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IC Design Process: It's not just your design flow.

"A design process that has clarity of responsibility and deliverables in mind will pull in your Time to Market Window." – Jeff Jorvig

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Introduction

This paper discusses the definition of the IC “design process” and how it can be utilized to keep things under control. The design flow does not tell the whole story since it is more about how the design moves from one tool to the next. The design process is much more about who, what, when, where and how of a design project. The design process also deals with the interactions of the design team with the rest of the product development team, including marketing, product engineering, test engineering, program management and product line management.

The time to market window is typically defined as the time to define, develop and ramp your product into production. This timing is not necessarily improved by only managing the time to fracture date on the first spin, although often there is great emphasis on this milestone. A team that is overly focused on the fracture date will be forced to cut corners that frequently enables an unexpected surprise and forces an entire mask spin in the development cycle. When done well, the design process manages the entire development from concept to production and relieves the team of being forced into near term “catch up” decisions.

A quality design process is really about not surprising anyone. No missed expectations, no I thought it was going to be this way or that way, no finger pointing. A well-done design process will enable predictability in design execution for your team.

A design process is about who, what, when, where and how. It also covers deliverables to and from the entire product development team for each and every task.

Design Process Defined

The Design Process

A design process is about how the entire design flows from initial concept through production ramp. A thorough design process will also include the interfaces of design to the rest of the product development team, outside of design. It includes the who, what, where, when and how of each step of the design in great detail. The intent of the ideal design process would be that no one individual on the product development team will ever be surprised by any actions, inactions or a deliverable from anyone else on the team. The product development team as used here refers to all disciplines involved in a new product development, not only the designers. Figure 1 below identifies each of the key steps that should be considered in the design process.

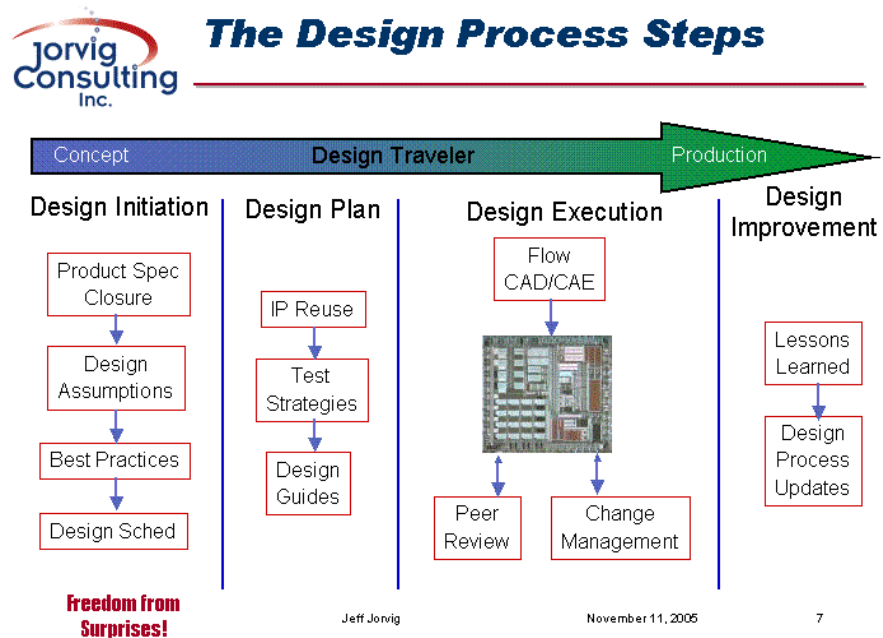


Figure 1: Steps of the Design Process

If there are no surprises, then by definition there will not be any wasted work in going back and having to make changes. This in turn

provides the most efficient flow through the product development cycle and gives you your best Time to Market.

Typical High Level Design Process

Figure 2 below is an example of a subset of design process steps from the specification through production release. The green represents the ideal flow from one step to the next. The red flow represents the backward flow that occurs when there is an expectation disconnect noted at a given step, requiring movement back to a previous step in the flow to resolve it. An expectation disconnect is best described as the inability to complete a step due to missing, incomplete or improperly formatted information from a previous step. To achieve the minimum product development time we do not want any flow backwards along the red path, to a previously completed step. Pretty simple in theory, but how can we best do this in real development efforts? This is done through development and/or refinement of your design process.

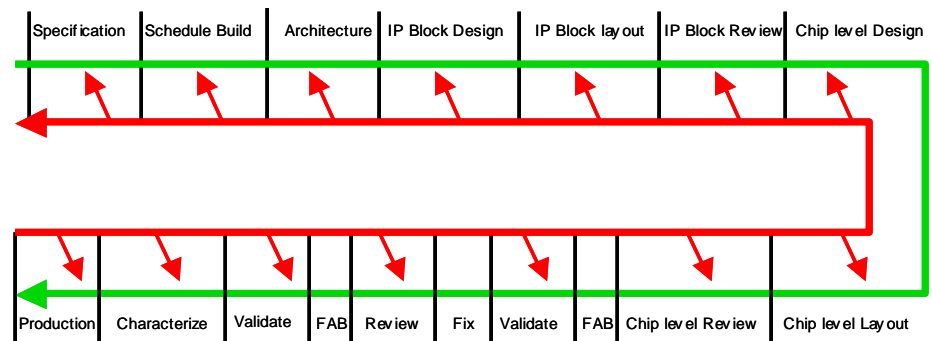


Figure 2: A Typical High Level Design Process with both Forward and Backward Flow

The Details of a Process

Defining a process is about breaking down and defining these steps in enough detail to ensure that every thing needed for follow on steps is covered in the previous steps. Let's take a look at the process steps

involved in running a simulation. Table 1 below represents the level of detail you should consider as you develop your process.

