

## What is Your PCB IQ?

Thursday, January 06, 2011 | Marissa Oskarsen & Chrys Shea, Printed Circuit Girls and Geeks (E-TEC Sales)

Take The Printed Circuit Girls and Geeks' 10-Question Pop Quiz on Qualifying a PWB Fabricator.

### Part One: Multiple Choice Questions

1. When qualifying a new fab shop, the first step is to:
  - a. Get a price quote
  - b. Send a questionnaire
  - c. Have a third party evaluate the quality
  - d. Perform a site visit
  - e. Call the one where your buddy works
2. The second step is to:
  - a. Get a price quote
  - b. Send a questionnaire
  - c. Have a third party evaluate the quality
  - d. Perform a site visit
  - e. Eat a doughnut
3. When qualifying a new fab shop, the third thing to do is:
  - a. Get a price quote
  - b. Send a questionnaire
  - c. Have a third party evaluate the quality
  - d. Perform a site visit
  - e. Go see if there are any doughnuts left in the break room
4. What primary factors drive the cost of PWB fabrication?
  - a. PWB size/surface area, in square inches
  - b. Layer count
  - c. Line spacing
  - d. Shop capacity/labor
  - e. All of the above
5. What is the most important inquiry on a vendor qualification survey?
  - a. Number of personnel in engineering
  - b. Number of personnel in quality control
  - c. Number of personnel with IPC certification
  - d. Number of personnel with advanced degrees
  - e. None of the above

### Part Two: True or False Questions

6. All fabrication processes should be performed in house.
7. If directions to add the date code, UL logo and 94-VO are not supplied, the fabricator should add them anyway.
8. Chemical processes should be scrutinized as thoroughly as automated, mechanical processes.
9. You should review the panelization layout prior to releasing your orders.
10. You can get better pricing by cutting out the middleman and purchasing your PWBs directly from the fabricator.

## Answers

### 1. Correct answer: a. Get a price quote

Yeah, you read that right, get the pricing first. That may sound a bit "unpopular," and maybe it is; but this practice is more common than you may think. While it's generally true that you get what you pay for, many factors influence fabrication pricing (more on that next month). And, let's face it, even if the fab-shop salesman gives you a doughnut and promises you his first born baby, he will NEVER be your beer buddy... but you will ALWAYS have cost goals. And if a fabricator cannot meet a product's financial requirements? I really don't think there is any immediate need to continue down the approval path.

### 2. Correct answer: c. Have a third party evaluate the quality

As we learned from question #1 and from reality TV, you're not here to make friends, so the next step is to determine which price-competitive suppliers can meet your quality, and, therefore, reliability, requirements. While I personally don't focus on the absolute lowest bidder, I quickly eliminate the highest, and work with those who provided the low to medium price quotes.

Before I qualify a vendor for my customers, I purchase a 10 to 100 piece lot of PWBs for third party destructive analysis, never for resale, but, of course, I don't let the fabricator know that the order is for the sole purpose of scrutinizing his quality. Sometimes I'll purchase several smaller lots over the course of a couple weeks to see if the quality varies from day to day or operator to operator.

At the very minimum, the test protocols should include cross-sectional microscopy to evaluate PTH drilling and plating results, lamination quality and blind or buried via construction. Other tests include ionic cleanliness, solder mask adhesion, layer registration and possibly (Highly Accelerated Stress Testing (HAST)). For a more extensive list of possible tests, visit [www.thetestlab.com](http://www.thetestlab.com).

### 3. Correct answer: d. Perform a site visit

Once a potential supplier has demonstrated that they can combine the price and quality to present the value you need, it's time to grab your fanny pack and head out for a site visit. When I visit a PWB fabricator, I look for a couple of key elements:

- Process control--Are there SPC charts? If not, that's generally a bad sign. If there are, are the control limits set by the manufacturing organization or by their equipment and materials suppliers? Ask for the rationale behind those limits, and why they were set at their current levels. If the answer doesn't make sense, keep asking questions.
- Equipment--Pretty much all North American PCB shops will have older equipment or, rather, what I usually think of as collectable antiques...and a lot of times those older machines are sufficient for the specific operations they perform. If you see a museum-worthy relic, ask what it is used for, if different machines in the shop perform similar operations, if newer technologies are available for the operation and what the differences are between the newer and older machines. When it comes to understanding their production engineering capabilities, this approach beats a paper survey hands-down!

