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Fiero Focus

THE NEW FIERO GT TAILLIGHT LENSES

Fiero GT Taillight Lenses and a Mouse Called George

The story of making GM reproduction lens for the Pontiac Fiero GT

Why Me?

To really enjoy the results of this project, you need to get to know the events along the way. Here is that story.

The fastback Fiero GT is an unusual car because it is innovative in many ways, yet not all that rare and not difficult for which to find parts. Good or bad, Fieros are priced reasonably and popular to restore or modify.

I own an '87 Fiero GT (Images 1a & 1b) with broken and delaminated taillight lenses. The Fiero GT taillight lenses are notorious for delaminating and over time the materials originally used became brittle and easily broken. Leaning on them or pushing on them inevitably leads to damage (Image 2).

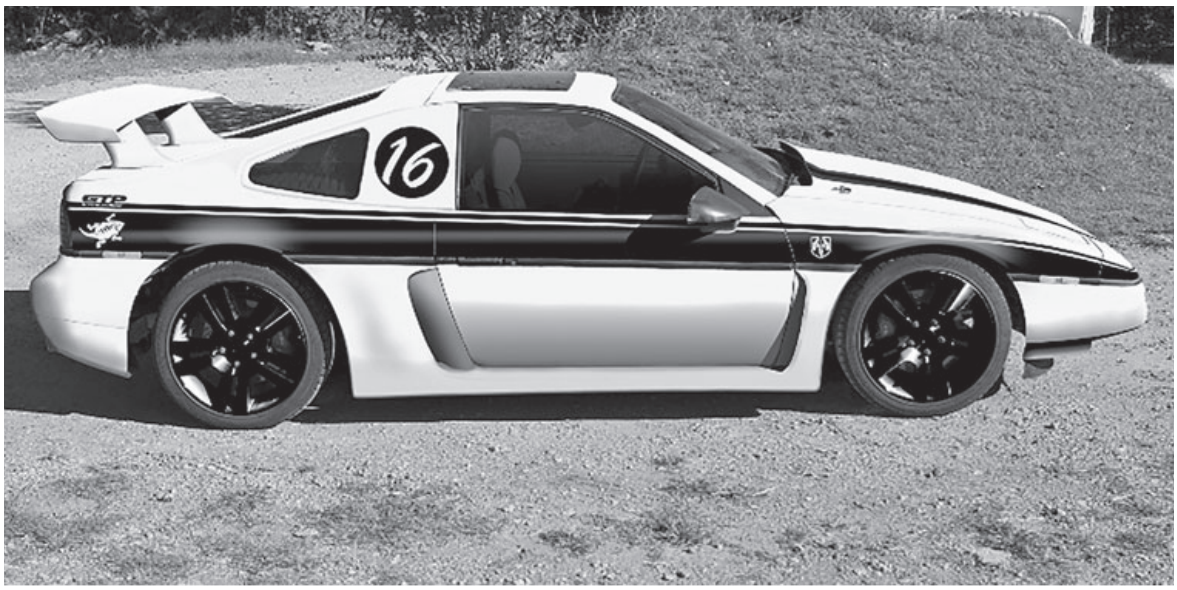
GM designed the lens cover as two parts, the first being the clear base and the second being the overmold (Images 3 &4). For the number of lenses GM had to make, this was likely the most economical way to do it and I doubt they anticipated the delamination issue at the time they designed the lens. Our new design is manufactured differently so the decoration will never delaminate and we chose a polycarbonate material due to its toughness.

An overmold is a process that lays hot plastic medium over the top of an existing substrate and bonds the two features together. The process is fast, intuitive and probably would have worked well had the car not lasted more than an average American car of the day. GM had a solution, but it complicated the delamination problem. With the hot sun shining on the lens, the expansion ratio of the black overmold compared to the clear was different and created significant stresses in the bond between the two materials. GM didn't have (much of) any UV protection built into the rather thin lens. It is very unlikely they could have anticipated such a problem. To my knowledge, no other GM product had this type of overmold decoration.

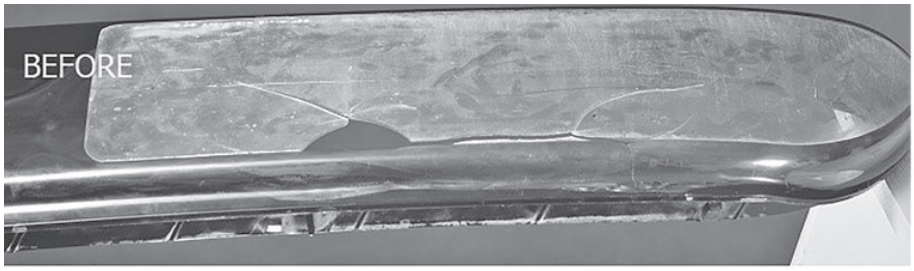
(Image 1a) Keith's '87 Fiero GT currently

The beginning of the solution started with some research after further damage was done to my already ragged lenses. When I began, I believed the lenses would be as easy to replace as are many of the other Fiero parts. Like most people, I went to the Internet in search of a set of nice-looking taillight lenses. Wrong! Not only were there few to be found, but most already had damage. If the damage was minimal, they could cost over $1,000—two-thirds what I paid for my Fiero! There were no undamaged lenses to be found anywhere. A sudden realization came over me that my car was going to have ugly taillight lenses and once car enthusiasts started looking at it, all they would see were the dreadful hole, cracks and delamination—no doubt a focal point when looking at the backside of my Fiero.

I had already



(Image 1b) What Keith's Fiero will look like soon (artist's rendering)



(Image 2) Typical GT taillight lens cover

been on Pennock's Fiero Forum (fiero.nl) a few times and thought surely there would be someone who had an answer to this problem. All I found were threads of half-baked solutions done on a low budget, and in some cases, funds had been pilfered and time wasted trying to cut corners. It was a sensitive topic leading to spirited rhetoric and I quickly dismissed using others' ideas to solve my problem.

