



IN THIS CLIMATE, OUTSOURCING IS BECOMING A MANDATORY SKILL FOR IC-DESIGN MANAGERS. BUT IT'S NOT INTUITIVELY OBVIOUS.

# OUTSOURCING AN IC DESIGN: SOME ADVICE FROM THE TRENCHES

BY RON WILSON • EXECUTIVE EDITOR

**T**here are many reasons to consider outsourcing all or part of a chip design. Perhaps you are on a board-level-design team, and the correct approach to your new project is a chip that doesn't today exist. Perhaps your team has previously done IC designs but lacks the skills for your next project. Maybe your organization has downsized so that only a few key individuals remain from what was once a full SOC (system-on-chip)-design team. In each of these cases, outsourcing may be the answer. In every case, however, defining the work, selecting the right vendor, and creating an adequate project-management structure are necessary conditions for success.

It's not easy to learn from others' experiences in outsourcing. Some companies—particularly in the fables area—don't want to admit that they use outsource vendors. Others don't discuss the question out of concern that revealing

their vendors or their management approaches might somehow give away a competitive advantage. A few experienced design teams and a few vendors share their ideas about what they've learned on the subject.

Reasons to outsource all or part of a chip design come down to two points: expertise and profit. And these two are themselves interrelated. "There are two categories of reasons people call us," says Jack Harding, chairman, president, and chief executive officer of eSilicon. "Customers do initiate the contact about two-thirds of the time. There are the reasons the customers tell us, and there are the underlying reasons that we infer."

Customers say that they need an outside vendor to help balance the load on their engineering team, that they want to avoid the cost of retooling, or that, because of eSilicon's volumes, it can negotiate a better deal than they can on IP (intellectual-property) licenses or wafers, Harding explains. "These things may be true," he says, "but the underlying issue is often that the number of design starts a team does in a year has

declined until it's become hard for the internal people to stay current with the tools." Meanwhile, the number of skills the team needs to succeed on a design keeps increasing. At some point, the engineering manager has to look at the capital distribution and decide whether to keep a full in-house design team.

This analysis often concludes that a small company should focus its engineering resources on its key differential advantages, rather than pay for the ability to execute a full chip-design flow. QuickLogic, for example, sells CSSP (customer-specific-standard-product) chips (Figure 1) that include both fixed blocks—interface controllers, buffer memories, and so forth—to implement a platform chip and a programmable-logic fabric so that a user can customize the chip for an application. QuickLogic's secret sauce is in the logic fabric rather than cell-based SOC design. Accordingly, the company outsources the fixed-function design and chip integration to a contractor and keeps chip architecture and the programmable-logic array with its proprietary antifuse technology in-house.

Similarly, RF signal-processing vendor Scintera Networks sees chip architecture and analog/mixed-signal design as its key areas of expertise. "We do about one digital design per year," says Bob Koupal, vice president of engineering at the company. "So we don't use the digital tool chain that much. It doesn't make sense for us to staff and tool up for a digital back-end flow." Instead, Scintera turned to Fastrack Design and Axi-

## AT A GLANCE

- ▣ Outsourcing can take many forms in a chip design.
- ▣ Selecting a vendor is both a technical and a personal decision.
- ▣ Any outsource work requires close management.
- ▣ Many companies have seen the last of full in-house chip-design teams.

om Design Automation to provide synthesis through back-end design and to perform verification on the digital portions of a recent design, respectively.

## PREPARATIONS

Experienced outsourcers emphasize that it is vital to go into the engagement with a detailed understanding of the skills you will require from your vendor. "We defined three criteria for our vendor search," says Ajith Dasari, QuickLogic's vice president of engineering. "First, we looked for a specific level of technical capability. Second, we looked for scalability. Could the vendor handle not just the first chip, but also the whole platform as it unfolded? Third, we looked at economics. Is this [approach] really going to be more economical than using the team I have?"

There may be other important criteria, as well. Koupal wanted a vendor whose tool flow would match Scintera's. "In a way, we chose our vendors first for their tool set and then for their capabilities," he says.

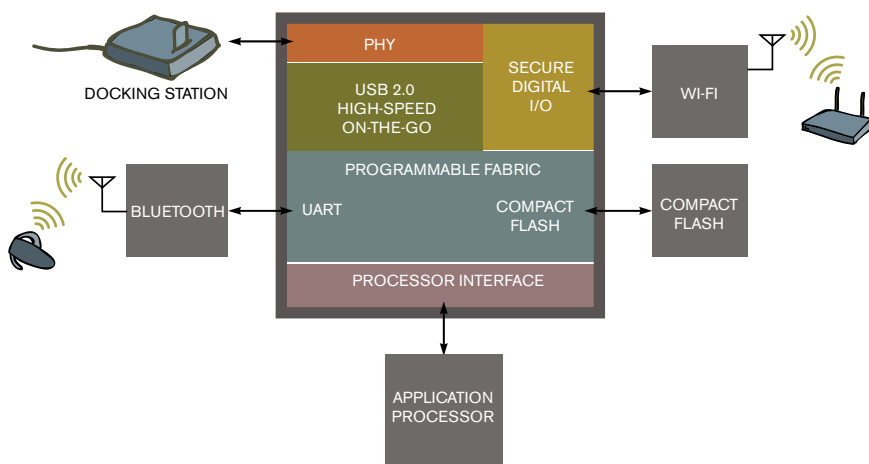


Figure 1 QuickLogic's CSSPs combine fixed-function interfaces with programmable-logic fabric.

