We need to perform our work efficiently, effectively, and in such a way that our customers know they receive excellent value from us. Since we often work with other engineers and since they are always asking for enhancements, we have found that building this axiom into our culture helps bring better value to our customers. It is not uncommon for us to ask our customer's engineers when they are requesting new features, if the feature will really create value for them. Or is it just another bell and whistle leading to feature bloat. Imagine hiring a firm that is committed to creating real value for you in the products they design.

And value doesn't just translate to the bottom line. Sometimes value is created by designing a simpler interface with less bells and whistles. Sometimes value is created when we encourage our customers to take the long view on a new design. Will this change add so much complexity that it is not sustainable? Or will this change break our backwards compatible paradigm that will not cost much today but will be a significant recurring cost downstream? Will this change create an unsafe condition not previously encountered? All of these questions help create value for our customers.

One time we violated this principle and have regretted it to this day. A customer asked for a feature that was unsafe by

PHOTO 2
The HP-64000 system featured a high-speed emulation bus connecting a processor emulator, a memory emulator and a logic analyzer. (Photo courtesy of hpmemoryproject.org)..

design. We pushed hard to prevent them from contracting us to change it. They threatened. We stood our ground. They beat on us. We pushed back. Finally, we gave in. Within two months of the release someone was hurt because of the change. Always thinking about creating value for your customer will include protecting him against his own bad ideas.

DON'T SWEAT IMPOSSIBLE SCHEDULES

We work in an environment where time-to-market can make or break a company. When our customer succeeds, we succeed. In spite of making every effort to plan for the unexpected delay, schedules can slip and deadlines can loom. This can create stress all around. We need to remember that there's more to life than meeting schedules. We do not want our employees kept awake at night due to deadline nightmares.

How can we practically live by this axiom? I have found two things that can help. The first is that the leaders have to buffer the workers from the schedule pressures as much as possible. This puts a significant burden on leadership but that's one of the traits of a good leader. This includes the pressure that the customer will put on you. It is easy for leaders to then pass the pressure downstream. In addition to buffering, as leaders, we need to provide grace when your team is working their hardest and you are still behind. Even if your customer is not providing any grace. Grace can take many forms. Dinner cards at a good restaurant. Letting the team go home early even when they are behind. Be creative. As leaders, your job is to do whatever it takes to help your team not sweat the impossible schedules that we face on every project.

YOU ARE NOT ALONE

Even though we want our employees to take an entrepreneurial approach to their jobs by taking risks and making decisions of import on their projects, we find that we need to stress to our employees that they are not alone. Not alone in their failures. Not alone in their successes. We are a team. This is especially true when one of your employees has made a serious error. I had this modeled for me once when I left some extremely customer confidential material at the guard house of our customer. The next day, our president took about every form of verbal abuse possible from the president of the customer (our customer was 300 times bigger than we were). When I was called into the office, the president told me two things. "I am not going to fire you." And, "I didn't hire you to be a courier. I hired you to be a top-notch engineer." In spite of my horrific failure, I knew that I was not alone in this. The president had my back. Your employees need to know this as well.

PRAY ABOUT IT

I am sure that the word "pray" does not shows up very often in technical journals but I want to throw this one out there. It is something we do because we believe that it helps us. We encourage our team to take time and pray about the things that they are doing. And not just when they are in trouble. We also have set aside two non-compulsory times for prayer each day. Not everyone in the company participates nor do we all have the same understanding of prayer but we encourage them to take some time in the silence. For those that believe in a God who hears prayers, they are encouraged to ask for His help. For those who do not believe this we still

circuitcellar.com/ccmaterials

RESOURCES

Lockheed Martin, "Kelly's 14 Rules & Practices," www.lockheedmartin.com/us/aeronautics/skunkworks/14rules.html.

M. Overbury, "10 Business Axioms—Required Reading," 2009, http://ezinearticles.com/?10-Business-Axioms---Required-Reading&id=2059499.

W. G. Sitton, "22 Business Axioms," 2015, http://blogs.the-ceo-magazine.com/guest/22-business-axioms.

encourage them to take time in the silence. This is because there is good evidence in the scientific literature that taking time for quiet reflection in the silence actually grows brain cells and stimulates our thinking. If you are interested in exploring this from a non-theist perspective, I would recommend the work of Andrew Newberg (www.andrewnewberg.com) out of the University of Pennsylvania.

A number of years ago, I read an article in IEEE's flagship magazine *Spectrum* about a very creative electrical engineer. He developed an amazing number of extremely technologically innovative inventions over the years. When they asked him how he did it, he told the interviewer that he spent one hour every evening in his big arm chair with his eyes closed. He wasn't praying but he was just being silent and allowing his mind to go and explore where it wanted. Silence works. At the leadership level, we believe that God is involved whether you believe in Him or not, but I would encourage everyone, wherever you fall on the spectrum of faith, to consider this as a very practical addition to your company.

KEEP UPDATING

Our axioms are not set in cement. Neither should yours. Keep reviewing them. Keep them ever before the team. Keep updating them. If you have some of your axioms that you would like to share with me, please drop me a line. Thanks for those who have passed theirs on me.

Next time we will talk about the blessings and the curse of fixed price contracts in embedded systems design. But, of course,

ABOUT THE AUTHOR

Bob Japenga has been designing embedded systems since 1973. In 1988, along with his best friend, he started MicroTools, which specializes in creating a variety of real-time embedded systems. MicroTools has a combined embedded systems experience base of more than 200 years. They love to tackle impossible problems together. Bob has been awarded 11 patents in many areas of embedded systems and motion control. You can reach him at rjapenga@microtoolsinc.com.