The Proto Labs
Journal
2008 ISSUE 2

SPECIAL ISSUE
How information molds our industry

Case study:
Healthsense slashes time-to-market

The Healthsense™ eNeighbor monitors activity in the home and generates a call for help.

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Built on information

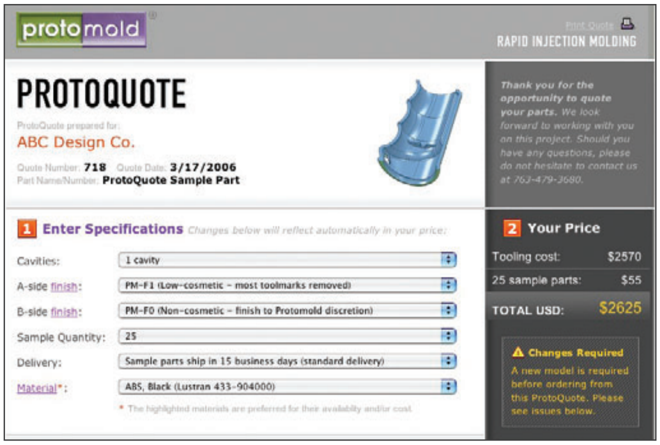
The Protomold and First Cut Prototype divisions of Proto Labs produce plastic prototypes and modest-size runs of production parts. Sure, we're very fast at what we do, but if you simply look at the parts we send to our customers, there's little to distinguish them from the parts that would come from another injection molding or machining vendor.

If you were to walk around our production floor, you wouldn't find equipment that you couldn't find in someone else's plant. And yet, there is that not-so-small matter of being the world's fastest custom manufacturer of injection molded and machined parts. So what, exactly, differentiates our operation from the others? The answer is that we have built our business around advanced ways to embody, transmit, and process information.

> "… we have built our business around advanced ways to embody, transmit, and process information."

Customers embody their designs in the form of 3D CAD solid models. Because our systems are designed to accommodate design information in this form, our ProtoQuote® system can respond quickly with interactive quotes and detailed design feedback. If we need to suggest a change to the customer's design, it is presented in a rotatable, color-coded, 3D illustration. If our ProtoFlow® system detects a potential mold-fill problem, it is demonstrated to the customer in an animated color simulation in their ProtoQuote. And because our quoting and analysis process is largely automated, it is fast and free.

We use the transmission capacity of the Web to make it very easy to find and do business with us, enhance our business relationships, educate design engineers about the processes we use, and collaborate with them in the production of their parts. Instead of just faxing a paper quote, we take advantage of the Internet's "fat pipe" to keep the process interactive, allow the designer to explore alternatives, and provide design feedback as though we were across a desk rather than across a continent.



Our ProtoQuote system can respond quickly with interactive quotes and detailed design feedback.

Finally, to process all this information, we have implemented a supercomputing compute cluster, which, besides quoting and analyzing, automates many of our business and manufacturing processes. The fact that just 10 years ago this cluster would have been the fastest computer system in the world is one more example of how quickly information systems have changed.

So that's how we've built our business: using information technology to embody, transmit, and process data. Oh, and we also make great plastic parts faster than anyone else. This issue of *The Proto Labs Journal* focuses on information and its importance to our business and yours. We hope you find it useful.

Proto Labs' 1.9 teraflop compute cluster.

Brad Cleveland
President & CEO
brad.cleveland@protolabs.com

Form, fit, function, and feasibility

The prototype as information

A lot of information is required to create a prototype. At the same time, however, a prototype embodies information — so much, in fact, that there is no other way the equivalent information could be stored and conveyed. This information falls into four categories: **form, fit, function, and feasibility.**

Form

Form is how a part looks and feels. Take one of the most common plastic parts we encounter in a day, the shell of an electronic device. We may not consciously notice, but its shape, texture, appearance, perceived weight and even temperature are all critical to our experience of the product. Shape can be approximated by a variety of processes, but the other factors depend on the material from which, and process by which, a prototype is made, which is a good argument for using production-type materials and processes.

Fit

Fit, of course, is how a part interacts with other components. Do the edges and bolt holes line up? Do the snaps hold? Are the seams waterproof? What looks right on paper or screen may not work after the resin shrinks or warps, if fine features don't hold, or if the resin isn't as rigid as expected. As with form, answers can only come from a prototype made of the material and by the process that will be used in production.

