

Reed Senior project paper

There is a certain thrill that comes with riding in a car that you have yourself wrenched on, taken apart, diagnosed, purchased something new and then put it all back together. It's a hard to describe feeling and one that many people don't care for and don't understand at all. It's a feeling of freedom after you've just been trapped in the house for days or maybe even weeks while you attempt to find and replace the part that needs fixing. It's a proud feeling as you roar down the roads throwing your perfect machine into turns, seeing how much this thing that you had a part in putting together can handle. It's an "ughh" not again" feeling when you push your vehicle too hard and you sense or hear something going wrong, maybe it's just a slight ticking or a little bump or maybe it's that you just aren't moving anymore. It's a brotherhood feeling when some random guy you just met helps you push your car out of the road while telling you about how the same thing happened to him, or when your friends come pick you up while your stranded on the side of the road or when they come over to help you make things works again. It's all of those feelings mixed together in a constant cycle that make me into the car guy that I am and made me know what I wanted my project to be with no doubts in my mind.

What My Project is

For my senior project I decided to swap a newer more powerful engine into my 1991 BMW E30. This car is my first car ever, I did a ton of research finding the kind of car I wanted but unfortunately not so much into what it would take to own one. So here I am over a year later, completely in love with it but even I admit that it has too many issues. The idea behind this swap is to increase reliability so I'm not constantly needing to repair it and hopefully to get a little bit more speed and fun out of the car while still sticking to it's small light car roots.

The Beginning

The beginning of my project was focused almost completely on gathering information and acquaintances as well as the not so easy task of convincing my parents to help support me in this endeavour. My parents were skeptical and rightly so about my ability to complete the swap, where it would happen, and of course how much it would cost. I started by doing extensive online research about what parts I would need, how hard they would be able to get and where I would get them from. Next I worked out with my dad that I would clean out his garage in return for being able to use it for my swap. After doing these things I met with my parents in a restaurant and pitched them my idea and answered any questions they had with the research that I had done. After I got the green light I went down and talked to a local certified BMW mechanic named Billy who had previously worked on both my dad's and my BMWs. I told him what I was trying to accomplish and asked him if he had any suggestions. I don't think he had himself ever done the swap before but being around BMWs and their drivers enough I think he knew roughly what he was talking about. He suggested an engine out of an e36 m3 because that would be the most power gain so my car would feel the most different. This swap is also a fairly common and straightforward one so he said it should be a good one for a first time swapper. After suggesting all the stuff that he thought I would need I asked him where I should go about getting those items. He told me that PickNPull would always be the cheapest so if I was on a budget I should check there first, but in case I didn't find my stuff at PicknPull he gave me some numbers of partyards that he himself used regularly. After giving me these answers/advice he also told me that if I ever had any trouble I could call him and he would do his best to help me out.

Deciding on an Engine and Purchasing it

After sort of completing the preparation/planning stage of my project I did as Billy suggested and took a trip down to the Windsor PicknPull. I tooled around the entire yard for a couple hours looking at all the different engine options I had. Also just as an small side note it had rained a lot recently and PicknPull's tend to retain their rainwater in massive puddles so I got my shoes socks and pants absolutely soaking while peeking about. At this point I was looking at engines from all sorts of cars, BMWs, Mustangs, and even some trucks. After taking some pictures I went home and did some more research about what engine I should actually decide to use. I found that swapping in an engine from a none BMW was a lot more fabrication work and unknown territory than I was willing to tackle so since I couldn't use any of those I decided I wanted the e36 m3 motor. Unfortunately there were none at the PicknPull I went to so I decided to call up one of the salvage yards that Billy has recommended to me. The man I spoke to on the phone was quite nice and told me they had one M3 engine but that it burned oil and had a hundred and seventy thousand miles on it. On top of that it was two thousand dollars which was quite a large chunk of my budget. I told him I had to think about it and I'd give him a call back later. After calling the other yard Billy had recommended and finding that it no longer existed I tried a couple more places that I found online and they all quoted me similar or larger prices, this concerned me because at the time I was quite set on the m3 engine and nothing else seemed good enough. The next day I called up the original salvage yard again and told them my predicament, I talked to a different man this time and he asked what I needed the new engine for. I told him about how I was doing an e30 swap and he told me that while the m3 engine swap (the m3 engine is an s52) an equally fun and cheaper swap is using an aluminum block m52. The logic behind this is that even though the s52 provides a decent amount more hp (roughly 50) it also brings along quite a bit of extra weight because it's like chunking on an extra two cylinders and a bunch of new more modern requirements to make it run. What this

