

A STROKE OF GENIUS: SAVING TIME AND EFFORT WITH SKETCH ROUTING

MENTOR GRAPHICS



P A D S P R O F E S S I O N A L

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INTRODUCTION

Automation in PCB design software lets engineers create more complex designs at an increased rate, and automated routing is part of that. Yet automation has its limits, and can even be more burdensome than the task it was intended to replace.

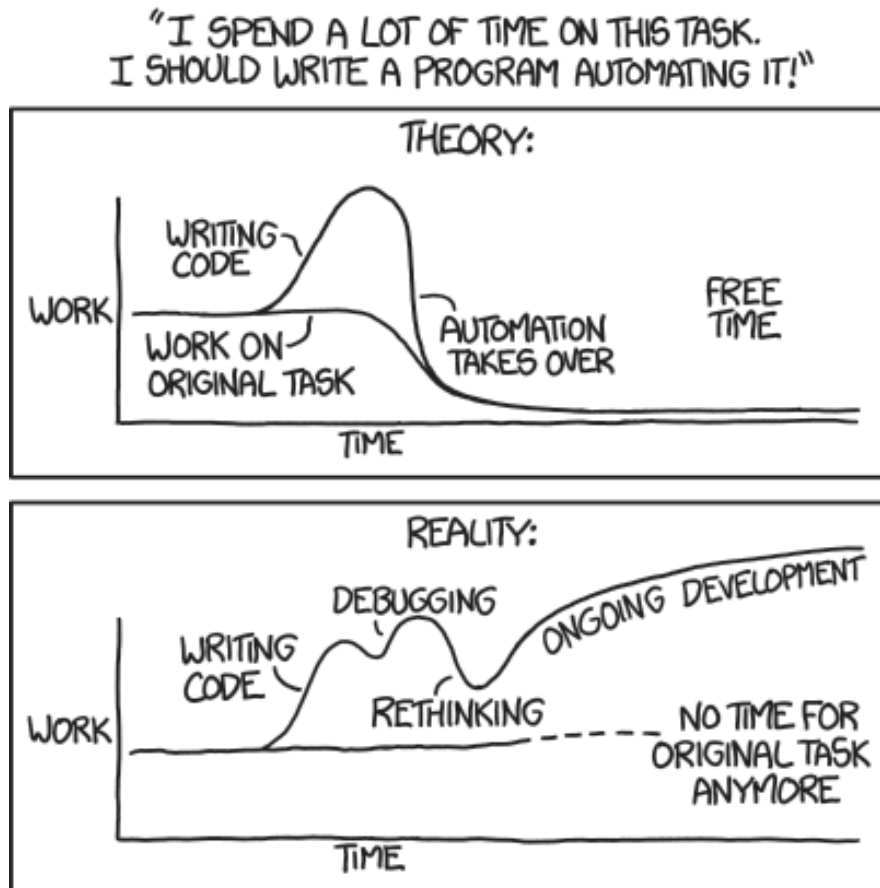


Figure 1: The concept of automation is often more pleasant than the reality. Comic courtesy of xkcd.com.

As designs increase in complexity, it becomes much more difficult to create and maintain design rules that will offer the results that an experienced designer can achieve routing manually. Some reasons that designers have for shunning autorouting include:

- The intimidation factor of trying to set up the autorouter in a way that will translate the designer's vision to the screen
- Reduction in quality versus a hand-drawn design
- Time spent cleaning up after the autorouter could have been spent manually routing it in the first place
- Too many vias—or, the general inability of an autorouter to complete a design with the elegance that an experienced designer could.

MANUAL ROUTING VS. AUTOMATIC ROUTING—IS THERE A COMPROMISE?

Both autorouting and manual routing require careful planning strategies and execution to achieve ideal results. Generally, the best autorouting success is accomplished when the design team has dedicated time to plan, place, constrain, and prioritize the design database with autorouting in mind. Autorouting success is also determined by the designer's knowledge of their autorouter's algorithms and historical performance.

Yet routing PCB designs is becoming increasingly more difficult—designs are highly constrained by more design rules, less physical space, signal integrity rules, and several other factors that present challenges for designers who want to streamline their process with traditional autorouting technologies. This task is even more formidable for the independent engineer who lacks a full team of designers to build and maintain a design database specifically geared for use with an autorouter. Could there be a way to combine the convenience of autorouting with the benefits of manual routing to meet the increasing number of design challenges?