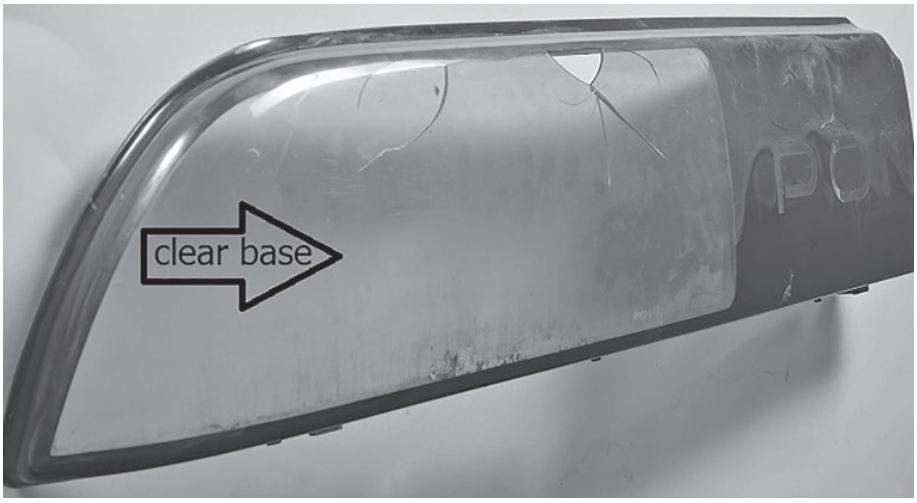
Different methods had been tried and failed to really address *all* the problems with the lenses. There was little to be gained by doing more than a cursory investigation into their failures or listening to a litany of unsolicited advice and surly remarks leftover from a previous failed venture. Positive and negative feedback, solicited or not, motivated me to move forward until I explored every combination of budget, materials, methods and results. In the back of my mind I suspected the solution, but only as a last resort.

I looked all over the U.S. for a project manager to help guide me and maybe see something I missed. RPM Prototyping out of Chicago was one of the few companies to return my call and David expressed enough interest to hear me out and manage the project. The Fiero community needed a solution and one they could afford.

By this time, I had a rapport with a well-established parts supplier, Rodney Dickman (rodneydickman.com). I flew to Chicago and met Rodney and David at RPM. We discussed several options within a reasonable budget but left the meeting with no real solution. Most of the ideas had either been visited and dismissed, or tried but didn't resolve all the problems. It didn't take long to face the inevitable solution and use injection molding. It met all the criteria for our solution except one—it cast a dark shadow over the budget.

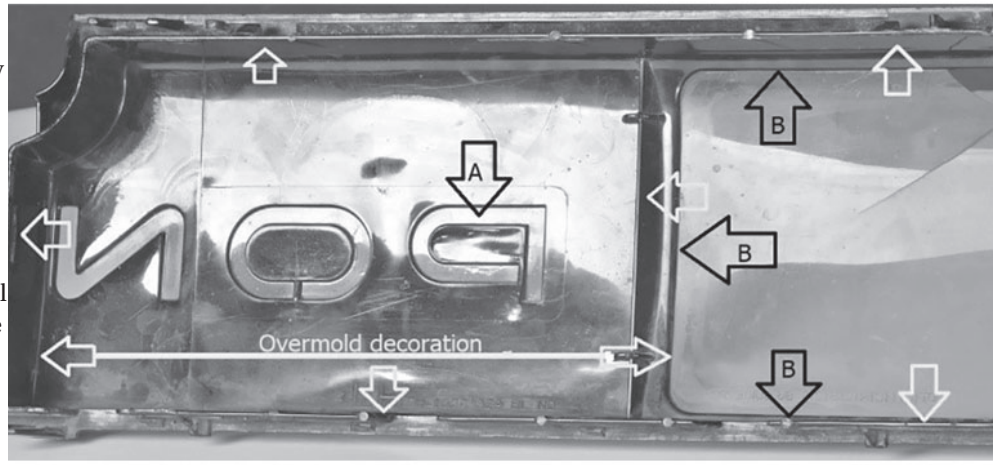
My financial portfolio had grown over the years and I felt I could dip into my retirement and use some of the money I'd stashed and managed. After a conference with my financial advisor, we found I could leverage my own portfolio and borrow from myself, at the same time continuing to collect income on the margin and paying a low percentage of interest since it was, after all, my own money. I wasn't required to pay it back immediately, so I had time to build a firm foundation for the business. It pays to have a sharp and austere financial advisor that looks out for the best interest of the client. My financial planning efforts were paying off. I'd worked my life doing what I wanted and at the same time built a portfolio I could now make work for me.

I committed to the proper solution of injection molding using polycarbonate material, so the budget would have to be open-ended; I wasn't going to cut corners. As with any injection molded product, the building block foundation was the "tool", or the device that makes the molded product. Capable of making tens of thousands of cycles, the tool is expensive, complicated, made of steel and required a 400-ton press to inject it with our preferred polycarbonate material. Because of the cutback (also known as "the bulbous end", where the sides come over and into the back) originally designed into the end of the lenses, parts had to slide and move then realign perfectly every cycle (Images 5 & 6).

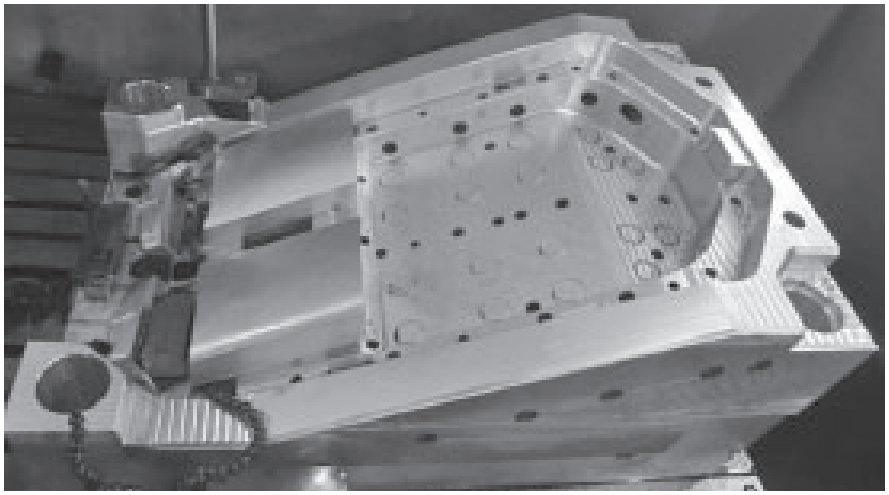


(Image 3) Typical OEM lens cover after 30 years

Everything had to be precise and the raw materials had to come from a list of products approved for use in the auto-