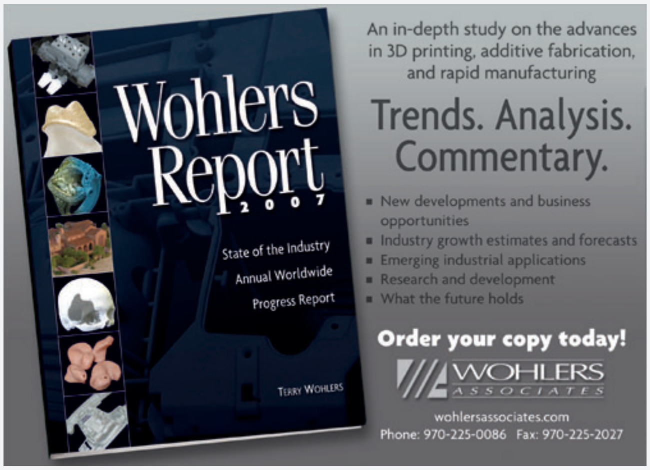
Function

Function—the strength, elasticity, chemical resistance, and other performance measures—of a part must be determined by testing, and depend heavily on the characteristics of the resin from which a part is made. Production parts can be made from hundreds of resins. Prototyping processes like Protomold's injection molding and First Cut's CNC machining also offer a wide variety of resins. But layering processes like stereolithography, selective laser sintering, and fused deposition modeling require very specific resins and probably not those that will be used in production. As a result, prototypes made by injection molding and CNC machining give more accurate information regarding function than layering processes can.

Feasibility

Finally, there is the matter of feasibility. This is how successfully and cost-effectively parts can be made by your chosen production method. Clearly, a prototyping method that uses the same materials and process as the production process, as Protomold does for injection molding and First Cut Prototype does for CNC machining, will help answer those questions. Other prototyping methods cannot.

Bottom line? The earlier in the development process you introduce the materials and processes you will use in production, the sooner you'll be able to identify and address issues of form, fit, function, and feasibility.



BACK TO THE FUTURE
via automated toolpath generation

Once upon a time prototyping was a labor-intensive manual process. Originals were laboriously carved out of wood, modeled in clay, or machined by hand. The cost of creating a prototype may have been small compared to that of setting up machinery for mass production, but prototyping was still a slow, costly, labor-intensive process ...

Then came digital automation. One of the first areas impacted was machining. Highly skilled machinist/programmers could develop toolpaths that would produce identical items in a variety of materials through computer numeric control (CNC) of machine tools. Suddenly, machining became an unattended process and skilled labor moved from manufacturing to the programming of toolpaths. The problem was that developing the program for the computer took a great deal of specialized skill and a great deal of the programmer's time. That made the process cost-effective for production, but still not economical for prototyping, where the small number of copies couldn't justify the cost of developing the program.

To overcome what was essentially a software problem (i.e. the lack of computationally efficient automated toolpath-generation algorithms for multi-axis CNC machining), clever engineers invented new manufacturing processes such as stereolithography (SLA), selective laser sintering (SLS), and fused deposition modeling (FDM) that were easier to support from a toolpath conversion point of view, due to the way they built plastic-like parts in even, predictable layers.

Using a 1.9 teraflop multi-node compute cluster, First Cut Prototype developed proprietary software to convert customers' 3D CAD models directly to toolpath files for machining.

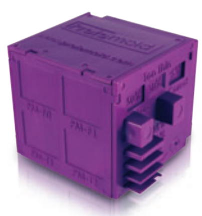
So in this manner, the software problem became dramatically easier, and the result was an automated ability to convert CAD models into a complete set of toolpaths for these new processes, which fundamentally enabled the entire "rapid prototyping" (RP) industry to flourish.

Unfortunately, the parts produced by RP processes are still something of a mixed blessing. Rapid prototyping processes are indeed fast and inexpensive, and they eliminate a lot of expensive labor, but they support very few resins, leave jagged steps at the edges of the layers, and offer little in the way of surface cosmetics. And while they can approximate the desired shape, the layering process often leaves parts weak and brittle compared to parts injection molded or machined from solid stock. They are certainly sometimes adequate for early, conceptual stages of product development, but tend to come up short when any kind of functional testing is required.