can end up doing is throwing off your car's weight distribution, and in a car like the e30 which is built more for handling than speed and has perfect fifty fifty weight distribution (50% in the back and 50% in the front) it can make it nose dive a bit which takes away from the nimbleness. The aluminum block m52 on the other hand still adds a significant amount of power while having an aluminium block keeps that perfect weight distribution and the same key handling. Another bonus to the m52 is that since it comes out of much more common and less expensive cars which makes the motors easier to find, cheaper and easier to get parts for. After telling me this information the man I was talking to told me that they had just got a car with an aluminium block m52 and it only had one hundred and two thousand miles on which was much lower than the s52 and that they could give it to me at a price that was more in my budget. (just a side note that the aluminum block m52 I got comes from a model called the Z3 which is more rare than just your average m52 which can come from an bmw from around 1991-2000, this makes it a decent bit more expensive than the iron iron block but for my particular swap I deemed it worthy to pay the difference.) So I told the helpful guy that I would give him a call back tomorrow after I had fully looked over my options, I wanted to not rush and make the right decision as I knew I was on a tight budget. Basically at this point my options were to buy an engine and transmission from the salvage yard I had been talking to, or I could attempt the PicknPull engine pull with some buddies and save some money but also it would be a lot of hard work and a lot of worry as I wouldn't know what sort of engine I was really getting. Or my final option would be to try and find another salvage yard with a better engine or a better price. From those three options it definitely still seems like I made the right choice in choosing the salvage yard I had already been talking to. The only problem with this choice ended up being that this particular salvage yard took ages to actually get me my engine. I'm pretty sure it took them around a month to actually ship it to me and I talked with them for around a week before getting

all negotiations done. It was from this that the biggest problem on my project came. Basically when getting car parts they sometimes tend to take a long time to arrive especially with big ones such as engines and transmissions, or just rare parts that are hard to find, and what you need to do while this large or hard to find part is coming is buy all the smaller parts that you know that your going to to put the big one in need. Having never replaced more than one part at a time I didn't really know how much not doing this would affect me until it was too late.

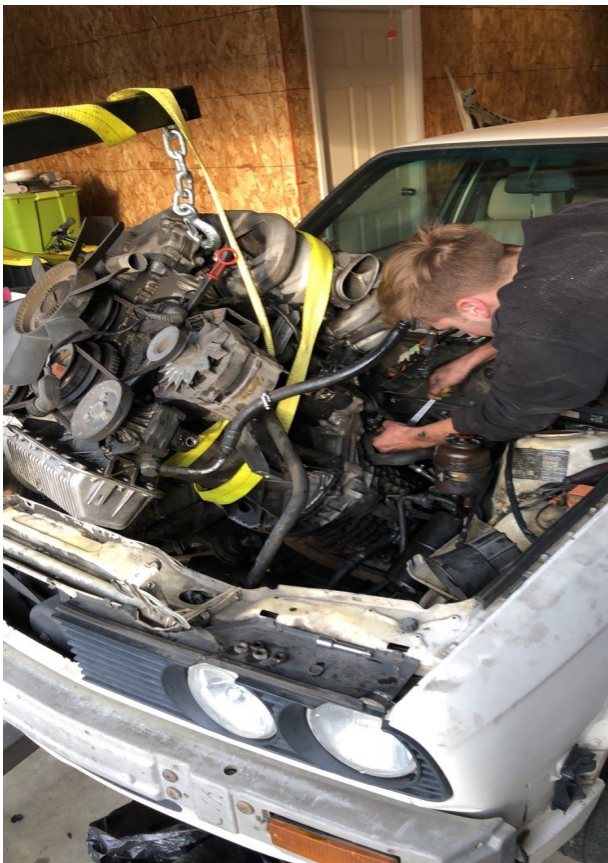
Ordering Part, Pulling Old Engine

During the time I was waiting for my engine and tranny I bought one other important thing and that was the custom mounts I needed to install them in my car. Since my swap is not

super uncommon there are many companies out there that sell parts that are specifically made for what I was trying to accomplish. I also purchased a new front quarter panel and a bumper during this period but unfortunately the bumper turned out to be the wrong one and turned into a whole disaster by itself. I also started prepping to get my engine out by first borrowing an engine hoist from a friend (thank god somebody I knew had one)



and also attempting to disconnect my driveshaft from the transmission. I'm not sure if this happens to everybody or it was just on my car because it's super old, but be prepared to really struggle with the driveshaft bolts. Given their positioning under the car and not too high off the road they end up getting water on them pretty much no matter what and if they have three hundred thousand and twenty seven years worth of water plus living in the bay area where it gets foggy all the time then chances are they are going to be a pain in the ass, which is exactly what mine were. I started out trying to remove it by jacking up my car and going under with a socket wrench to try and undo it, unfortunately this did not work in the slightest because the bolts are so close to the drive shaft that my socket wrench hits on the drive shaft causing the socket to not fit on correctly. After finding out that wouldn't work I rummaged through a bin of wrenches until I found the right one and then I went back under the car. It was at this point that