(Image 4) Arrows show overmold



(Image 5) Part of the tool

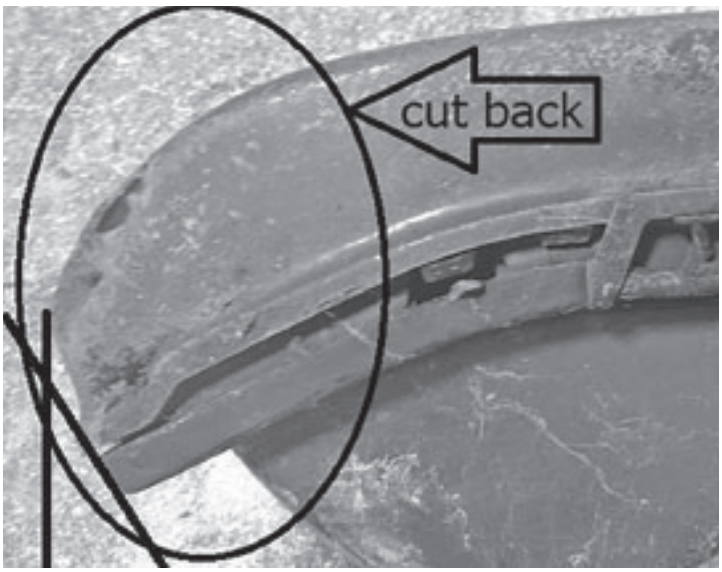
motive industry. I canvassed the lower 48 states for injection molding companies capable of handling such a large, clear and complicated part. A maelstrom of candidates filled my web browser screen and I feel like I called every one of them. The prices varied, but generally speaking, were all about the same. The tool turned out to be more complicated then I'd thought because of the previously mentioned cutback. Estimates were around $150,000 and didn't include decorating the lenses (the black painted border around the perimeter and the PONTIAC lettering). I still didn't have a solution for that because I did not want anything that would delaminate or degrade over years of punishing UV exposure.

I wanted "Made in the USA" associated with the lenses. I finally found Leonard Koren, a tool maker at International Mold and Production, LLC out of Grayslake, IL willing to take on the job for what happened to be the best price. Because of the size of the lens, we had to have the tool and the injecting done in China. I had to give up "Made in the USA" for "Made in China" or the project just wasn't going to happen.

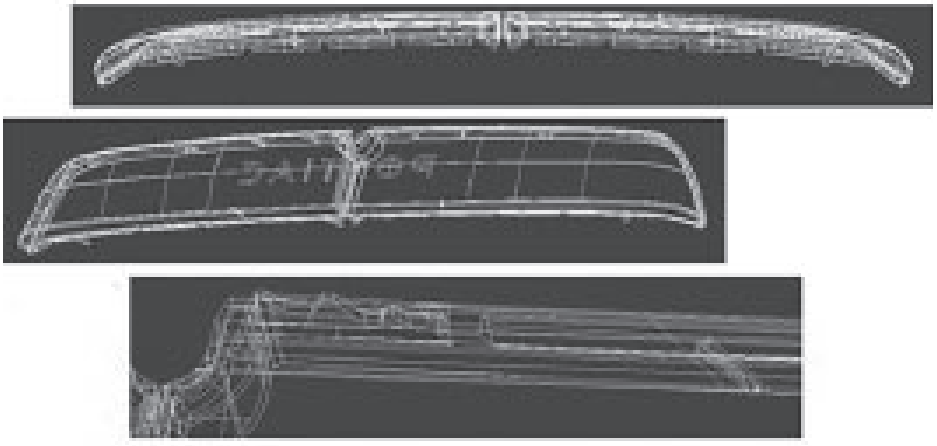
I gathered all the numbers and information I could to present to my financial adviser. After a heart-to-heart talk with her, she was satisfied with my simple business plan with a guess at the return. I did not have all the numbers, but we both knew the reality was that it was going to cost more than we predicted. We decided I could start the research and development phase. I was going to finance the whole project with some fancy bookkeeping, being frugal, but without cutting corners.

Technology has changed since 1986 ½ when the fastback GT model was first introduced. Better designing tools, better CNC machines, and better raw materials rounded out what makes a beautiful, robust product. We started by having a laser scan of the lens and converting it into a digital file the CNC machine could understand (Image 7).

Using the same software, we removed imperfections in the old lens. In some cases, this included holes, cracks and waves in the lens. We made minor modifications to the design, necessary to eliminate the black overmold, and we realized compromises were required to eradicate the delamination issue. Originally, the lens was designed by draftsman and sculpted, so there were a certain number of imperfections in the design of not only the lens but also the "PONTIAC" lettering; this all had to be digitally removed (Image 8). Time is money and with the lenses being so large, a significant amount of work was necessary to smooth them out, unify and blend the curved sides and improve the design without compromising the original design.



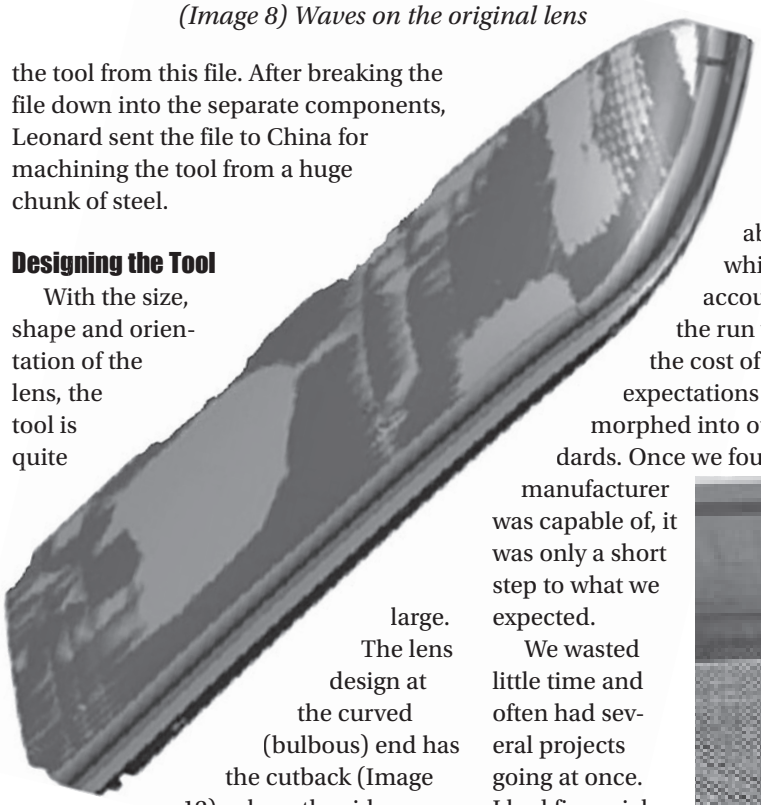
(Image 6) The cutback of "the bulbus end"



