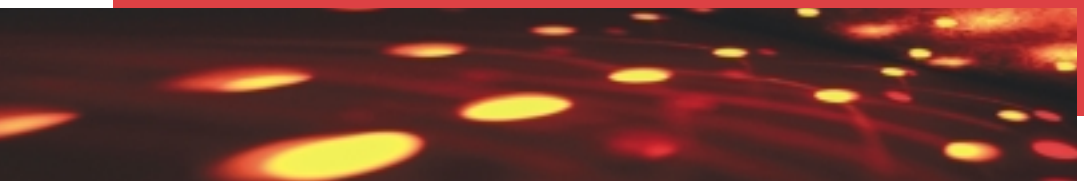


A Collaborative Approach to Complex, High-Speed Board Design

With the advent of high speed and increasing complexity at the board level, the process of using external layout is under strain. We look at how managing constraints using an integrated tool chain enables today's complex designs to be completed through close collaboration between remote sites.

Outsourcing to a Design Bureau

Traditionally, external printed circuit board (PCB) design activities were used as an outlet to undertake and complete designs when multiple project plans converged. A PCB Design Bureau would develop a relationship with the customer's internal design team, taking the lead from them with respect to design procedures and release to manufacture. Although this relationship was necessary, in many cases the expertise within the bureau was often more advanced than that of the internal design team. Internal designers focus on methods determined by their own company to satisfy the hand-off to manufacture. A PCB Design Bureau quickly builds up experience of many techniques and methods to supply output that can be readily used by specific or varied suppliers.

Our featured design house, 3Dlabs, has no internal board layout personnel or tools. It relies entirely on external contractors and, in particular, Advanced Layout Solutions based in Reading, UK, with whom they have worked for many years.

Increasing Design Complexity

Recently, many companies have reviewed their approaches to electronic design and implementation. Internal manufacturing, assembly and test activities have been divested as sub-contracting becomes the more viable option. The need within the company to concentrate on core competencies that add most value to products, leads to a radical re-think of the design process. This has associated risk that can be quantified, assessed and managed.

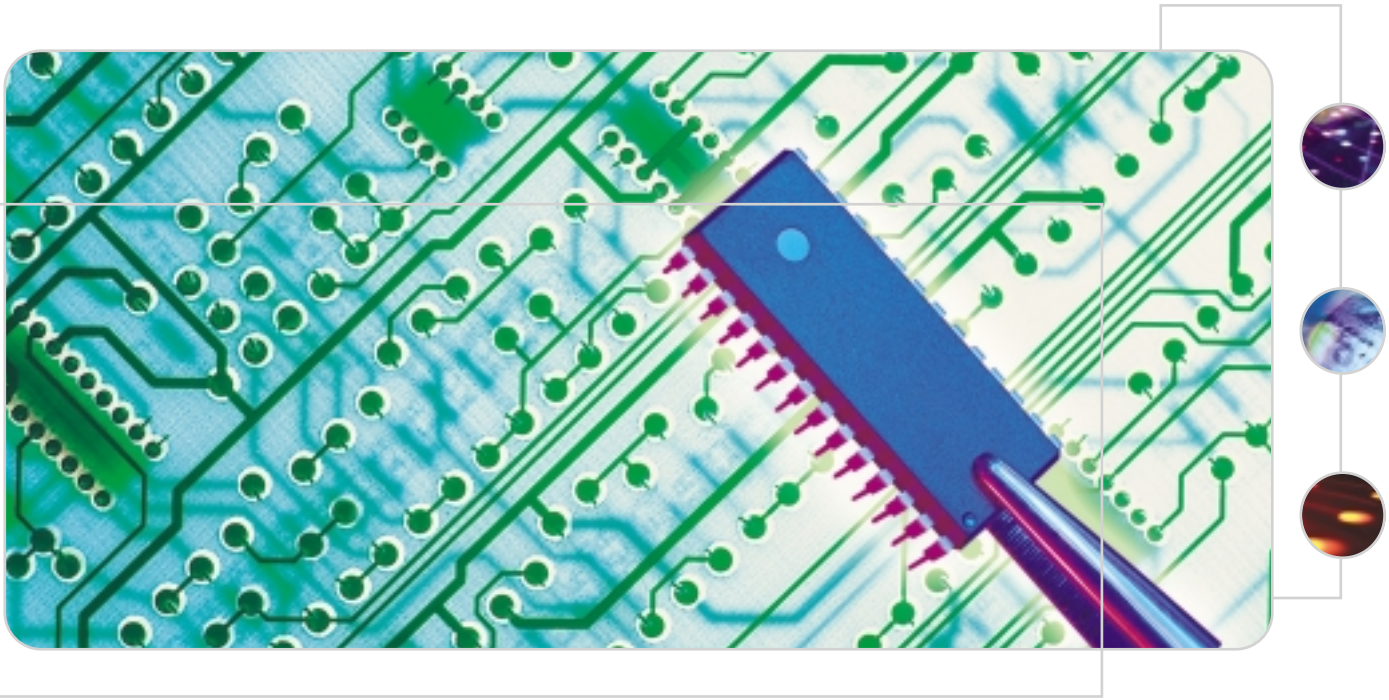
However, at the same time that companies are attempting to streamline design activity, technology is conspiring to add new challenges. With the explosion in silicon complexity, the typical PCB layout now faces significant design issues. Compliance to a netlist for connectivity and manufacturing guidelines for assembly and test is no longer sufficient. With rising clock speeds, higher frequencies and fast edge rates on components, the task of board layout becomes critical.