I realized I had a real problem because when I put my wrench on the bolt it was on so tightly that it would simply just not move, like I could hang on it and it just wouldn't budge. My car is also quite low to the ground and so it was impossible to jack it up high enough to get some kind of pipe or bar on the end of my wrench for leverage. I tried spraying it with rust eating spray to try and loosen it up for several days while still trying to wrench it off but it did not work at all. After youtubeing my problem I decided that my

only option was an impact wrench which is basically what they would use in a more professional setting as they are much faster and stronger. So I bought an impact wrench and also borrowed a socket that could bend from a friend so that I could get my socket fully over the bolt. Of course after I had all this stuff my dad's air compressor broke so I had to wait a few days longer, but finally after waiting for at least a week or two I had all the right stuff and I finally disconnected my driveshaft. Pretty soon my engine came and right after that me and a friend of mine pulled my engine out in about a day of work (it took us two afternoons) and honestly it wasn't too much trouble. Oh I did forget to say that while I was working on my driveshaft I also pulled out anything that I would need to take out before we pulled the engine. This included the radiator plus all its housing, the hood, air intake, and then just anything that was easy to disconnect. Once we really got down to work specifically trying to pull the engine (and tranny) it actually wasn't all that hard. I didn't even bother youtubing it we pretty much just disconnected everything we could see (including engine and transmission mounts) and then tried to pull it out a bit and if it wouldn't come then we'd look back to see what we had not disconnected and after doing this a couple time she came right out and we only broke one thing and it wasn't even an important part! After pulling it I decided to keep my engine and tranny around instead of dumping it, which turned out to be a good idea as throughout the rest of the project I borrowed several different parts from it.

Bringing the New Engine to My Garage

A couple days after pulling the engine and tranny the same friend and I transported the new engine and tranny to my dad's house which actually turned out to be quite hard because we had to hoist it out of the box it was in and into the back of my dad's truck and we had a pretty janky setup but we still managed to do it in an evening with no major problems. After this was done my project unfortunately started to get very slow for a while. If you asked me what

happened I honestly don't really know if I could tell you, I think it was a combination of having a lot of work and things to do along with basketball and a bit of procrastination. Essentially I spent



a couple weeks doing not much, I did order one part (a drive shaft) but the company said it was out of stock so I was left pretty high and dry on that front. After that small hiatus I came back and needed to find a BMW e34 oil pan which turned out to be one of the biggest problems of my whole project. The BMW e34 is the more luxurious option above the e36 and as such it is more expensive which means less people can afford them which makes them more rare. On top of this they were offered with two engine types one which I believe was a v8 and the other was the straight six m52 which is what I needed but because there were two

engine types the already small number of cars had to be narrowed even more. Then add on to it all that this is an absolutely essential part of doing all of the most common e30 swaps and you have got yourself a very rare part. This oil pan is so necessary because the e36 and e30 have differently placed front subframes, the e36s is more towards the front, while the e30s is more towards the back/middle so their respective oil pans have different big reservoirs as you can see

in the picture below. Thankfully however for us e30 boys the e34 has a similarly positioned subframe too an e30 so the oil pan from that car works perfect with no custom or aftermarket parts needed. This was a key theme throughout my whole project and helped out a ton in me being able to get all the parts I needed with minimum fabrication. Everything nuts and bolts which I could pull off my old engine to driveshafts, ecus and throttle cables I could all get off different model BMWs and they would work together and help me to complete my swap.

Locating + Buying New Oil Pan

For My first step in locating an oil pan I looked online to see if I could get one but couldn't find any in good shape that would get to me soon enough, so I turned to the guys at the salvage yard that I had purchased my engine from. They told me they had a car coming in that would have it and they'd get it soon but around a week passed and they still hadn't taken it off the car. I was pretty worried that this was going to turn into the engine situation all over again so I turned back to the internet. And this time it was a huge score! I found the oil pan that I needed in Vacaville which is around an hour away for a somewhat fair price (still however ridiculously high for an oil pan, it was around the cost of replacing my old motor's oil pan fifteen times.) I reached out to the gentleman who was selling it and we arranged a meeting two days later for me to buy it. I drove down and It turned out that he too was an e30 enthusiast who had already done the swap I was doing and was on his way to doing another but he just didn't have the time. We talked for a while and he asked about how far I had got and I went over the stuff I thought I needed with him to make sure I knew it all. It seemed that I had most things correct except for the engine control unit (ECU) I would need to run my car. This leads me to a complicated subject on my car and one that I feel I have the least knowledge and ability in. In the very beginning of my swap I didn't even know I would need to replace my ECU (engine control module, basically the brain of the car) at all which was pretty dumb of me but at the time I just