Fortunately, the same trend in software development that enabled additive rapid prototyping has been extended to the automated development of toolpaths for CNC machining. Using a 1.9 teraflop multi-node compute cluster, First Cut Prototype developed proprietary software to convert customers' 3D CAD models directly to toolpath files for machining. The result is the best of both worlds: high-quality parts machined directly from solid stock in a wide variety of resins at speeds and prices comparable to those of rapid prototyping. These are strong enough for functional testing, have excellent cosmetics, can use most standard production resins, and can be made in as little as one day. Pretty much everything we ever really wanted in a prototyping process in the first place.

A ~~picture~~ *model* is worth a ~~thousand~~ *million* words

While seeing may be believing, we at Proto Labs are committed to the idea that holding something in your hand conveys information that no picture—not even a 3D CAD model—can. Of course, we have nothing against words, as evidenced by the Journal you are reading and the other online and hard-copy publications we produce. But we're lucky enough to have extensive production facilities, so every once in a while, between customer jobs, we like to see how much information we can pack into a molded model of our own.



You may have seen **The Sample Cube**, a flat, six-panel demo piece that folds and locks into a cube. Its various surfaces demonstrate rib thicknesses, surface finishes, and boss designs, along with little tricks like a horizontal axle carrier that could be made in a two-piece mold. The entire piece is also an excellent demonstration of living hinges and self-locking clips.

Next came **The Resin Puzzle**, a bag of nine plastic pieces, each molded in a different resin, that could be assembled into a multi-colored cube. We know it can be done because we've seen several completed cubes on desks around the office. The folks who own those completed cubes all claim it was easy, but none of them is willing to take it apart and demonstrate the assembly process.

Which brings us to our latest production, **The Demo Mold**. (If data about data is "metadata," could a mold of a mold be properly called a "metamold?") Until now, we've focused on what comes out of a mold, but now we'd like to focus on the features and operation of the mold itself. This five part model consists of A- and B-side mold halves, a side action cam that actually operates within the mold, the part that would be produced in the mold, and a multi-pin ejector that pushes the part off the B-side mold half. Open it up and you'll see a lot of the features we write about: runners, sprues, gates, cores, and more. And the part itself, while relatively simple, demonstrates the formation of a self latching hook with the use of a sliding shutoff.

We can't promise "hours of fun," but it is a quick way to orient yourself to the operations of the injection molding process. **Get yours today.** It's free and can be ordered at www.protomold.com/demomold. It's as educational as the Resin Puzzle and will take up a lot less of your time.

FREE WEB OFFERS

Our Web site also offers free access to:

- Back issues of **The Proto Labs Journal**
- **Design guidelines** pertaining to injection molding and our specific processes
- **Design tips**, available as a free monthly e-mail service and in downloadable compilations
- **A resin guide** with detailed information on almost 100 Protomold-stocked resins and links to the vast MatWeb and IDES materials databases
- **Plastics glossary and FAQ sections**

A brief history of information

(as applied to Proto Labs)

For all its power, information can be fragile stuff.

A tiny break in a thousand-mile circuit will stop it dead. A linguistic disconnect between communicators can halt its flow or corrupt its content beyond recognition. And without the right equipment—biological or electronic—it cannot be processed. In other words, for information to work, a lot of things must be in place.

At Proto Labs, our business model depends on the intake, processing, output, and use of information. Our contribution to that model—some unique and powerful software—stands on a foundation of preexisting technology. If it weren't for 3D CAD modeling and the Internet, Proto Labs wouldn't exist.