Consider the impact of these issues on the traditional design process, which is based around a schematic to layout flow. It must surely decrease the value of a bureau (as a remote or external support organisation) as the number of design constraints and considerations increase. For successful implementation, many issues need to be considered and defined, making external design seem difficult or even unmanageable. But is this always the case?

Finding a Suitable Solution

If hardware engineers have access to tools that are fully compatible with the bureau's tools, it is possible to develop the design needs remotely. Complex designs need to be managed to achieve a predictable result. Importing a netlist and manually following a set of guidelines is both time consuming and risky. During the initial design phase, it is necessary for the two teams to get together. Often the hardware engineer is looking over the shoulder of the PCB designer, whether he is in an internal design team or working externally at a bureau.





Solutions to this problem have been tried, such as physically locating the PCB designer with the hardware design team. Unfortunately, if the PCB designer is readily accessible, this tends to promote continual change cycles, as the hardware team over-engineers to obtain acceptable performance. Another method involves the hardware engineers doing the board layout. Once again, this can be counter-productive as PCB design requires a disciplined approach to ensure that products can be manufactured, assembled and tested to high yields. Solutions need to be found that do not compromise quality – a difficult task to set the hardware engineer!

Achieving Design Compatibility

Like all processes, the output result is dependent on the quality of the input data. In the case of the latest 3Dlabs board, the issues faced were significant. The design utilised the latest 600 Mbits per second DDR memory, with both standard and custom chips in use. The standard form factor was fixed as an AGP (ATX) outline, with connector and interface components pre-positioned. Typical design rules were 0.004" track width with 0.004" spacing from element to element.

The development environment at each site was based around the expert-level system design tools from Cadence. At 3Dlabs, Concept®HDL and SPECCTRAQuest™ SI Expert were used. At Advanced Layout Solutions, Allegro® Expert and SPECCTRA® Expert were available. Full compatibility between the sites was vital, eliminating the need to translate data from one format to another.

"Being dependent on an external design team always carries a degree of risk. As our design technology needs have multiplied, this dependence was almost unacceptable. By implementing SPECCTRAQuest SI Expert, we have the ability to explore different solutions, change the design and ensure that these are implemented correctly by Advanced Layout Solutions."

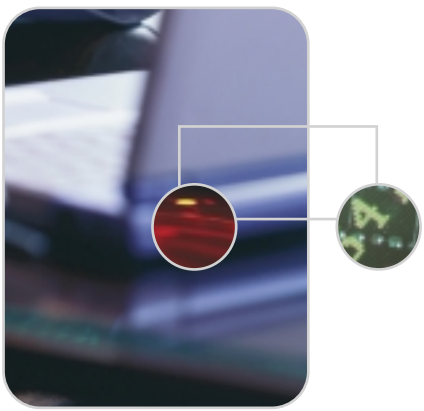
Chris Halford
Principle Design Engineer, 3Dlabs

Paving the Way for Design Development

Initial development of the design was in fact performed before schematics were started. IBIS models for different device technology were obtained from vendor web sites. These models were then assigned and used to perform high-level simulations. Once the feasibility of the design was proven, simple schematics were defined allowing the hardware designer to start initial board placement, using board outline and cross section details supplied by Advanced Layout Solutions. Using this data, a first pass placement is possible, providing more detailed analysis to verify initial results. These new simulation results will now confirm whether the design, which was feasible at a high-level, is still possible from a physical perspective.