didn't know better. I first discovered something was going to need to happen with it when I talked to the guys who were sending me my engine. They told me that essentially I have two options, the first would be to stay in obd1 which was the system already in my car. In order to do this I would need to replace all the sensors in my engine (which came from an obd2 car so it is obd2) with all obd1 sensors so that my obd1 ecu can read and operate them. The benefits of obd1 are that it's older so just in general less technologically sophisticated which means there are less things to go wrong and that turbocharging your car is much easier. Turbos and forced induction is a whole very complicated thing that I have no room for in this paper, particularly because I never planned on introducing it to my car. On the other side we have obd2, in order to switch to obd2 I would need the correct ECU out of a newer BMW and a tune on it to make it run in my e30. The benefits of OBD2 are it is much more tuneable so somebody can make sure my car is running correctly and can even make it so I pass smog which would be potentially necessary down the road. Unfortunately it also means more computers so there are more technological things that could go wrong and since I'm not great at the technological side I first opted to try and go for obd1. About a week or so after deciding this I called up Billy and told him what I was doing and the sensors I would need, he told me he would call around and see what he could find. Naturally however being a car related business, took quite a long time and a decent amount of reminding to get it done and when he finally did the news was not good. Billy told me that it was going to cost me around twelve hundred bucks to purchase all the sensors. Now I have no idea how those parts were that expensive but in that moment I knew that with my budget obd1 was out of the question. Unfortunately after finding this out I didn't do any further research on how to do obd2, I'm not exactly sure why I didn't but it sort of came back to haunt me later on. How this haunting happened went like this, I asked the guy I bought the oil pan off of what ecu he had used and he told what it was and that it should run in my car too. Rather

stupidly I took his word for it and did very minimal further research, which again turned out to be a big mistake. What ended up happening was that I ordered the ecu the oil pan man had suggested and then reached out to an ecu tuner through craigslist, only to have him call me up and tell me that I had bought the wrong one. Apparently the one I bought was actually obd1 and only ran m50 motors (the motors from early e36 models.) At the time I was fairly frustrated but the lesson I learned was don't trust anybody completely, they may think they know what they are talking about but if they don't know your exact situation or are an expert in the topic you

have to do your own independent research.

Replacing the Oil Pan

Before/during these frustrating ecu events I was working on putting on my new oil pan. In order to do this I first tested the dipstick of my motor to check and see if it was empty and having it come out clean I hoisted up my engine so that it was dangling in mid air and went to work.

Taking off an oil pan isn't really all that hard of a job.



Basically you are just undoing a bunch of bolts placed all around the lip of the pan and where it

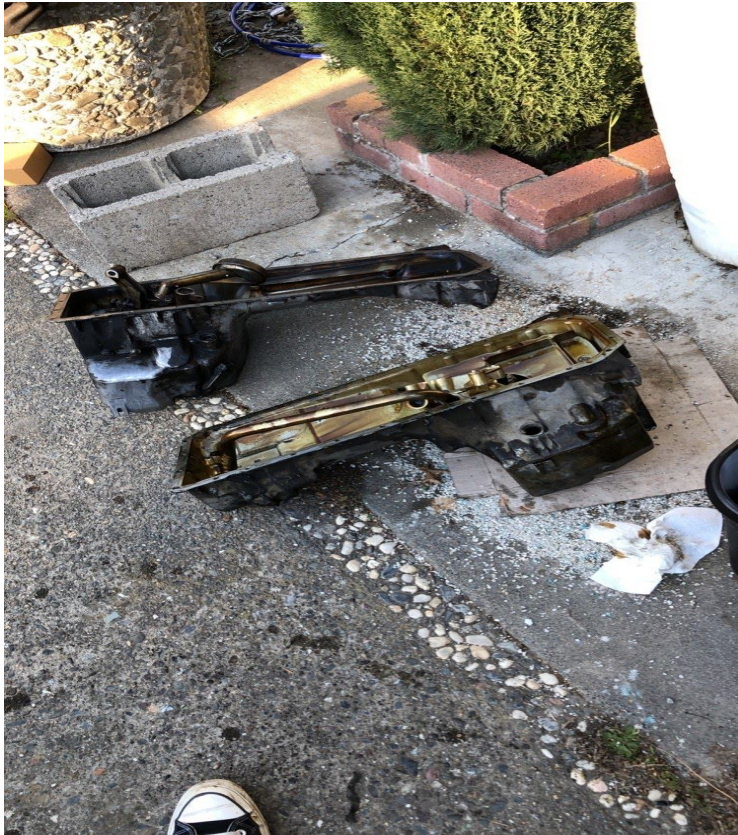


meets the motor. What made my case a little more challenging was that I was first of all trying to save my old oil pan gasket because I didn't want to wait around while a new one waited to arrive, and second it turns out that my checking for oil had been insufficient and that there was a great deal of it still left in my pan. What ended up happening was that