(Image 7) Digital imaging of what the laser saw

After having all the scanning and editing done, I was committed. I couldn't walk away now and save face in the Fiero community. The project was feasible and the costs were, for the most part, irrelevant. We created a 3D model, verified the changes and made it possible to actually fit the lens to the reflective housing, checking for correct fitment (Images 9, 10 & 11). Later, the tool maker designed

(Image 8) Waves on the original lens



the tool from this file. After breaking the file down into the separate components, Leonard sent the file to China for machining the tool from a huge chunk of steel.

Designing the Tool

With the size, shape and orientation of the lens, the tool is quite large. The lens design at the curved (bulbous) end has the cutback (Image 12), where the side curves back on itself. This cutback required the mold to be more complicated and have a part that moves to allow the ejection of the molded piece (Image 13). The more complex the tool, the more it costs to not only design, but also to machine the steel. The surface inside and outside of the "window" had to be polished to the highest of industry standards. This surface gives the lens its optical clarity.

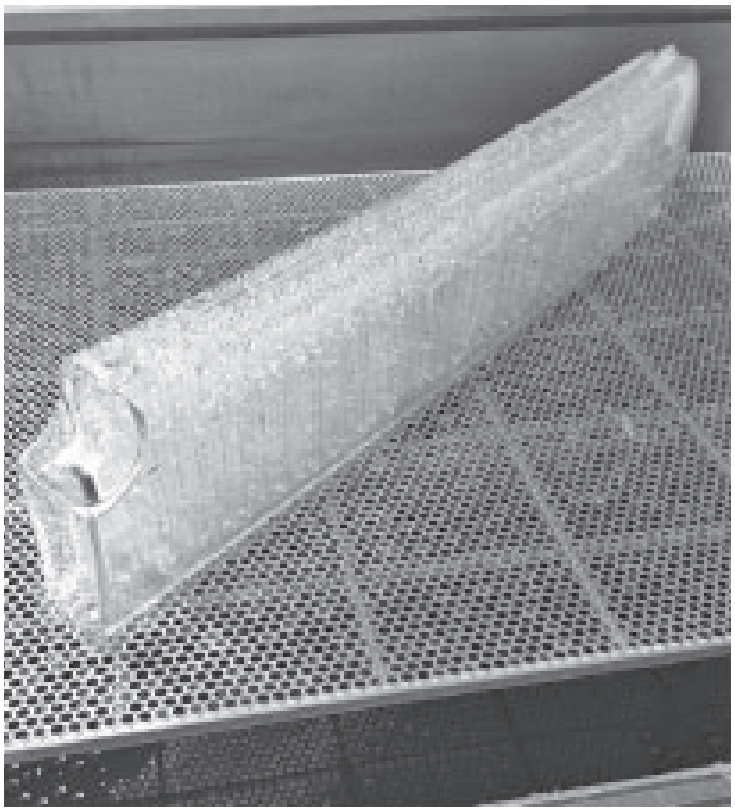
Refining the tool to get the desired results required several runs. I began calling these "T" series lenses for "Test" lenses; group one was T1 and so on. Generally, the customer (me) is allocated three test runs to make corrections and communicate with the tool maker the changes necessary to meet our expectations. The T series required more iterations and the cost was absorbed by the tool vendor. With obvious cultural and communication differences, it required a bit more effort to reach our expectations. I had a very accommodating tool maker!

Throughout these changes we gradually developed what we thought were reasonable expectations while taking into account how small the run would be and the cost of the tool. These expectations gradually morphed into our QA standards. Once we found out what the manufacturer was capable of, it was only a short step to what we expected.

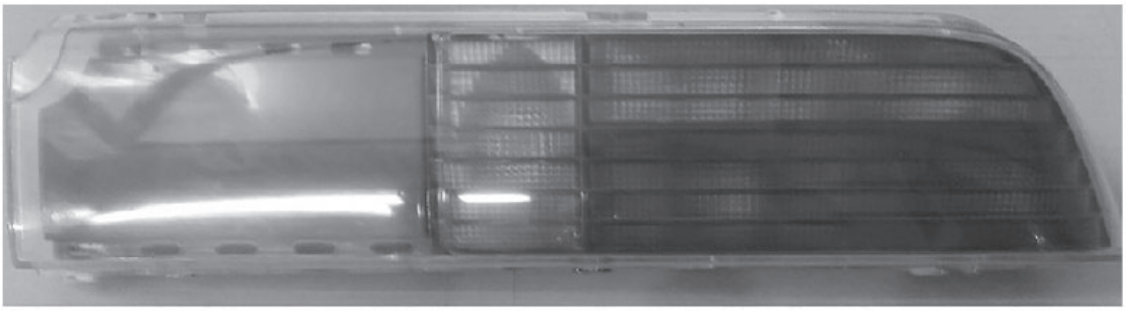
We wasted little time and often had several projects going at once. I had financial responsibilities; the tool maker had their tasks and the project supervisor had probably the most important and challenging part of the project—decorating the lenses.

The decorating process is proprietary even from me. Admittedly it makes me nervous, but it is proprietary, nevertheless. I now know through several iterations we had to come up with a robust coating that would stick permanently to polycarbonate and at the same time absorb the same expansion and contraction that caused the problems with the OEM lenses.

