

STRENGTHENING YOUR DOWNSIZED DESIGN TEAMS THROUGH A STRONG PROTOTYPE PARTNER

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ABSTRACT

Original equipment manufacturer (OEM) product development teams are downsizing, yet workload is increasing. This presentation looks at ways to strategically fill the gaps in team expertise by leveraging your supply base. Topics covered will include:

- Important considerations in outsourcing products using open architecture platforms
- Best ways to leverage engineering expertise at your PCB fabrication house and prototype supplier
- Ways to cut time and cost in sourcing prototypes.

INTRODUCTION

The recession has sped up the trend toward downsizing product development teams. Product development managers who once managed strong teams with dedicated engineers, technicians and administrative resources now find themselves doing everything from engineering tasks to procurement. The workload continues to increase, technology challenges abound and product development timelines continue to shrink. Those who are left have two choices: continue to juggle as resources disappear or strategically use suppliers to fill the gaps. This paper discusses some critical issues in strengthening your team through supply base partnerships and specifically looks at ways to cut time and cost in prototype development.

LEVERAGING OPEN ARCHITECTURE

Semiconductor manufacturers have also noticed the trend toward downsizing product development teams. They have responded to these resource constraints by facilitating the development of single-board solutions that incorporate their processors. One such example is the Beagle Board (www.beagleboard.org), an ultra-low cost, high performance, low power Texas Instruments' OMAP3 processor-based platform designed by the BeagleBoard.org community. The processor is a .4mm pitch BGA in a package-on-package (PoP) form factor that accepts a .5mm pitch BGA memory chip on top.

The Beagle Board is designed to be either a development system or an out-of-the-box platform for embedded applications such as firewalls, video distribution systems, multimedia picture frames and robotics. The positive aspect is that a standard platform can cut development time and compensate for the challenges associated with manufacturing the OMAP processor. Further, the hardware designs are open source with the CAD files, bill of materials

and Gerber files all available for use as is or in modified form by the engineering community. Having a pre-built platform and open source design files as options allows for much faster adoption of such advanced components as the PoP OMAP processor.

This also encouraged faster adoption of the new technology microprocessor within both the hardware and software design communities. However, the combination of extra fine-pitch pitch BGAs, PoP and the microvias found within the board's layout can add complexity to the assembly process. In some cases, this manufacturing technology may not be well understood by the OEM product development team and/or their selected prototype manufacturer. For example, poorly designed vias-in-pads are one of the key causes of bad prototypes. In many cases, it is unavoidable as discrete components, QFNs and fine pitch BGAs often require via-in-pad. But if left open, solder capillary action sucks the solder through the via and down to the other side of the board. Small parts can tombstone, large parts end up with poor mechanical connections and BGA balls can be sucked off the component. When via-in-pad is used, capping it and/or masking it can solve the manufacturability issue. Capping the chip-side is better than capping the bottom because it reduces chance of outgassing and voids. If QFNs are used, vias should be capped or tented. With such small pads as required by the OMAP processor, filling and plating over the vias-in-pads is the only workable solution.

An additional challenge is that while PoP and .4mm pitch BGA technology is well-deployed in the higher volume EMS community, it is not necessarily widely used in all standalone prototyping facilities and other low-volume/high-mix facilities. It is important to select a prototype manufacturer capable of not only placing such advanced packaged parts, but also able to discuss the potential design for manufacturability and testability issues (DFM/DFT) associated with this packaging technology. Familiarity with the open architecture being used is also a plus, because in those cases the prototype house may already be aware of critical issues to watch with specific open architecture platforms and the best resources in the development community to address known issues.

LEVERAGING SUPPLY BASE ENGINEERING EXPERTISE

One of the advantages of a more competitive market is that suppliers are anxious to differentiate themselves through

their focus on customer service and breadth of value-added services. This focus on delivering lowest total cost may include access to engineering support.

A good prototyping partner can be an extension of your technical team. When filling gaps, consider your team's technical weaknesses compared with supplier capabilities. For example, when mixed signal technology or embedded processors are used, the difference between receiving prototypes vs. prototypes that work can be your supplier's in-house engineering expertise in those technologies. Prototype houses see a far greater range of technical challenges than your team will likely see. Leveraging this shared expertise can cut your product development time and cost.

In some cases, this engineering focus may also extend further into the supply base and even involve teaming efforts between suppliers. For example, Sunstone Circuits worked with Screaming Circuits to improve procedures in their raw board electrical test process to fit within the parameters of Screaming Circuit's quickturn environment. Their strategic partnership includes focused continuous improvement efforts which benefit both companies and their respective customer bases.

CUTTING COSTS IN SOURCING PROTOTYPES

Approaching prototype sourcing strategically is the fastest way to cut costs long term. Five key areas in which to focus are:

- Buy the services you need
- Develop a good handoff process
- Look for strong DFM/DFT expertise
- Consider long-term requirements
- Listen to advice.

Buy The Services You Need

Administrative and lower level technical resources are often the first to be cut from a product development team. This can leave engineers doing mundane administrative or lower level technical tasks that they don't enjoy or have the training to efficiently perform. The job of a good prototype house isn't simply building boards. Instead, it is helping product development teams meet their deadlines on time and on budget. Selecting a prototype house capable of sourcing components, handling PCB fabrication and transforming the file set into a documentation package is one way to eliminate inefficiencies and learning curve in a downsized team.