This paper describes how Mentor Graphics' PADS® Professional sketch routing environment, adapted from proven Xpedition® technology, enables independent and project-based PCB designers to quickly and easily route high-quality, rules-driven designs with the look and feel of a manually routed design.

A QUICK LOOK INSIDE THE MIND OF A PCB DESIGNER

Typically, when designers first begin work on a new PCB layout, they begin visualizing the routes as they place the components in the design.

They must be attentive to how their components are arranged and how fan-out patterns must be generated to ensure that component pins and vias are accessible and that the routing channels are optimized. At the same time, the designer is concentrating on which nets have the highest priority, determining which ones they'll route manually, and keeping in mind all of the design rules. Configuring an autorouter to accomplish the routing as the designer visualizes it can be daunting. As a result, most designers resort to routing much of the design by hand—especially the critical nets—to ensure that the ideal results are achieved.

RETHINKING AUTOMATION WITH SKETCH ROUTING

Can routing critical nets be “automated”? With a new assisted-routing approach called sketch routing, it's possible! Mentor Graphics' Sketch Router eliminates the steps that PCB designers painstakingly set up in an autorouting execution scheme. With sketch routing, PCB designers can perform complex routing tasks the way they visualize them—all in real time.

The PADS sketch routing environment offers a set of highly integrated, automated routing features such as the sketch router, real trace routing, and dynamic push-and-shove. These capabilities combine to create a routing experience that enables high quality, user control, and exceptional performance.

With sketch routing, designers can:

- Draw sketch paths to determine the trace routing of selected netlines
- Achieve high design quality and high completion rates much more quickly than with manual routing
- Route individual traces or hundreds of single-ended/differential pairs
- Automatically optimize pin escapes for enhanced routing without adding unnecessary vias

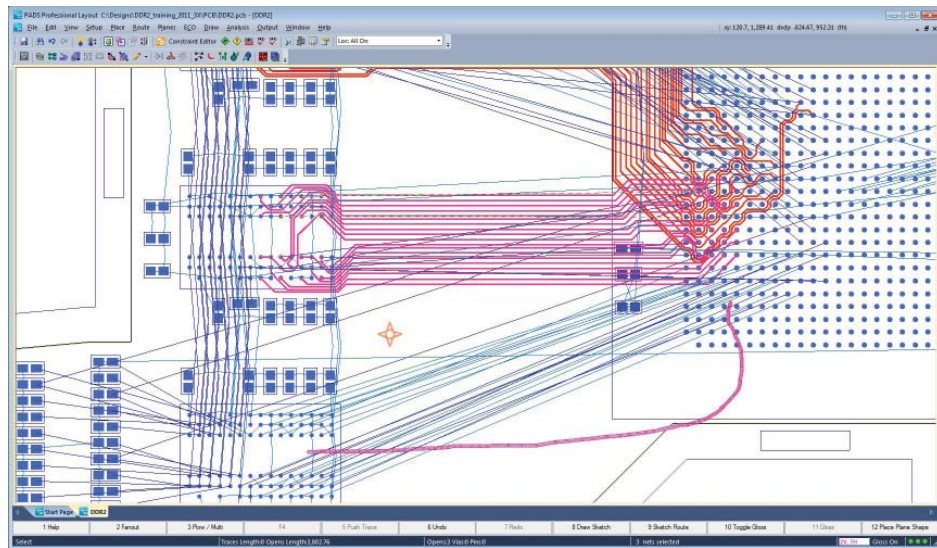


Figure 2: PADS Professional makes routing easier than ever.

HOW DOES SKETCH ROUTING WORK?

To use sketch routing, the designer simply draws a line to dictate the path around which the selected netlines should be routed. The sketch router can route individual, dozens, or even hundreds of netlines many times faster than manual routing. In Figure 3, twenty-two data lines have been selected. The most common method of sketch routing uses the existing via fan-outs and does not add any additional vias.