Task	Input	Output
Create Simulation Environment	1) Model location 2) Simulation tool(s) 3) Parasitic extraction flow.	1) Environment setup
Define Validation Strategy	1) Module requirements 2) Sim Corners 3) Identify areas of concern 4) Parasitic R/C nodes identified.	1) Stimulus files/schematics completed 2) Strategy reviewed with chip technical lead.
Execute sims as per the validation strategy.	1) Validation strategy	1) Raw simulation to cover validation requirements.
Deliver Validation Output	1) Chip level simulation documentation requirements. 2) Test requirements.	1) Simulation results compiled as per the standards for the chip. 2) Test validation matrix.
Peer Review	1) Validation strategy. 2) Validation Output	1) Actions that cover any areas of concern in the design.

Table 1: Example Process Steps for Simulation Task

Each one of the items in the input column is information needed, in the proper format, for the current task that should already have been completed from an earlier task. The output column is the deliverable out of completion of the current task that will be needed for a follow on task. In all cases the input and output must define the format of the information to be passed on.

Development of Your Design Process

This section discusses considerations in developing your design process.

Large Group Brainstorming

The best place to start the definition of your design process is in a large group setting with the entire design team present. I would suggest you prepare some type of framework prior to meeting to provide some structure to the discussion. The role of the person running the meeting is to facilitate discussion and closure on items. In design there are many “right” ways to do things and the idea of formalizing the design process is to ensure the team is doing things the same “right” way. This ensures that as the chip comes together there will not be any surprises. One final thought: You will never get 100% agreement on each step of your process so you will need to make a call at some point during the discussion and move on.

Documenting your Process

Believe it or not the actual discussion and review of the documentation is far more useful than the documents themselves. The overriding benefit of documentation is the alignment of the team that takes place in developing. You cannot develop documentation in a vacuum and achieve these goodies. Having said that let’s move on to the documents that will best capture your design process, and stimulate quality discussion about how the team will be working together.

In general, you will find that your process is not documented in only one document. There may be pieces of it in a Design Traveler, your schedule, your design guides and your design best practices. There may also be other documents that compliment your process. Remember, the key is not that you create all this documentation but that it has all been discussed and agreed to by the net team.

DESIGN TRAVELERS

The design traveler is your key document for mapping out how you will move from one step to the next of your design process. You can view the traveler content as being very similar to what you may have in a

checklist. The key difference is that the traveler includes much more detail. If your schedule has enough detail it can serve as your design traveler. Keep in mind that it must contain every little detail as I mentioned in the “The Details of a Process” section. If anything is left out you will end up leaving yourself open to a surprise during the project execution.

I have found that the development of a traveler makes a lot of sense in all cases. It documents your process making it an ideal template to bring into the schedule building process where time, resource and predecessor details are addressed.

BEST PRACTICES

The best practices document contains much of the operational information such as what the directory tree will be, where the models come from, what tools will be used and so on. Below is a list of the type of content you would expect in your best practices:

- Schematic standards
 - View types, symbol reference libs, design kit release, view categories, symbol generation standards...
- Which tools and versions are valid for this design?
- Design validation and reviews
 - Model location, sim corners, design documentation requirements, design deliverables back to the project, peer review expectations and deliverables...
- Expectations of what must be done in preparation for fracture.
- Team communications
 - Team meeting schedule and agenda, communication practices among the team...

The design guide is best described as the merging of the design specification, the design checklist and the design flow. Design guides are created in a template form to pilot your design process through the various phases from initial concept to production release. Any information or directives that define how the design team is to operate as the design work progresses should be part of the design guide.

There are usually guide templates developed for digital IP, analog IP, the chip level and in some cases the system level. The design organization should create a set of these guide templates for each one of the design flows they must support. When they are done properly, a completed guide should be all that is necessary to guide the design review of a block, a chip or the system.

Design Process Maintenance

Project Learning's

One important aspect of a design project is that the team meets to discuss what went well and what did not go well. The output of this discussion must be some very specific actions that will prevent any recurring issues on the next project. Any changes that the team has decided upon must be updated in your design process documentation. This step is the key to a continuous improvement mindset and once you get the team seeing that things can get better, and keep getting better the negative chatter about documentation, process and reviews will quickly fade.

These learning discussions and action generation should occur after tapeout, 1st silicon validation and also once the design has been

Summary

released into production. There may be project level learning's taking place also but do not assume that will cover design needs. Design must have their own learning sessions that specifically are intended to improve the design process.

Continuous Improvement is a Daily Activity

As you are moving through your project execution the net team must always be challenging themselves to ensure that the way things are being done is the best and most efficient they can be. There will always be room for improvement and if the team has an open mind for finding better ways, then the team has joined the ranks of the continuous improvement mindset. Design management must take an active role in fostering mindset.

In summary this paper has taken you through the definition of a design process, implications of a bad or non-existent process (reverse flow in Figure 2), the level of detail that is needed for a proper process and the mechanisms for creating and documenting your process. The key take away here is that if you do not have a clear process for each step of your development, you are enabling surprises that will slowly eat away at your schedule.

Another thought to keep in mind is that a design process it not necessarily one size fit's all. Every project should review and tweak a previous process to fit for their new project

Key objective: Kill the reverse flow in your
product development process.