I undid all the bolts but the

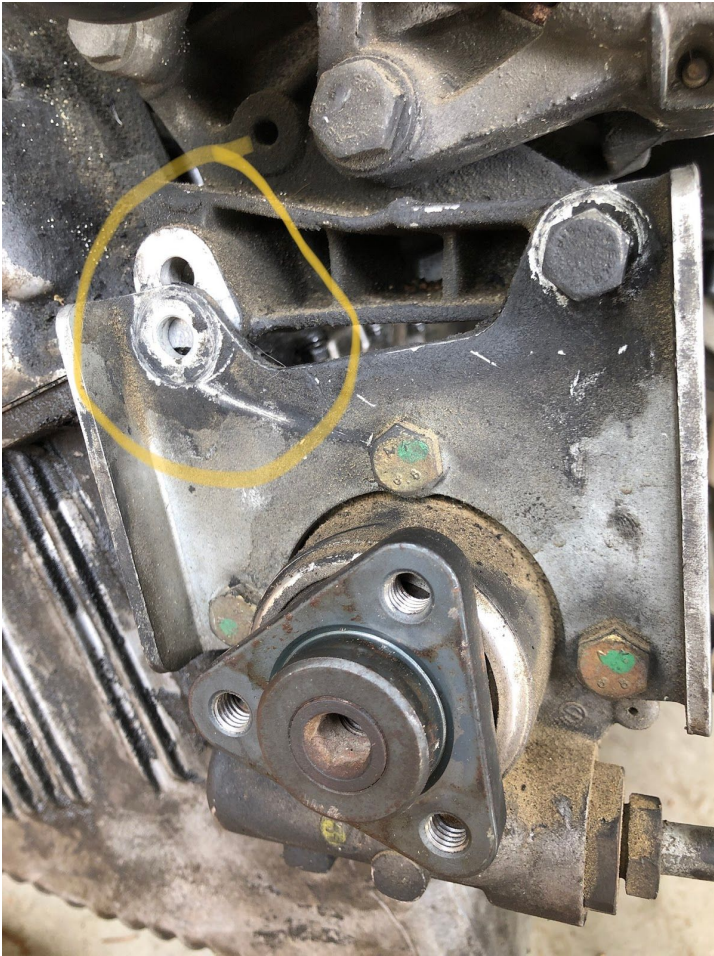
seal from the gasket was still holding it on and so I popped the seal open with a flat headed screwdriver and instantly a flood of oil spilled out on my garage floor. To my credit I did react somewhat quickly and managed to contain it atleast and not let it ruin anything, but it was still probably the biggest oil spill any garage has ever seen. At this point I was reasonably a little bit disappointed in myself but atleast I learned my lesson and hopefully nothing like that will ever happen in the future because of it. Also there was one upside to this whole experience and that was that I managed to get the oil pan gasket off in one piece so it should definitely work again when I bolt it up with my new oil pan. The next day I came back and managed (with a bit of trouble) to weezle my old oil pan all the way off, and then proceed to unbolt the old oil sump I had on as well as it would not work with my new oil pan. In the picture there you can see the

differences between the two oil pans and sumps. The one on the bottom was the one that



came on my car and you can see that the sump has a long tube in order to reach all the way back to the deeper section where most of the oil is, while the E34 oil pan doesn't need a long tube as the sump sits right over the deeper section. An oil sump is what sucks oil up and through the engine so everything stays smooth and lubricated, it is chain driven by a little chain that comes down from inside the engine that is connected to the timing directly so whenever the is running or moving how fast

the engine is going controls how much oil the sump is sucking. It's called an oil sump and not pump because it does not pump oil through the engine it sucks oil up and into it, so basically it's not pushing like a pump it's pulling. Unfortunately nothing to do with this car ever went down without a fight and in this case it was the little gear wheel I needed that connected to the chain to actually make the sump mechanism suck. The bolt holding this on absolutely would not budge, fortunately the old sump was not necessary so I took it to a friends and he cut it off without any trouble. Now I had all the things I needed so I began putting it all back together with the new oil pan but again something had to go awry. This time it was my power steering pump



on the new M52 that was in the way. At the time I simply unbolted the side that was getting the way and then finished up bolting on my oil pan the whole way.