Flow of data within a design environment is typically from front-to-back with the schematics being used to drive the requirements for physical layout. With the 3Dlabs design this was not practical. What the hardware engineer wants and what can be successfully implemented in the layout are often very different. The logic drawings were generated and a netlist passed forward. This netlist had some constraints, typically items that were non-negotiable such as component placement guides, line widths, clearances, etc. Mechanically defined components were placed and assigned logically.

This data was emailed to the PCB designer at Advanced Layout Solutions for the layout to be started. Using SPECCTRAQuest SI Expert, the hardware engineer was able to adjust, interrogate and modify critical sections of the design, such as the CPU / memory interface. Even with a partially placed layout the hardware engineer was able to extract and simulate the net characteristics of either individual or collective nets (such as a buss).



Exploring net characteristics at this stage allows signal integrity to be evaluated. Once acceptable performance is achieved, constraints necessary to drive the physical implementation of the nets can be added to the design file. Previously, this was only possible from the schematic tools.

With a new version of the layout database, the PCB designer can continue to complete the placement or even decide to complete the routing for a section of the design. At any stage of the layout process, the design can be made available to the hardware engineer for in-depth evaluation. This modular approach has many benefits and is gaining in popularity when trying to complete difficult designs.

Use of the SPECCTRA automatic router has no fixed model. It may be used up front to complete selected nets within the design, or it may be used to complete signals, after the PCB designer has entered some tracks manually. The process for design has no rigid procedure. Instead it relies on a flexible approach that allows the right tool to be used at the right time.

Given the complex nature of many board designs, change is inevitable. Certain nets may suffer from excessive ringing, requiring termination that was not considered necessary at the outset. With a constraint-managed approach, this becomes possible at any stage of the layout. The state of the design is stored within each tool and is read when opening either the schematic, placed board or routed layout. Changes can be explored, refined and implemented, alerting the design team to what has changed and where.

When the layout is completed, the traditional design rule checks (DRC) will identify any non-compliance with the physical, spacing and electrical rules. Even if there are no violations, it may still be necessary to simulate the whole design and review the 'non-critical' items. This ensures that they are not neglected in light of more challenging aspects of the design.

Collaborative Design

For a number of years, 3Dlabs and Advanced Layout Solutions have worked closely together, with an increasing need to spend time at each other's site. Significant time and effort was also required to develop design rules, often with no real analysis available. In this situation, a manufactured board was required for testing, demonstrating how the companies were over-engineering designs in an attempt to reduce the risk of failure. This led to heavily restricted designs that were rising in complexity. Both parties were aware that the methodology needed to change to accommodate the increasing demands.

Advanced Layout Solutions is an established user of Cadence technology. It recognised that Cadence system design solutions could be a key enabler in developing their working relationship with 3Dlabs. A tighter level of integration would facilitate rapid data transfer between the two design sites and promote better communication.

The 3Dlabs board is proof that change was necessary. Both hardware and PCB designers agree that an exploration, design and implementation model facilitates designing the most complex layouts. The need to manage information back and forth in a controlled fashion is paramount to success. In fact, during the design of the 3Dlabs board, there were 22 versions of the netlist. Importantly, however, the board worked first time.

"The Cadence tools provide a backbone that enables us to readily exchange data. This is vital, as the process of design is no longer a serial activity."

John Sutton
Director, Advanced Layout Solutions

About 3Dlabs

3Dlabs, a wholly owned subsidiary of Creative Technology Ltd., supplies graphics accelerator solutions to a broad range of professionals including the computer aided design (CAD), digital content creation (DCC), and visual simulation markets.

The company's award-winning Oxygen™ and Wildcat® graphics are available in the industry's leading OEM workstations, to the channel through an international distributor/reseller network, and directly to end-users at 3Dlabs' online store.

About Advanced Layout Solutions

Advanced Layout Solutions (ALS) was formed in 1995 by the common goal of its three founding directors to provide a professional PCB design service built around leading edge software and hardware.

Since the company's inception it has had a dramatic affect on the industry by being able to produce good quality designs, accurately, consistently and on time for a wide range of electronics companies both in the UK and abroad.

ALS has grown over the years to include additional designers and solutions to new emerging technologies such as micro-vias, BGAs, signal integrity and design for manufacture, and will continue to offer its customers the latest design features and software solutions in this fast moving arena.