3D CAD

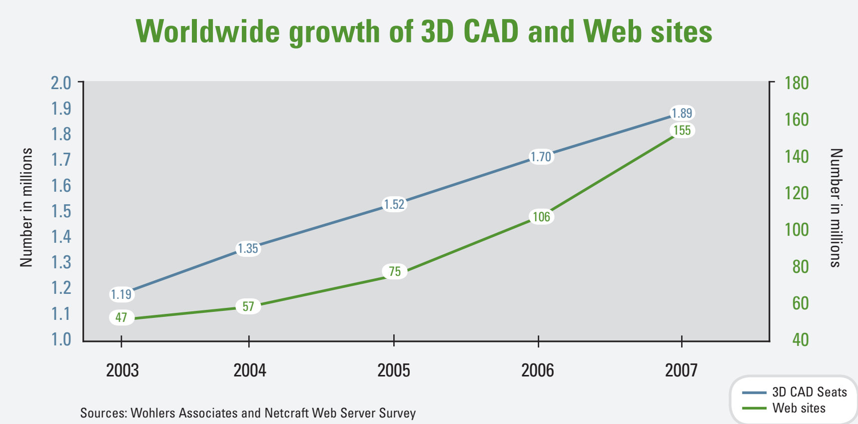
Early work in computer aided design (CAD) began in the 1960s in the auto and aircraft industries. More widely available packages like AutoCAD® were introduced in the early 1980s, followed by Pro/ENGINEER® in the late '80s and SolidWorks® in the mid-'90s, to name a few. Today, most designers use some form of CAD, and more turn from 2D to 3D implementations every day. 3D CAD is the standard input for both Protomold's injection molding process and First Cut Prototype's CNC machining process.

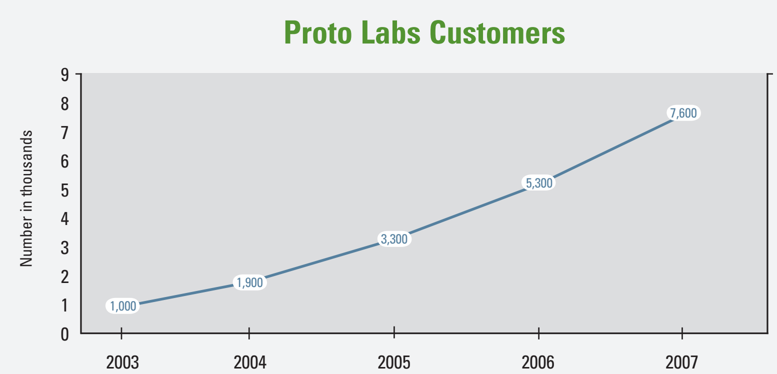
The Internet

Early computers relied on networks to connect "dumb" terminals to centralized mainframes. In the early 1960s, as dedicated networks grew, computer scientists began exploring the possibility of developing interoperability among networks. A major milestone in that process was the introduction of the Internet Protocol Suite, which allowed existing networks to implement a standard and communicate with one another regardless of their individual designs and internal protocols.

TCP/IP became the ARPANET standard in 1983, but the real beginning of the World Wide Web as we know it today came in 1993 with the introduction of the Mosaic graphical browser (which was, in fact, funded through then-Senator Al Gore's High Performance Computing and Communication Act of 1991). Mosaic was eventually superseded by Netscape Navigator, which, in turn, gave way to Microsoft's Internet Explorer and various competing browsers. By making the Internet a user-friendly, global resource, the Web enabled Proto Labs to provide customers with massive amounts of information, and interactive overnight quotes and design analysis, and offer quick-turnaround injection molding and CNC machining direct from 3D CAD models.

The following graphs illustrate the similar, dramatic ramp-ups experienced by 3D CAD, Web sites and Proto Labs US customers from 2003 to 2007.





Healthsense™ slashes time-to-market with Proto Labs

The eNeighbor monitors activity in the home and generates a call for help.

> **"... they provide all the prototype and low-volume production parts we need ..."**

Mechanical Designer Dave Anderson of Healthsense™ is a fan of both the Protomold® and First Cut Prototype® divisions of Proto Labs. "Three years ago I looked at ProtoQuote®, Protomold's free online quoting tool," says Anderson. "I uploaded a CAD model and was very impressed with what I got back. Within a day I had a detailed quote along with feedback on the moldability and design of my model. I could adjust parameters like finish, resin, and quantity, and the pricing changed while I watched. And ProtoQuote's 3D viewer pointed out where I could adjust and improve the design." Healthsense, located in Mendota Heights, Minnesota, develops systems for senior living facilities providing independent living and assisted living services, along with systems that allow older individuals to stay in their own residences. "Within a care facility, a pendant worn by each resident broadcasts a radio signal allowing the resident's location to be determined by triangulation across multiple WiFi access points," says Vice President of Research and Development Dan Vatland. "A push-button request for help is forwarded over the Internet to Healthsense 24-hour data centers, and on-site help is dispatched."