Once my oil pan was on the final step before putting my engine in the car was to bolt up my transmission, which I did without much trouble using bolts I stole off of my old engine and tranny. The only tricky thing about this was that there was a little free floating ring in my engine that the rod from my transmission had to fit through. It was hard to line this up with one person because of how exact the fit had to be but I got my dad to help and with two people the job was done very quickly and surprisingly without any problems.

At this point in time I was feeling pretty good about my project, despite how long things had been taking I was still making progress and I felt like I was sort of on a roll. Unfortunately of course something came up. The first thing was definitely my fault and if I were to do this swap or any engine swap ever again this would be the number one thing I'd change. This thing was that yet again I was out of parts and of course I couldn't continue, this stopped all of my forward momentum which is something that really really helps working on cars more than you would think and it's really the thing that decides whether you have a year long project or a month long

project. When you have everything you get into the rhythm of knocking out sections every day or every couple days and then while your still in the mood of the project you move onto the next thing, everything flows into the next and even if you run into an issue you can work on another aspect while you figure out what you can do to work through your issue. The problem with waiting for parts is the waiting time in between them all which adds way more time on then you would and also you become less motivated when you only have one thing to do. It ends up feeling like you are just working to finish up each task separately and not to combine them all and build something from it. Unfortunately I was still learning this lesson so here I was again, stuck with nothing to do but order parts. This time however I decided to make a change and made a list of parts that was everything else I would need to complete everything. Around the time that I made this list the Corona virus started stirring up and school started to get busier, I got distracted and before I knew it school was cancelled and I was stuck at home not exactly sure what to do. My parents were hesitant for me to order parts because nobody exactly knew what was going on. In the end this cost me around two more weeks during which the only thing I did was a price analysis and found that the budget was getting very tight and that I probably would go a bit over. At the time I decided that it was best not to worry about it and I should continue until I was completely out. So I took my final list, double checked it to make sure I had everything that I would need for the rest of my project and began ordering. Most of the items on here were just finishing touches/small items so I bought all those because I knew I could afford them. The only two items that were still somewhat pricey left to purchase was the driveshaft (which I'm going to need to be shortened by a professional) and the exhaust system which I have a lot of options for and I'm still not sure what's going to happen with that.

Unfortunately the notebook in which I recorded this information went missing so I don't know the exact parts and when I ordered them but I can still tell you the important ones that I

remember installing. The first was a slave clutch master cylinder; this item is extremely important for any manual transmission. It is a little cylinder that goes on the side of your transmission and connects to your clutch pedal through a long tube of fluid. When you press down on the clutch it moves fluid in the line which activates the cylinder and a little rod extends out of it pushing the clutch in and allowing you to switch gears. Unfortunately I did not do enough research and bought a clutch slave for too old of a car so it didn't fit my transmission. At the time I was fairly bummed because I wanted the clutch slave on the car when I put in my motor and tranny but after a quick youtube search I learned that it wasn't actually too troublesome to put on with everything bottled up.

Deleting My Power Steering

The next little part was a power steering delete kit that I ended up needing to buy. Earlier on in this paper I touched on how I had to undo one of the bolts on my power steering pump in order to install the new oil pan. At the time I hoped that it would be able to bolt back down after the oil pan was fully on but unfortunately this was not the case. I called up Alex (the man I talked to about tuning my ecu) and told him my issue, after talking for awhile and sending pictures back and forth we determined that I would need a whole new mounting bracket to allow me to mount the power steering pump where it was supposed to go. The brackets aren't actually that expensive but it does require a bit of cutting and welding and since I don't have a welder and did not have access to one because of the quarantine pretty much my fastest option was to simply delete it all. Before following through on this I checked in with a friend who had done the same thing to his car and he told me the difference wasn't that noticeable. With this information I decided finally that the delete was my best option and so I set to work. The first step I took was to order an e30 power steering delete kit, it's a very simple product, just a machined rectangle on plastic with holes to put your banjo screws in and then tighten down.

After ordering that I went to work removing all aspects of power steering from my engine which was basically just the reservoir for fluid and the power steering pump I had already partially



disconnected. Fortunately the power steering system is completely closed so when I removed it it was simply gone, there isn't a lot of blocking off you need to do, the only thing not having it causes you to need on the engine is a different sized belt. After doing this I removed the two banjo bolts from my power steering rack and the tubes attached to them. A few days later my part came, and after fully turning the wheel to each

side twice (to flush all the steering fluid out) I bolted the piece down with my old banjo bolts and just like that my power steering was gone.