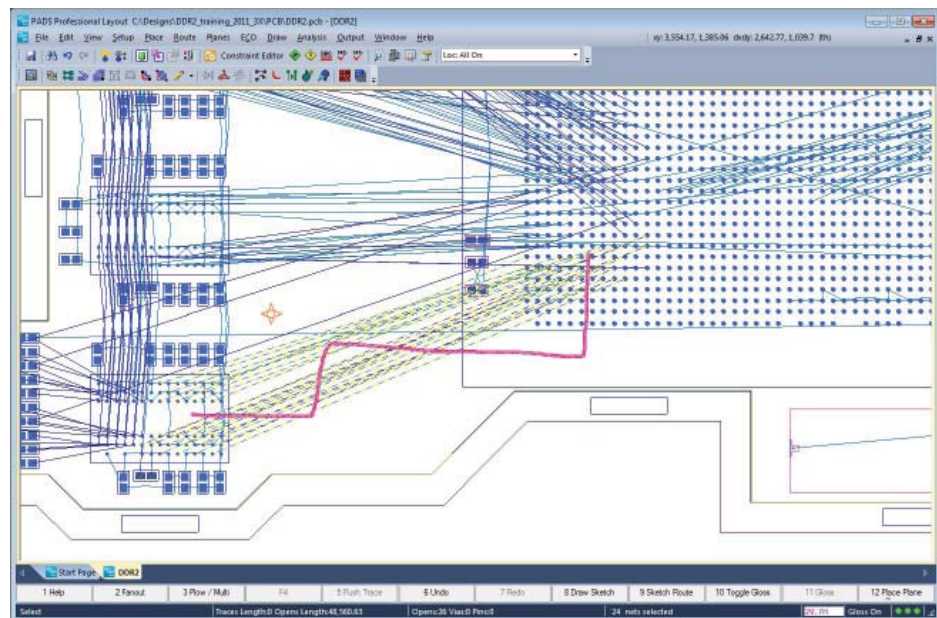


Figure 3: Sketch path to dictate routing location.

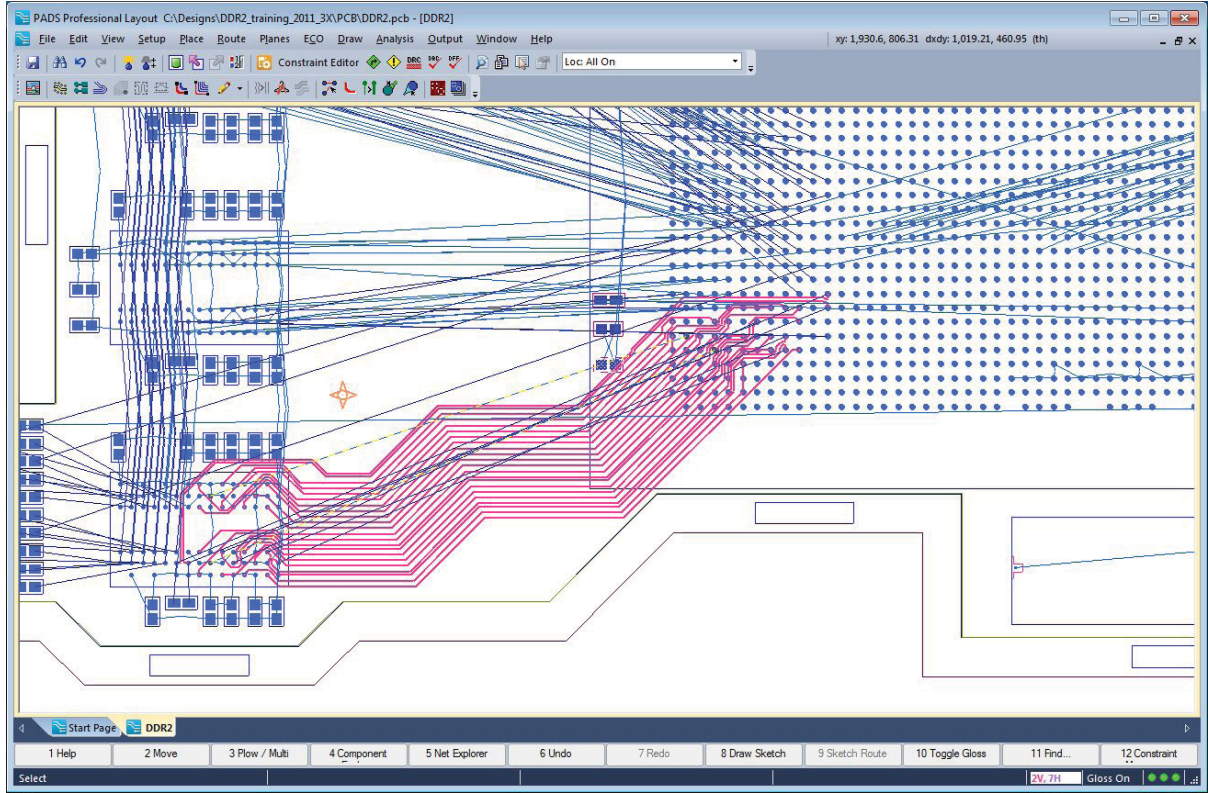


Figure 4: Push-button routing results from Figure 3 sketch path.