In 2006, Healthsense rolled out eNeighbor, a new platform developed with a grant from NIH. Under this program, sensors are placed around the user's home to monitor activities. The system watches for anomalies like unusually long periods of inactivity, and can generate a call for help, which is sent to a neighbor. "We first used Protomold with the eNeighbor system," says Anderson. "We didn't want to invest in expensive steel molds, but we needed a product we could take to market. Protomold made parts for 1000 pendants, quickly and inexpensively."

"We started working with First Cut Prototype, Proto Labs' quick-turn CNC-machining division, when we needed five sets of prototypes for functional testing of a new device," says Vatland. Their price was reasonable, they could produce parts in one day, and their parts were ideal for functional testing. Their prototypes cost a little more than FDM (fused deposition modeling), but they offer a wide variety of materials, allowing us to perform testing we couldn't do with FDM. It was a complex design, and along with fit we had to confirm details like water tightness and get feedback on issues like 'look and feel.' FDM parts are too rough for a lot of those tests, and SLA (stereolithography) parts are too brittle."

"We have nothing against rapid prototyping," says Anderson. "SLA is quick and inexpensive, but you can't use it for functional testing. And with FDM's ABS-type material the finer features didn't hold up. First Cut's machined parts had no such problems. In the future, we would probably use First Cut for prototypes. Then we would contact Protomold if we needed production parts while we were waiting for high-volume steel tooling. Together, they provide all the prototype and low-volume production parts we need, in a variety of resins at reasonable prices."

What's New

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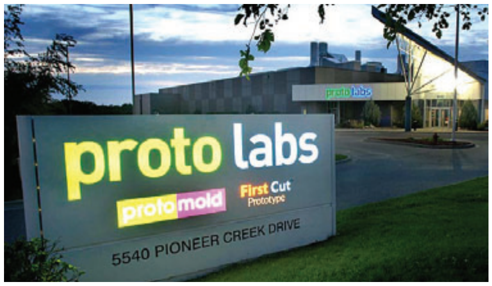


WHAT'S NEW AT PROTO LABS?

The portal is open

Since so much of our work is for returning customers, we set out to develop customer portals where First Cut Prototype and Protomold customers could log in, place and track orders, and check their accounts. After months of design, the First Cut portal is now online and accessible at https://portal.firstcut.com. The new Protomold portal will follow shortly. We have great plans for how this can make doing business with Proto Labs easier and we welcome your comments.

Everybody needs an attic

Since moving our offices to our new 90,000 square feet headquarters building, we were left wondering what to do with all that former desk space at Plant 1, where our Protomold milling and molding operations remain. We didn't have to wonder for long. The answer was obvious: mold storage.

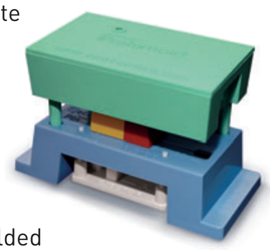
No matter how fast our milling and molding operations grow, our stock of customer molds grows faster. In fact, besides converting our former office space for additional storage, we've taken over the 6,000 square feet of space in that building that wasn't already ours and knocked down more walls, giving us a full 36,000 square feet for Protomold operations and storage in that building, plus the other roughly 30,000 square feet in Plant 2 down the street. First Cut Prototype and administrative operations will continue to grow in the new headquarters building.

Big molds are a big hit

We keep working to serve you better and meet more of your needs. You asked for bigger molds and we delivered, and customer response has been strong. So we are actively adding equipment to let us produce more big molds to continue to keep up with demand.

Get your free Demo Mold

In case you missed the note on page 5, we are offering a free injection molded model of an injection mold. This five-part model includes two mold halves, a side action cam, ejectors, and a model molded part and demonstrates how our process works. Get yours today. It's free. It's informative. And you can order one of your very own at www.protomold.com/demomold.



We'll see you at ...

Our next tradeshow appearance will be at Atlantic Design & Manufacturing in New York on June 3-5. Look for Protomold in Booth 300 and First Cut Prototype in Booth 302.