Brake Booster Relocation

The next step of my project was one of the most fun but at the same time most sketchy part of my project, and that's actually saying a lot because the whole thing was pretty sketch, it

was also the last thing I thought I needed to do before I could finally drop in my new engine and tranny. The problem that I had to tackle now was that e30s have surprisingly large stock brake boosters, comparing it to others and the size of the cars it's actually pretty huge. Now in a stock e30 this is no issue as there is quite a lot of extra space in the engine compartment. The problem comes when you are trying to shove in an engine with an extra two cylinders that was never meant to go in the car. Long story short putting in a bigger engine creates some space issues and the main one is that the factory brake booster is in the way. Luckily for me I had learned my lesson at this point and I did all the research I could before attempting to put in the engine, if I hadn't I would have been very frustrated because the whole engine and tranny would have needed to come back out. While digging around on this topic I found one video that seemed particularly well done and I basically just followed what they said. Apparently it is possible to simply replace the stock brake booster with a newer smaller one but this can change up the brake feel of your car so most people prefer to keep it stock, also money was tight as I mentioned earlier so I didn't really have the cash for that option either. Since relocating it was my best option I set to work. I first removed my stock brake booster because it would need to first come fully out of the car before I could relocate it. This turned out to be one of the most annoying jobs I had to do on the car. In most situations taking something out of the car was always the easier task, but not with the brake booster. The trouble was that you have to unbolt all four of the bolts that hold it in from inside the car underneath the steering wheel where your clutch brake and gas pedal are, accompanied by all of their pedal systems and wires. My first step was to disconnect my clevis pin from the brake pedal. This by itself took me around forty five minutes of me laying in an extremely uncomfortable position with my bottom and lower back in my seat and my whole upper body crammed underneath in the pedal assembly area. Luckily after a bit of a struggle I finally got the little clip that was holding it in off and from there it slid out



with a bit of WD40 and not much more trouble. Next I managed to get three of the bolts out with a combination of many different extension configurations and a very uncomfortable body position. After those three I was finally ready to tackle the fourth one, I'm not exactly sure why but for some reason the engineers had decided to tuck this one directly behind the brake pedal so any extension was out of the question. It was also very annoyingly tucked in between two pieces of metal so the socket wrench I was using was too thick to fit in between them to access it. This frustrated me because whenever you can't use a socket and have to use just a regular wrench you know you're in for a very substantial period of wrenching. But there was nothing else I could do so I went and started looking through my tool box to find the right one. While looking through it I found an old socket that wasn't working too well but was actually thin enough to fit in the tiny area I needed it to, so I oiled it up a bit and set to work. Taking off this one bolt still took me around an hour because I could only turn the socket about an inch each



time and my hand kept cramping up because of the awkward position but I was just thankful that I didn't have to use just a regular wrench.

Finally after everything was detached I managed to slide my brake booster completely out and I was finally ready to begin the relocation, unfortunately getting the actual thing out had taken pretty much all afternoon so I had to stop for the day. The next afternoon I began the process of actually moving it over. The youtube video I got my information from claimed that you only had to over it over half an inch so that's all I did but in hindsight it would have been better to air slightly on on the bigger side, not a ton but just slightly more as my brake booster

still managed to get in the way while installing my engine. The first thing I did was measure over half an inch to the right from three of the holes (the fourth one which was the pain to take out has no room to move it over so you simply don't use it.) After measuring over as precisely as I could I selected the right drill bit for the size holes I needed to make and began drilling, having never drilled metal before or even used a drill much I was pretty proud of my results. All my holes had gone in the right spot and when I test fitted the bolts on the brake booster and they all fit in. My next step was to cut off the extra bolt that didn't get a new hole and then I was ready for the somewhat sketchy part which was cutting out the whole so that the booster would fit all the way down in its new bolt holes. The first thing I did was draw how much I thought I



would need to cut but that turned out to be completely inaccurate so pay no attention to that. Originally I wanted to use a grinder and make it as pretty as possible but the grinder wheel I had was too big and ended up not working out very well at all, so I had to resort to a sawzall and metal cutting blade and pretty much just cut until it fit. I will admit that this is not the prettiest nor the safest method but it definitely got the job done and at the end of the day all the sawed areas are going to be covered up by my brake booster so know one except for the people who read this paper will ever know.

Getting My ECU

After completing my first actual sort of fabrication work I was feeling pretty good and my project was still rolling along pretty steadily, I'd been working on it and getting things done every day. At this point I was ready to put my engine in but I was getting smarter so instead of just going for it I took an off day and went to PicknPull to find the ECU that I would need to ship off and get tuned before I could get my car running, there were a couple other things I was looking for as well one of them being another clevis pin (to finish of my brake booster relocation) and the other was e36 shift linkage which at the time I was sure I needed but now as I'm writing this paper I'm not so sure off. Either way it was time for a trip to PicknPull so off I went. If you have ever been to pick and pull you know it's not the