Although most outsource relationships follow an ASIC-style pattern—the customer hands off a verified netlist to the contractor—it is possible to outsource any part of the chip or any part of the flow (Figure 2). Alternatively, you can outsource an entire chip design and have only applications—but not chip-design—expertise in-house. If you lack the in-house expertise to evaluate your contractor's work, you may want to outsource this oversight function, as well. Harding says that eSilicon is working on one project in which the company's role is to evaluate a design that another contractor did.

Once you have established the criteria and estimated the scope of the work, it's time to start looking for prospective vendors. In real life, the search is often more informal than exhaustive. Scintera looked first at vendors it had used before. Dasari worked through his personal network to get recommendations for vendors that might fit QuickLogic's project requirements. Often, first- or second-hand experience is the most trusted tool for building a short list. When you have the short list, the detailed investigation starts, and this inquiry quickly moves from the technical to the personal.

"Before we made a final decision, we asked the vendors to actually send the key people we'd be working with to our office," Koupal says. "The engineers came from India, and we interviewed them here. It sounds like a lot to ask, but the vendors understood why we needed to [take this approach]."

These interviews can become intense. "We kept asking questions in increasing detail until we felt we understood how much the guys really knew," Dasari says. "For instance, we would define a block and then ask them for estimates on final power and timing. Checking their estimates against our experience told us about how much work they'd done with our kinds of structures."

## GETTING DOWN TO WORK

Once you've chosen a vendor, it's time to get to work. Often, the first step is to distill a general understanding of the project into a detailed statement of work. This document may figure in price negotiations and become a key project-management tool. Accordingly, it can be quite detailed. The statement

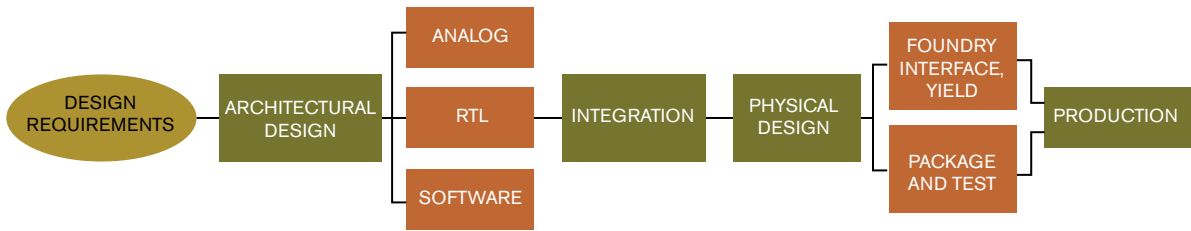


Figure 2 An SOC design comprises many steps, of which a design team may outsource all but the first.

of work may contain architectural descriptions; requirements for function, area, speed, and power on individual blocks; detailed itemization of the flow the vendor will use; completion criteria for each stage in the design and verification tasks; and a schedule. It is not wise to hurry through the statement of work as if it were a formality, experienced managers warn. It's not a pro forma document, but a road map of the joint development. "We spent three or four weeks just developing a document that described the microarchitecture," Dasari says. Koupal, particularly concerned about the interface between his team's analog blocks and the outsourced digital blocks, defined not only the pins in the interface, but also the pins on all the digital blocks.

In some cases, though, a shared understanding of the design may be more important than a detailed statement of work. Harding says that, when a new client works with eSilicon for the first time, the client usually shows up with a detailed state-

ment of work. As teams get more experience working with the company, however, the relationship begins to look less like contracting and more like a joint development. Only experience with a team can teach the best trade-off between upfront detail and downstream flexibility.

In addition to the statement of work, managers emphasize the importance of a defined project-management protocol. With or without formal tracking tools, a regimen of closely spaced milestones, regular design reviews, and periodic face-to-face encounters appears essential to keeping the project on track.

Both Koupal and Dasari argue for starting the project with the vendor's senior engineers on-site. The outsource vendor's presence in the building shortens the feedback loop at this early stage when there are lots of questions flowing back and forth between the two teams. It also puts faces on people who would otherwise just be e-mail addresses or voices on the con-

ference phone during most of the project. There's a more subtle benefit, as well. "Having their senior people start out in our shop for a couple of weeks brought them closer to the project," Dasari says. "When they went back to India, they became the local experts on the project. They were able to deal with a lot of questions locally that would otherwise have required a phone conference the next morning."