As seen in Figure 4, the quality of the sketch routing is exceptional and mirrors the quality and characteristics achieved when hand routing. Minimal cleanup is needed—often none at all. The high completion rate (90% - 100%) is attributable to the sketch router's ability to automatically organize the escapes so that they are optimal for routing without any additional vias. If you don't care for the results, or if you wish to try an alternative approach, simply undo and re-sketch the route with just a few clicks. With sketch routing, even the most experienced designers are able to produce routing results more than 30 times faster than manual routing.

PACKED AND UNPACKED MODES

Another helpful feature of sketch routing is the ability to route nets in either a packed or unpacked mode. In the packed mode, route spacing is optimized according to minimum design-rule values, as seen in the serial nets routed in Figure 5. In this situation, the unpacked mode shown in Figure 6 is more ideal since it provides the most direct net connections and avoids unnecessary overcrowding of traces.

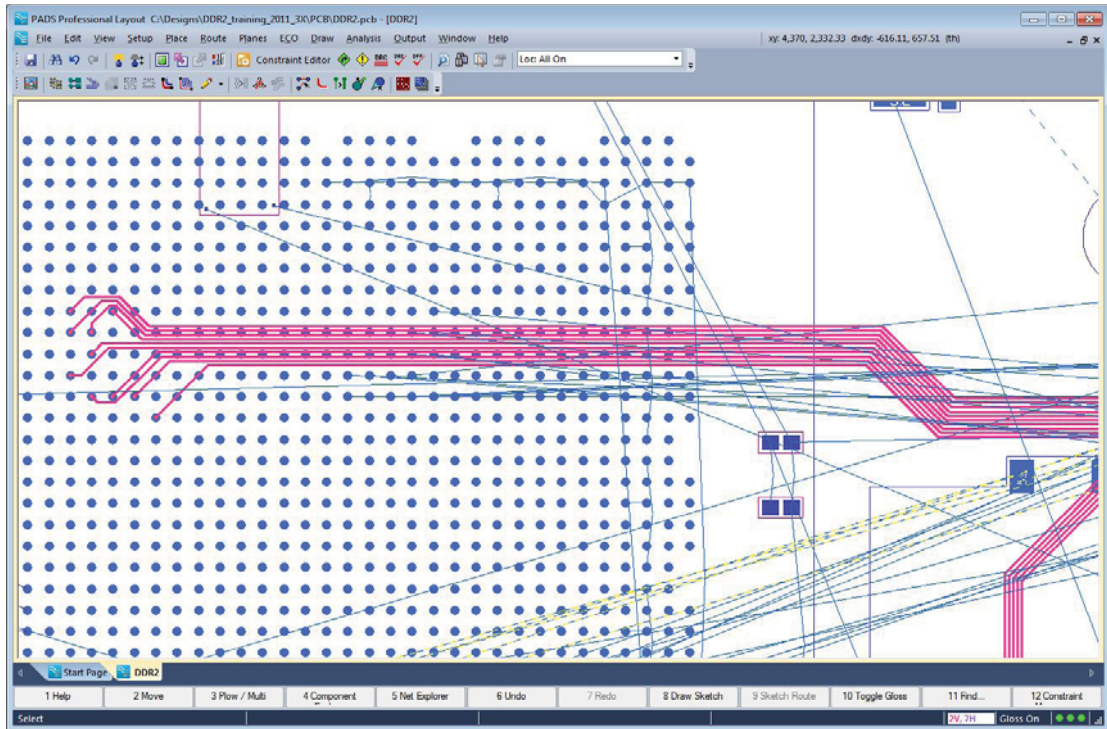


Figure 5: Sketch routing serial nets in packed mode

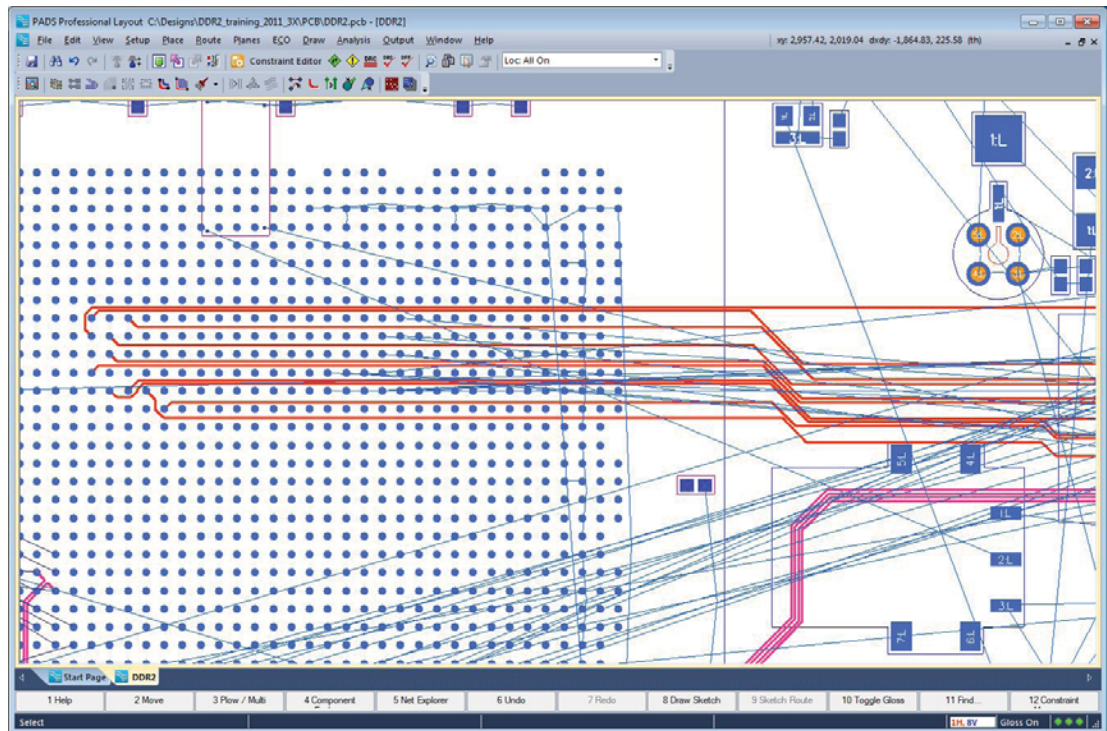


Figure 6: Sketch routing serial nets in unpacked mode

WHAT MAKES SKETCH ROUTING SO EFFICIENT?

Sketch paths are easy to draw. The direction in which the path is sketched determines the start pins and end pins. If necessary, the sketch router will consider up to ten different approaches before completing the routes for the selected nets, yet it only takes a moment to complete. Each approach considers the routing results for each pin escape direction and then places the routes for the best resulting approach.

COMPRESSING

Once the optimal approach is determined, the sketch router runs passes that compress the nets towards the pins. This ensures that the route's pin escapes are optimized to accommodate further design routing.

CENTRALIZING

Next the sketch router centers the routes between the compressed pin escapes surrounding the designer-drawn sketch path. If no sketch path is drawn, the sketch router centralizes the routes between the compressed pin escapes.