On the other hand, you should also see some modern equipment. I look for things like:

- A post-etch punch tooling system;
- Direct laser imaging;
- Automatic plating equipment;
- Controlled impedance modeling and calculation capability;
- Cross-sectional microscopy equipment;
- Air bearing drills; and
- Laser drills.

While newer technologies, like laser direct imaging and laser drills, cannot be expected on every shop floor, I always like to look for the areas where the supplier is making new capital investments.

Also, ask to see the repair, calibration and maintenance schedules. Do they exist and are they followed? Check the calibration stickers on the machines to see if they're up to date.

Overall cleanliness, organization and a readily available flow of caffeine to the workforce are all signs of efficient production and commitment to quality.

4. Correct answer: f. All of the above

All the factors listed influence price quotes, so figuring out how much it actually costs to build a PCB is like trying to find a unicorn. However, for any given PWB design, cost can be estimated into \$/sq in. I usually take several quotes and do some basic math, backing into their cost per square inch, and then set my benchmark as the average of the low-medium bidders.

I will be revealing this formula in our next pop quiz, "Pricing: The Smoking Machine Gun," to be released in March.

5. Correct answer: e. None of the above

Vendor qualification surveys are so cheesy! Let's not kid ourselves--everybody knows what the right answers are to put on these forms, so nobody gives the wrong answers that will eliminate them from contention. (Don't worry, we won't tell your boss if this was your approach!) Personally, I don't put a lot of weight on paper audits. If the supplier can provide the price and quality my clients need, and I have seen their operation and am comfortable with their capabilities, I don't need a paper audit that contains the "right" answers.

6. Correct answer: False--Not all fabrication processes need to be in-house.

Outsourcing technically challenging processes such as plating, final finish application or laser drilling can provide distinct advantages. The subcontractor can concentrate on their core competency, often times outperforming shops that try to manage a broad spectrum of manufacturing processes under one roof. In the specific case of plating, outsourcing makes perfect sense to me because it:

- Usually provides superior quality through improved process controls;
- Lowers cost and limits liability because the wastewater treatment is outsourced; and
- Improves delivery and keeps capacities balanced.

As a hardcore printed circuit junkie and role-playing gamer, I'm here to tell you that it's perfectly reasonable to expect a fabricator to outsource up to 10% of their manufacturing processes, particularly the specialized ones.

7. Correct answer: True--Date codes and other traceability indicators should always be included.

These are standard items that are usually contained in the readme.txt file. Sometimes I will send my evaluation order WITHOUT the directions for standard items in the readme file. This is a test that emulates real life, because sometimes omissions happen at the design level. If the fab shop asks if they should include it, they understand the importance of traceability. If they don't ask and don't include it, I deem them inexperienced and incompetent, and banish them to the dungeon.

8. Correct answer: True--Chemical processes need the same level of control as mechanical processes.

This is often a grossly overlooked area during process audits. Visitors are shown charts that are often complicated or confusing, and glance past them assuming they are good indicators of solid process control. You don't want to be the geek who is easily fooled, so you should start asking questions like:

- Who sets the charts? The control settings should be provided by the chemical suppliers. Ask for a copy of them for all chemical lines. You may want to verify the control limits with the supplier as homework.
- Where is the data backed up? The data should be backed up for traceability and liability purposes. I've found numerous fabricators that don't like this question because they don't have off-site data backup and recovery, but, in general, the practice is improving.
- Are the operators trained in troubleshooting? The correct answer is yes, but if you get the correct answer, press on to find out what their training and level of empowerment is.
- How is chemical replenishment controlled?
- How often are the baths analyzed?

- Are the analysis lab records complete and up to date? Don't just accept what you are shown; ask to pull some records at random.
- How often are D&Rs performed for each chemistry?
- What is the preventive maintenance schedule on each chemical tank? Do the records match the procedure?
- What are the bath temperatures? Bring a thermometer with you to measure some and compare with the readings on the tank monitors. Record both. Later on, you can compare them with the suppliers' spec sheets that you download from their Web sites.
- How does the bath taste? Just kidding, I don't eat the chemicals anymore.