The process of decorating the lenses is labor intensive, but in the end, the result was a masterful and slightly improved version of the original concept. To my knowledge, the lenses were never completely designed by computer so there were not-so obvious flaws in the original



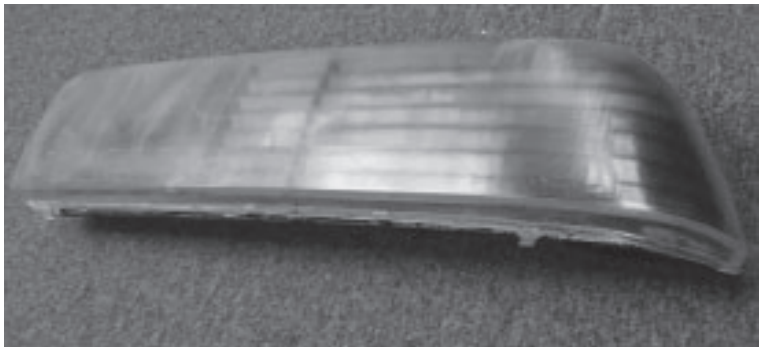
(Image 9) 3D model fresh from the printer



Hey guys! Here is the first prototype lens.
Obviously not decorated.

.....George

(Image 10) Face on a 3D printed prototype

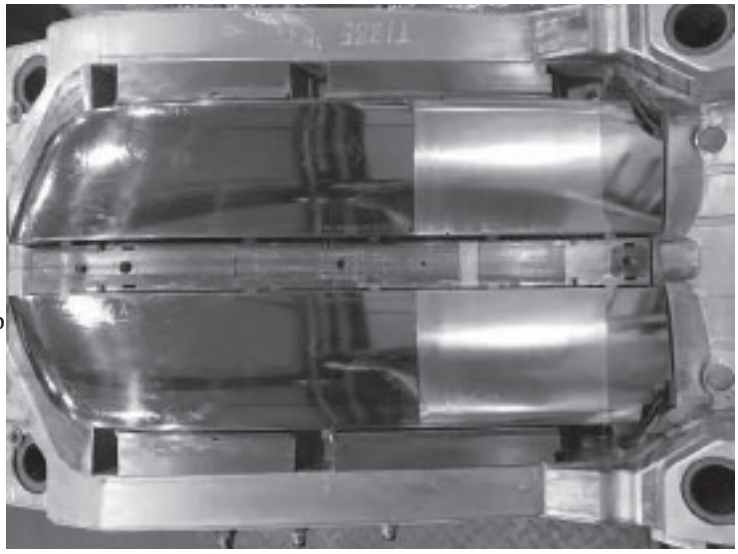


(Image 11) Three-quarter view of 3D printed prototype

"PONTIAC" lettering (now known as the "GOOD TIMES" font). We went through the letters and, using modern digital programs, removed tiny errors. One of the more interesting elements of the array of letters was the letter "O". All the other letters had openings in the letters to let the overmold push the black plastic into the mold for the letters, but to create balance between the two sides of the lens, GM cleverly widened the letter "O" and placed a space at the bottom for the black plastic to flow. The GOOD TIMES font doesn't have this style of "O", so we modified the font to create it. I found the original solution to the "O" ingenious and solved two problems with one simple solution (Image 14). Additionally, we modified all the widths of the letters so they were the same no matter where you measured the widths of their individual typographic anomalies.

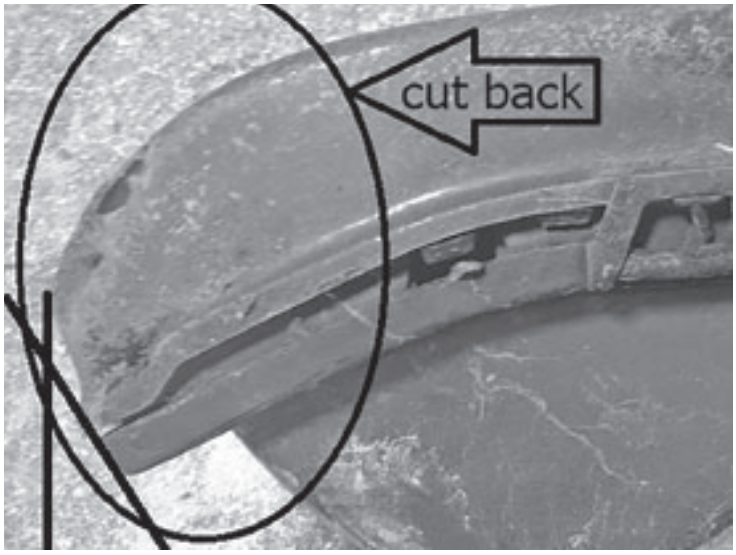
Decorating the lenses requires the lens, masking, a jig and a process to clean and prepare the surface for coating. Masking the window and the letters and at the same time maintaining the black on the side took some practice, but we finally decided on a design that worked well. I purchased a vinyl cutting machine and with help from the vendor, selected a material that works well for the process of masking the lenses for decoration. I cut the masking, prepare them and send them to the decorator.

One must test the ability of the coating to properly adhere to the polycarbonate. A standard test for this is to score quarter-inch squares into the coating and place a piece of good adhesive tape on it, then quickly rip the tape from the coating (Image 15). If no coating comes off on the tape, it would pass the test. We did several other abusive tests to the coating and it never failed. I have great confidence in the process.



(Image 12) Half of the tool with high polish

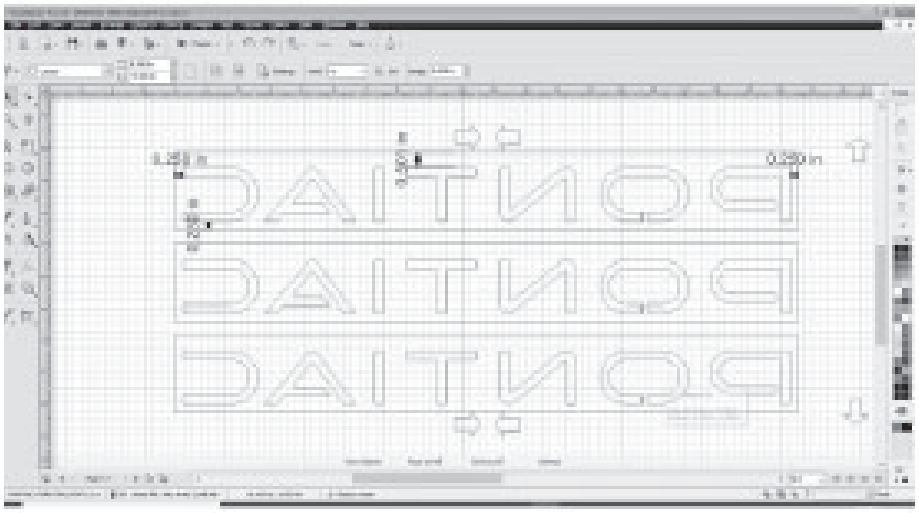
Through the entire development process, we tried to keep potential customers informed on Pennock's Fiero Forum and I often referred to my team as "we". Of course, I was referring to the team necessary to help bring these lenses to customers. I never built anything or even actively managed a project, but only supplied the financing, so I never felt comfortable taking all of the credit for the project. One day on Pennock's, a member posted a question wondering who this "we" is and wondering if I had a mouse in my pocket. This very short exchange gave birth to our favorite mascot; there was no question from the very beginning that the mouse's name was going to be George (Image 16).