Once the project is under way, it settles into a familiar pattern of regular meetings. "We managed the outsource relationship as if it were part of our own company," Dasari says. Both Scintera and QuickLogic used weekly teleconferences as their basic management tool, whether or not the vendor offered any Web-based tracking. "We generated detailed milestones, never more than two weeks apart," Dasari explains. "Then we broke the milestones down into activities, which we tracked in the meetings. At the first hint that someone was struggling with an activity, we could fly our 'tiger team' out there to work with them." That sort of subtle perception would never come through on an activity-tracking report.

This need to understand the nuance of what engineers say in a teleconference is an important issue. The local management team needs to have enough expertise—and strong enough listening skills—to detect whether the project leader in India is saying that the company will be late on closing timing on the DSP datapath or that there's no way it can meet timing requirements and is just spinning its wheels.

That perception requires expertise. Koupal points to his analog/mixed-signal expert and chip architect as indispensable to a successful outcome. Dasari agrees. "You have to have a tiger team. We need one really good guy each in RTL [register-transfer-level] design and physical design to act as project supervisors. You must have your most senior people to successfully manage an outsourced project."

Koupal puts it succinctly. "For us, design outsourcing is a way to amplify the expertise of your in-house people. It's not about doing a project completely outside your range of expertise."

You hope that everything comes together at the end of the project. Again,

⊕ [Go to www.edn.com/090903df](http://www.edn.com/090903df) for more information on the vendors this article mentions.

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managers say, it is vital to have the key outsource people in your office during the final days or weeks of the project to shorten the loop during the frantic scrambles to achieve tapeout.

## **MULTIPLE PARTIES**

Creating a chip isn't just a two-party affair. Both third-party-IP vendors and at least one foundry will also usually be involved. Multiple outsource vendors may do different parts of the work. Koupal feels strongly that it's a good idea to have different shops do the design work and the verification, even though this arrangement complicates the management process. This attitude mirrors one side of a long-running debate in the industry about the wisdom of having a design team do its own verification. In any case, though, it's important to understand from the outset who will be doing the verification and who will be managing it. Few figures in a chip design are more elusive than verification-coverage metrics, and few more difficult decisions exist than when verification has gone far enough.

Third-party IP presents another complexity. Some outsource vendors differentiate themselves in part on their relationships with a wide range of IP vendors, their ability to get good prices, and their access to timely service. In such cases, Harding says, the outsource vendor would normally take full responsibility for the IP. In other cases, however, the main design team may want to have its own relationships with IP vendors. In this case, according to Dasari, you have to make sure that the license includes provision for your outsource vendor to work with the IP to get it into your chip, and you must be sure that the IP format and deliverables match both the outsource vendor's tool chain and the overall architectural decisions for the chip in such areas as voltages, design-for-test structures, and DFM (design-for-manufacturing) standards.

Foundry relationships can also vary. Companies such as eSilicon not only

maintain foundry relationships, but also own the contracts with the foundry, package, and test houses; own the wafers; and sell packaged silicon directly to their customers. They can develop and qualify second-source foundries, negotiate prices, and manage end-of-life processes, as well.

Sometimes, the foundry relationship goes through the customer, not the outsource vendor. In QuickLogic's case, for instance, the company's programmable-logic fabric requires a custom process, so QuickLogic must maintain the foundry relationship. "We pass the PDK [process design kit] to our vendor, and they pass the GDS [graphical-design-system]-II back to us to send to the foundry," Dasari says. Even so, there may be a dotted-line relationship between the foundry and the outsource company anyway, so that PDK updates, process questions, and DFM issues don't find the customer an unwelcome intermediary between the foundry support engineers and the physical design team.

Clearly, no standard technique exists for outsourcing a chip design. You can see a few fundamental principles, however. First, it is vital to have enough in-house expertise to manage the interface between your team and your outsource vendor. Just what this expertise is depends on what you are outsourcing. But you will need this expertise during requirements definition and vendor selection and continuously throughout the management of the design. Second, an outsource relationship requires at least the same level of management as an equivalent in-house design, including a management team that understands the actual state of the project and the objectives, a regimen of frequent detailed reviews, and methods of checks and balances to ensure that every phase of the design is completed correctly. This oversight may require the use of outside resources from a third party.

Finally, there is the issue of flexibility. "You do give up some flexibility when you outsource parts of a design," Dasari admits. "You can't just make a big change to the requirements in the middle of the design and expect to have your partner track it. They will see this as a change order, and they'll want to negotiate additional money and schedule, even if the change isn't that big." For some market-

ing-driven organizations, this hurdle may be the largest of all.

Just as hard economic times are here, design outsourcing is here. For most organizations, it will mean the end of full in-house design teams in favor of small engineering departments that focus on the company's differentiating technology. It also means that a category of professional engineering managers will emerge

who can work with the unique challenge of this organizational structure. **EDN**

You can reach  
Executive Editor  
**Ron Wilson** at  
1-510-744-1263 and  
ronald.wilson@  
reedbusiness.com.