Similarly, prototype service offerings are changing with changes in demand. Quickturn prototypes carry premium pricing that is driven by turnaround time. Consider your required turn time when sourcing prototypes. A recent Screaming Circuits' customer survey indicated that over 30% of clients were purchasing quickturn prototyping services to support their low volume/short-run production needs. They were doing it because they found it preferable to trying to outsource a short-run project in a traditional

EMS environment. They were also trying to avoid excessive tooling or non-recurring engineering (NRE) charges. This drove creation of a lower cost hybrid service with a simplified project launch and a longer turn time than found in the quickturn prototyping realm.

In another of the Company's customer surveys, 21% of respondents said that the most difficult part of getting prototypes built was coordinating the overall process. Another 10% said it was getting the order placed. Look for suppliers with systems in place that take the work out of ordering and coordination. Web-based ordering, extended hour customer service support, online quote calculators, and one-stop shopping for PCB fabrication and prototype assembly are all examples of streamlined processes which can reduce engineering teams' administrative time commitment and prototype ordering leadtime.

Develop a Good Handoff Process

Poor quality in prototyping can be customer-driven. Poor handoff habits that can increase cost or drive poor quality include:

- Ambiguous part substitutions - Some applications are tolerant of "fuzzy" part substitutions, but others need parts that are exactly to specifications. Components that can cause problems include: resistors that are close to specification values but not exact, passive component sizes that are close but don't match up and barrier diode ratings that don't match. Motor control and RF-based products are two examples where variance from specifications will likely cause significant product performance issues. Check potential application issues before substitutions are made.
- Ambiguous silk screen marking - Silk screen markings for diodes sometimes include ambiguous symbols making it difficult to determine whether the anode goes to negative or positive. Properly identifying components in a non-confusing manner helps ensure correct placement. While a silkscreen is not an absolute requirement if boards are being outsourced without silk screen, some other form of documentation should be provided to verify component placement and rotation.
- Poor raw PCB storage and handling practices - Different PCB finishes are susceptible to damage as a result of incompatible handling or storage practices. Silver boards are sensitive to corrosion, light and oxidation. Gold boards, particularly those with thin layers of gold, are also sensitive to defects caused by poor handling or storage practices. Most boards need to be moisture-sealed. Storage in humidity-controlled, dark environments is best.
- Excessive moisture exposure of consigned components - Moisture sensitivity is predominantly an issue with RoHS-compliant components but can be an issue in some leaded components as well. After improper storage, moisture-sensitive chips

may popcorn or crack subtly underneath. This can create hard to find or intermittent defects. It is often more of an issue with prototypes because components are often consigned in partial lots. This may result in impaired moisture sensitive packaging or storage beyond recommended shelf life. Be sure to evaluate parts in opened packages and bake moisture-sensitive parts that have not been stored properly.

- **Layout inconsistency** - Layout inconsistency is one trend that drives tombstoning issues. For example, when a small trace is going to one pad and a large trace is going to another pad, the large trace will act as a heat sink. The smaller pad melts first and surface tension causes the large trace's side to pop up. Inner copper layers under one pad, but not another can also cause the same effect. Larger thermal mass components can also cause this. Another common cause of tombstoning is a thick solder mask. Good mask registration will help. Using a board vendor that has tight tolerances and delivers a thin flat mask surface will also help. In some cases, with the smallest parts, you may want to keep the soldermask off the pads by using non-solder mask defined (NSMD) pads.
- **Parts library mismatch** - CAD system parts libraries often contain land patterns that are close to that needed for the actual component, but just enough off to create issues. For example, parts with uneven solder pads cause headaches on a fairly regular basis when matched with PCB land patterns that don't also follow the uneven dimensions. The surface tension of the molten solder will act on the bigger surface area of the pad and cause the part to shift during reflow. That can lead to reliability issues. In some cases, it can also lead to shorts with nearby components or mechanical structures. Sometimes there is variation between metric and English measurement systems in parts libraries. That difference can be irrelevant in a part with a few leads but significant in a part with a large number of leads.

Look For Strong DFM/DFT Expertise

Your prototype supplier should be able to provide design for manufacturability/testability (DFM/DFT) advice, as well as general board layout recommendations. Look for informational resources, design guidelines or a helpline to assist with component footprints not in your CAD library, best layout options for odd form components or other resources that can be tapped to speed your internal layout efforts. For example, PCB fabricator Sunstone Circuits offers PCB123, a schematic and PCB layout CAD system that has built-in design rules. They also provide design rule add-ins for many popular CAD systems.

Consider Long Term Requirements

While an immediate objective may be finding the cheapest source for the prototypes you needed yesterday, taking a

longer term view may lower total cost. Is your prototype supplier a standalone resource or a partner who can bridge the gaps between your design efforts and your volume production facility? Can you automate parts of your ordering process or set up standard practices that simplify continuing orders? Can developing one or two strategic prototype sources get you better pricing than randomly bidding every new product as a standalone project?

Listen To Advice

Good prototype houses don't want to make money on your inefficiencies. If they identify ways you can save money and time by changing your process, take their advice. Review their design guidelines and resources such as blogs or white papers. While changing your process may seem like added work you don't have time for, setting up a robust partnering process with your key prototype suppliers will reduce both your workload and cost long-term.

CONCLUSION

Downsized product development teams are likely here to stay. However, engineering staffs who find ways to meet the challenge of increased project complexity, tighter deadlines and reduced internal resources ultimately will increase their companies' overall competitiveness. Identify your team's strengths and weaknesses, and then team with your supply base to fill the gaps.

REFERENCES

- [1] D. Benson, "The Changing Role of OEM Product Development Engineering Teams," Circuits Assembly, February 2009.