While some of these questions have obvious right and wrong answers, others play in the gray area where the evaluator must use his or her experience, scientific background and common geek sense to judge or interpret the responses.

*Many, many thanks to my good friend Michael Carano of OMG chemicals (I know what you're thinking, why not WTF chemicals, but they are so over that joke) for his expert guidance and advice on the finer points of chemistry evaluation. He's related many stories to me of how he's been able to install process controls to improve quality and lower cost.*

9. Correct answer: True--Checking the panelization is very important!

Step and repeat seems easy, right? Totally is, EXCEPT when your fabricator is not familiar with the SMT process. The panelization layout not only indicates the shop's CAD capabilities, but also their genuine interest in your assembly yields. Items to look for include:

- Orientation: If the boards contain SMT devices with pitches less than 25 mil (0.65 mm), they should all be oriented in the same direction. If some boards are oriented at 90° angles, PWB shrinkage may affect the component locations and hurt assembly yields.
- Rails, fiducials and tooling holes: Even if you do not provide this information, you should expect it to be questioned. It's important for efficiency and part placement accuracy in assembly.

10. Correct answer: False--You can get better pricing an service by working with a PWB distributor.

I'm a salesman, so I can be trusted! Really!!

Basically, it all boils down to sales volumes. PWB distributors such as myself have the combined purchasing power of many assemblers and OEMs. The pooled demand gives us better leverage than singular buyers, affording us not only improved pricing, but also better quality, delivery and vendor response to last-minute changes.

Even with the price markup associated with brokerage, customers still get a better deal by working through a broker than if they do it alone. This is true with just about any broker, not just The Printed Circuit Girls and Geeks.

## Scoring

Ok, hotshot, how did you do? Use this simple formula to figure your score:

For the multiple choice section, assign a number by reversing the alphabet and count to your letter. Plot the values on a logarithmic scale and set a polynomial trend line using a least square fit through the data points. Integrate your polynomial equation and find the area below the curve. With your result, use Boolean algebra for the true-false section to arrive at your final result.

- OR -

Give yourself one point for every right answer and deduct one point for every wrong answer.

**If you scored 8-10, you're an awesome, but pathetic, geek.**

Unlike the normal human being, you have thoroughly considered every aspect of approving a PWB vendor. That makes you the most advanced (and probably socially challenged) PCB misfit in the dusky land of tented, dual-monitor cubicles. You are qualified to make decisions for your company and on the world's most critical missions. You've earned your pocket protector!

**If you scored 0-6, you're a potential geek.**

You would be a billion percent more awesome if you had scored just a few more points...I'm just saying. But don't panic, you have potential! Keep taking the upcoming PCB IQ Pop Quizzes that give away trade secrets and clues to understanding our industry, and soon you'll be able to dominate the world - or at least communicate your PCB issues intelligently, even to the uber-geeks who outsourced you!

**If you scored LESS THAN ZERO, you're a wannabe geek.**

Yes, it is possible to have a negative PCB IQ, if you answered more questions wrong than right! Your best bet is to keep learning and hope to one day emerge on the positive side of the scale, or plan for a future in sales and marketing.

Thank you for participation! Please check back again soon. We will be releasing quiz's every other month. At the end of our series, we hope you will have proof that your PCB IQ is higher than your boss's.

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**About The Printed Circuit Girls and Geeks**



The Printed Circuit Girls and Geeks are a small, close-knit group with exclusive PCB distributorships with Asia and the United States. They are experienced (yes!) electronic professionals who have a reputation of being "all that and brains too." For more information, visit [www.pcgandg.com](http://www.pcgandg.com).

**About Shea Engineering**



Shea Engineering Services provides technical marketing, sales and training materials to the electronics industry. Founded by Chrys Shea in 2008, the company leverages her 20+ years of process engineering experience to help suppliers test and introduce new products, promote their technical capabilities, and produce top quality reports, presentations and white papers. The company also provides customized on-site SMT and wave solder process assessment and training to assemblers. For more information, visit [www.sheaengineering.com](http://www.sheaengineering.com).