GLOSSING

During the glossing pass, the sketch router ensures that routes are as direct as possible by attempting to minimize trace segments.

WHAT IF THE SKETCH ROUTER IS UNABLE TO ROUTE A NET?

If sketch routing cannot complete 100% of the routes in a given bundle of nets, the designer can use real-trace routing and dynamic push-and-shove to complete the route.

REAL-TRACE ROUTING

When individual nets need to be routed, real-trace routing minimizes the effort of routing single-ended and differential pair nets by having the traces flow from the mouse as it moves—no additional clicks needed, not even to complete the route! Real trace routing automation guides the routing with dynamic visual feedback while pushing and shoving unfixed vias and traces out of the way, even clearing plane areas as you route.

DYNAMIC PUSH-AND-SHOVE

To move a large set of routes, even across rule areas, use dynamic push-and-shove for smooth, quick movement that automatically removes extra segments and maintains high quality.

CONCLUSION

Anybody who has plugged a local destination into their GPS and received questionable route suggestions has likely discovered that, as advanced as the technology has become, it cannot replace the familiarity with the roads that comes with driving on them every day.

Ultimately you, the experienced driver, must choose the path that is best.

It's the same with PCB routing. As useful as automation can be, there is still no replacement for the knowledge and experience of a proficient PCB designer (much to the relief of said designers). We trust our experience to give guidance and to make everything 'look right.' But time is a critical concern these days. Assisted routing, automated by the sketch routing environment in PADS Professional, enables PCB designers to easily route high-quality, rules-driven designs over 30 times faster than manually routing, all with the quality and the look and feel of a hand-routed PCB design. By rethinking automation, we've created a way for advanced routing technology to work in tandem with the knowledge and vision of individual PCB designers.

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