(Image 13) The angle of cutback

To pay homage to this little fella, one must take at least a short look at the history of "the mouse"; it is a long and tangled one made of modifications over the generations. Originally, a Scotsman in 1785 named Robert Burns wrote the poem called "To a Mouse"—a wonderful poem especially when translated into The Queen's English. Later, George Steinbeck adopted the concept and referenced the poem's title in his book as "Of Mice and Men." Movies used Steinbeck's concept to present it on the screen. Later, Warner Brothers took (inconsistent) variations and built cartoons around numerous characters that we loved, petted, squeezed and called "George".

It wasn't a stretch to reach back in my memory and name our new mascot George. Simply, he is a little gray *Mus musculus*. We have all come to love George, who helps relay noncritical information to anxious customers. He has his own email address and people recognize him in their messages to us. He seems to keep a bit of humor moving during stressful times. (I usually include a small stuffed mouse with my lenses and have scared people at his realistic appearance, hanging from the instruction sheet.) Personally, I can't stand mice and have no bones about killing



(Image 14) OEM lettering

them—though I must admit it conjers up thoughts of George as I empty the trap.

But I digress! There exists a list of approved polycarbonates available to the automotive industry. These raw materials have been tested and approved to meet automotive industry standards for plastics used in applications such as ours. We had chosen a brand of raw material and used this to complete a prototype in December 2018, when we started the next phase of the development process.

At the end of every year, the powers that be review the list of materials. The Chinese New Year takes up much of January and the timing of both created a mess that delayed the project for several weeks. By this time our first choice for polycarbonate had dropped off the approved list and we had to start testing the mold again with a new material (Image 17).

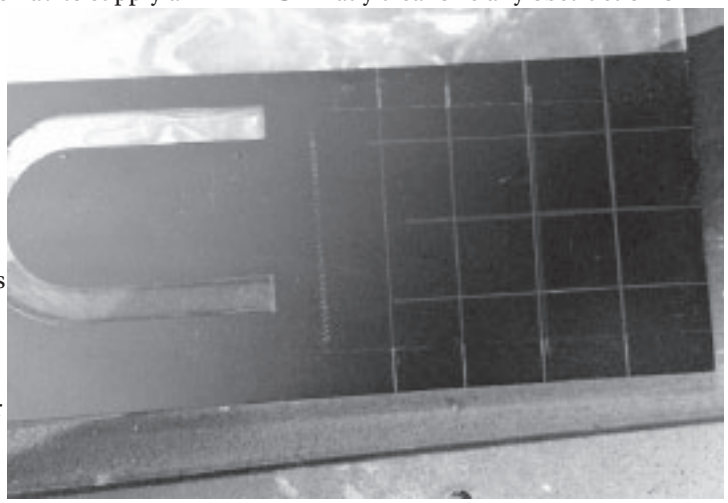
(Image 16)…George

The Dreaded Testing

GM's requirements were, in my opinion, intuitive and generally unnecessary. Essentially, we had to supply an independent lab with a final set of lens assemblies to determine if the lenses were clear. (Anyone could have held the lenses up to the light and seen the lenses were quite clear.) They insisted the clarity test was a pivotal part of their approval process. Lab costs were expensive; what did they test? GM insisted on testing the complete assembly: the housing with incandescent bulbs, the Fresnel lenses (the composite, yellow and red lens) and of course our new lens cover. We tried to explain to GM we were making only the lens cover and that was it.

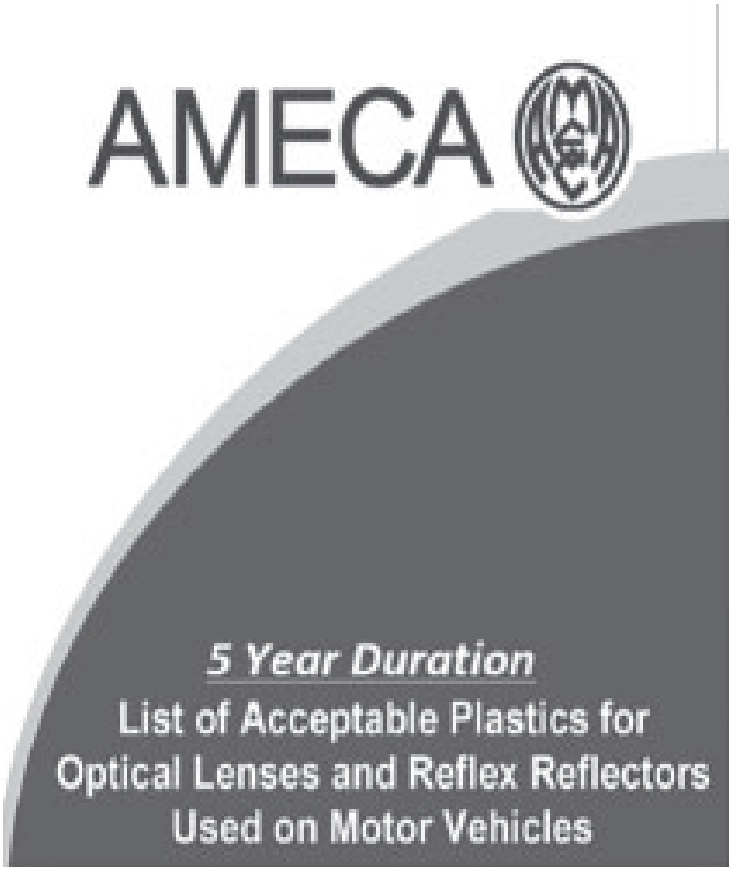
So, we tested the housing in an expensive device that held the assembly at the laboratory, and the test failed (Image 18). I was defiant with GM and reiterated our original allegation that the lens assembly had nothing to do with the lens cover. As we had predicted, the returned lab results verified the original reflector and Fresnel lenses were under established specification standards and putting a clear lens on the assembly could only improve it. Along with the receipt for the final payment to the lab, the lab results stated while the assembly did indeed fail, it failed with and without the lens making the net result delta 0; the lens was clear. Apparently, GM was satisfied but held firm that the test was necessary for approval. In the end, I cannot believe they didn't feel a bit embarrassed at requiring such an obvious conclusion.

From the beginning, we detected there might be a market for tinted lenses. GM flatly disallows any obstruction of light transmission through the cover of the assembly. I do agree that while it looks pretty cool, it can inhibit light transmission (by design) from the bulbs, making it less obvious that the driver is braking or turning, setting them up for a rear-end collision. GM was not going to approve any product that inhibits the transmission of the colored brake and turn signal lights. As it turns out, it was just as well we dropped the tinted lenses, as making them would have involved tinted raw material and inventory likely unsold because most people want OEM lenses.



(Image 15) Adhesion test

The infamous DOT identification requirement came to us through GM at the most inopportune time after testing. It took significant research to find out just what the DOT number was and how to go about getting it. Contacting the



(Image 17) The document containing the new, approved list of polycarbonates

DOT was met with blank stares and endless time spent listing to elevator music. We finally found out just what went into the DOT number: DOT is not a governing entity but does publish (somewhere) the requirements of newly manufactured components through which light flows (Images 19a & 19b).

This DOT number was fed into the CNC machine and incorporated into the mold. After stumbling across an article, we found the numbers were really quite meaningless but nevertheless required. The numbers reflected the number of bulbs (filaments) per light chamber, the name of the company making them and the year they were designed. That's it. We finally met GM's requirements for the DOT number, which meant we had to go through another iteration of testing to make sure the DOT number showed up as required. Of course, this meant another set in the "T" series of lenses. At this time we finally had a lens in our hands that we felt confident would please the staff at GM. We packed the lenses up and sent them to my point of contact at GM and waited.

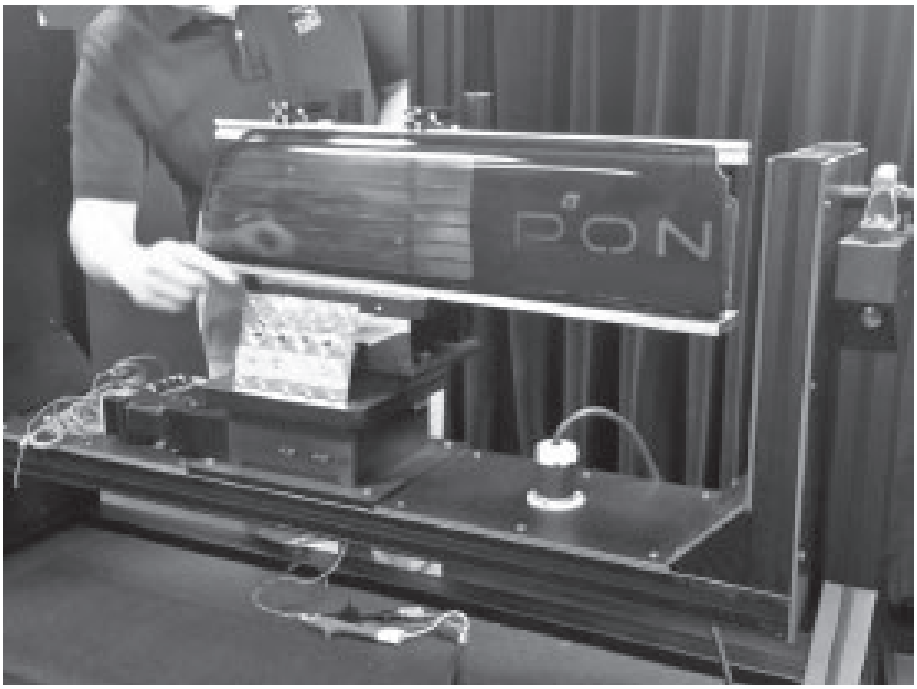
A lot of time was spent waiting. Negotiating the halls of GM was not really so much the problem; we had a good point of contact and she truly wanted the project to succeed. However, GM had recently taken back the process of vetting prospective projects for their restoration division and my project languished at the previous company responsible for this vetting process for several months until someone found the request for licensure in a pile of papers and forwarded it on to GM. GM had to build their vetting and licensing processes from the ground up; this is about when the project arrived on their doorstep. In the end, when they finally did get this project, it went about as quickly as it could in a very large organization, especially considering different departments were often in different cities.

We could do little during this vetting and licensing process, so we moved on to other things as if our project was going to be approved. We were confident. We continued to arrange financing and build a platform to do our bookkeeping and shipping. At the same time, we began building a base of customers offering them no-obligation preorders, which helped us with our business metrics. Doing this also gave us an idea of the project's financial feasibility.

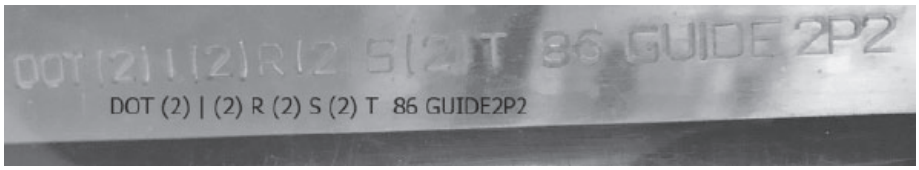
After months of waiting, GM finally approved the latest "T" series submission. The team breathed a sigh of relief, but we were not done with the approval for our license just yet. GM required one more test called the Customer Experience test.

This involved the packing, presentation, delivery and GM-required badges associated with the license. By this time, we had worked our way through three or four batches we thought would be the production run, but there turned out to be some final tweaks on the tool, billing, customer service and logistics. Finally, on the last run after approval, we had our finest lens produced to date, packed it in custom packaging, and applied not only the required GM stickers but also the stickers we wanted to include, such as the part number and serial number (later discontinued).

I assigned serial number p1 0007 to



(Image 18) The test jig

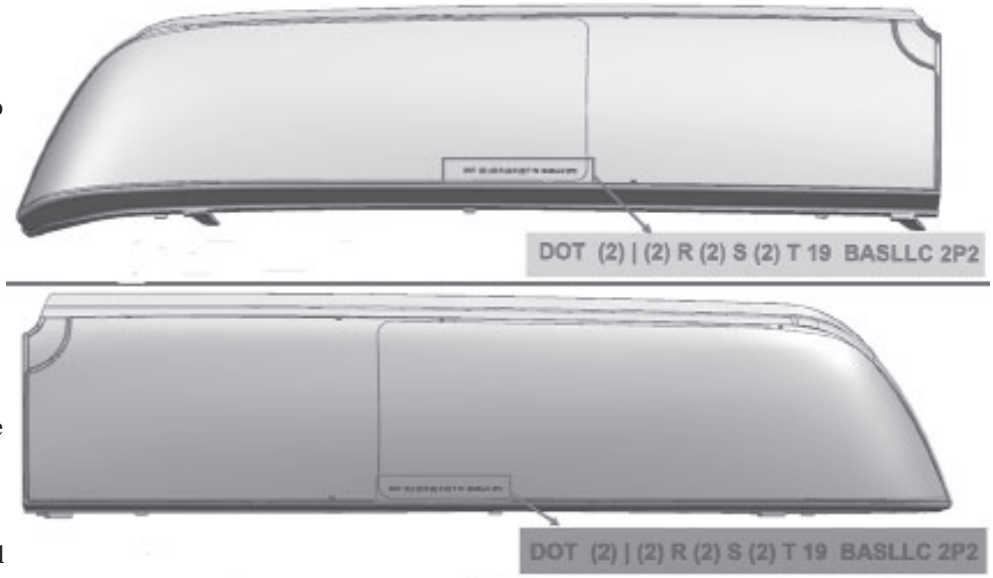


(Image 19a) This is the original DOT number which GUIDE Lamp Division used. 2P2 represents the GT

GM's set of lenses, boxed them up and billed them at $1.00 for the lens, $1.00 for handling and $1.00 for postage. (All was later refunded as GM was not expected to pay anything for this.) We sent the package on its way using the USPS, our chosen method of shipping.

After a couple of weeks, we received our final approval to begin serious planning for producing the first 200 sets. I had supplied the down payment to secure producing the lenses—but even with approval, GM wasn't ready to sign over the license yet.

The GM contract was twenty-one pages long, required a significant down payment and demanded a fair royalty. I had to pay the first quarter of royalties and then unceremoniously received the signed contract. We had our contract and could now begin the production of the lenses in earnest. I was expecting something to put in a frame and place on the wall that I could proudly display, but there was no fanfare! I have to say there were few benefits awarded to me, but GM was well protected, even to the point that I had to take out an insurance policy (on myself) and make it payable to GM if I should die, become disabled, or if the product were to become unavailable. Through this all I discovered these processes were not uncommon, and while a bit unsettling, something that served GM's best interest in the project.



(Image 19b) Here the "BASLLC" identifies the maker as BellyAcreStudios, LLC and the year of manufacture noted as 2019

(Image 20) Viewing the end result makes all of the effort worth it!

I was planning to have our first batch of 200 lenses be the foundation of the final process to build up operating funds and smooth out accounting, customer service, billing and logistics. I knew I was going to need a printer, assorted supplies, shipping materials and the like. The first batch of 200 was air freighted over from China with the shipping costs totaling more than the product itself. This batch was given the name "p1" and successive batches will go up from there. To this day, we have no idea how many lenses we will sell. We've learned nothing is predictable in sales.

Once we received p1, it was already a couple of weeks into the first month of our first quarter of the contract. Add a couple of weeks to make some changes to the decorating and it was not until November 1, 2019 that we were able to get our first three sets of lenses out to a well-respected customer and leader in the Fiero community, Fred Bartemeyer, Jr. We thought it best for Fred to get the lenses with serial numbers 0001, 0002 and 0003. The rest of the lenses went to customers in the order they placed their names on the preorder list. Lens number 0007 was signed by staff at GM and is now stored with the printed prototype, a T1 lens. Maybe someday they will be more than a conversation piece.

With most of the kinks worked out of the logistics and accounting processes, I started shipping lenses out the door as fast as I could. The biggest frustration was getting people to not only purchase the lenses after requesting them, but getting them to pay the invoices once sent. Since initially receiving the first orders, I've streamlined the process so only after I receive verification of payment do I print out the shipping label.

There have been some bumps in the road but overall, the process remained flexible enough for us to work with our customers to make sure they were

pleased with their lenses. Our business plan, mostly in our head, is fairly stable and running smoothly.

I managed to pay for p2, a batch of 800 sets, and hope now to sell those and start paying back capital allocated for the project. Currently, we don't plan on selling in any other venue than through emails, public exposure and word of mouth. We produce a good quality product, which basically sells itself. However, I have had to learn how to use social media, which turned out to be beneficial to the project and an excellent way to share pictures of the end results (Image 20), along with impressive support videos on YouTube. If I had to guess, most of the people who watch these videos end up being satisfied customers!

That being said, it didn't take long to saturate the social media market. Advertisements put in social media now only provide mediocre results. Other efforts include putting boots on the ground and visiting with Fiero clubs, plus encouraging our many satisfied customers to tell a Fiero friend about our product's availability. Depending on the return on investment from this project, only time will tell if other projects will be financially possible.

(Image 21) The beauty of a solution lies in its simplicity

I do see us going to eBay to sell the lenses toward the sixth quarter of the contract. This should pick up the stragglers that don't use social media or any of the popular forums, though future marketing avenues will include finding other ways to target Fiero customers that don't use social media. As far as the payback of loans, to date it is going well; no doubt I will breathe a sigh of relief when it is paid off.

Through all of this, Fiero customers have been endlessly patient as we worked through some pretty tough challenges, and although Fiero customers have a history of being frugal, they have ponied up the cash to buy the lenses. Reviews have always been favorable and to date there has been no negative feedback (Image 21).

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Image Source(s): Keith Goodyear