most wonderful place, sure it's fun to look through the rows and rows of cars but once you actually find what you're looking for and try to get parts off it you experience becomes a bit less enjoyable. The first reason for this is that It always seems to be either ridiculously hot (which it was in this case) or very cold and wet and you just can't avoid not getting soaked in nasty water. The second reason is that all the cars are very wrecked, now of course this is a PicknPull so of course they are going to be smashed but I'm talking about the exposure to the elements and the facts that people completely trash them looking for parts. Now I'm not even mad at

people trashing cars for parts because that's pretty much what you're supposed to do there but it does make it very hard and annoying for some people to get other parts. Nevertheless it's still an effective way to find cheaper parts or parts that are hard to find online. I started by trying to get a manual shift linkage out of the only maula e36 there unfortunately after a while I still couldn't get it so I went home to get some more tools and do a little research. After this I came back and tried some more but still with no luck, I got the pin off that should have been holding it in place but it still wouldn't budge probably because it was rusted in. This was a bit

disappointing but it's pretty hit or miss at PicknPull so I let it go. After not being able to get the shift linkage I did manage to get the correct ECU of the same car which was the most important item to get anyway so I was pretty happy with that. Before I went home I decided to quickly check for e30s to see if I could find a clevis pin and I did find one but I decided against the couple hour long struggle of getting it out (clevis pins are also cheap online so it just wasn't worth it.) Overall I would say this was a fairly successful trip because I still managed to get the item that I needed the most. And the next day I sent it off to be tuned.

Dropping In the Engine and Transmission

With my ECU on it's way to be tuned, my power steering deleted and my brake booster relocated I was finally able to put my engine and transmission in. For this process I used an engine hoist and an engine leveler set at maximum angle with the transmission side tilted down. It had to be tilted down because the basic motion of putting it in is like a steep slide down with the transmission at the bottom and then as you slowly get it further and further in you lower it down a bit each time until it's pretty much leveled out. It's a bit hard to describe without a video but if you look at that picture it's as if it's constantly moving slightly to the right and everytime you move to the right you drop it down a bit more. This process of lowering the engine in was

actually surprisingly easy and I got it done with the engine and transmission fully in the car in under an hour, unfortunately that was when the real problem struck. I quickly realized that getting the engine in that space is not really the hard part, the hard part is getting everything to line up and by



everything I actually just mean the two engine mounts lined up with where they mount up to the chassi. All the rest of that day I tried to figure out how to make them line up and eventually I just had to give up having been defeated for the day. That night I watched a bunch of youtube videos of people doing what I was trying to do and seeming to have no difficulties at all. The one thing that I figured I could do to make it easier was take off my tranny and just drop the plain engine in straight down (I was pretty sure that it was my transmission that was not letting me line it up right.) The next day I was about to remove my tranny when I decided to try one more thing and it actually ended up working, well somewhat at least. What I realized had gone wrong was that my engine was not horizontally level enough, one side dipped far lower than the other so there was no way it would line up no matter what. So I looped some towing rope around the side that was lower, hoisted it up and tied it off on the arm of my engine hoist. To my instant elation I found that I could now easily get one of my engine mounts (the one on the left) to line up with the hole it needed to go through. Unfortunately this satisfaction did not last too long because pretty soon I realized that I couldn't get the right one to line up, no matter what I tried it was a couple millimeters off. After looking at this problem for a while I decided that the only possible solution was that my old driveshaft which I hadn't completely uninstalled was

getting in the way. Naturally after coming to this conclusion I set to work trying to disconnect the other end of my drive shaft. At first I figured it wouldn't be too bad because I'd bought a pneumatic wrench specifically for this job just on the other end of my driveshaft. Very frustratingly however on this end of the driveshaft it is impossible



to get to these nuts with anything but a normal wrench, you can even fit a socket wrench. And being drive shaft nuts they are extremely tight and probably pretty rusted on. So far I have tried soaking them with WD40 and heating them up to hopefully expand the metal and break the rust that is under there but neither thing has had any effect on them. My next option is making my own solvent out of acetone and ATF transmission fluid, apparently this solvent is much stronger than anything you can buy in stores so right now I'm just praying that it works. At this point I've technically got the engine in the car and I'm just millimeters away from tightening it down.

Final Thoughts

Writing this paper was a great way to look back on this project (at least how far I've gotten on it) and see just everything that happened, everything I did right, everything I did wrong, what I learned from it and how I grew as a person throughout it. If you've been paying attention while reading my paper you'll have noticed that a lot of problems came up and a lot of things didn't go the way I planned, or maybe they went wrong because I didn't really plan them. Personally I know myself to be a very chill laid back guy, I like to just mind my own business and sort of just go with the flow. Generally so far throughout life I can't say that this has been a big problem for me so I never thought I would need to change it a whole ton. Something that this project really taught me is that sometimes instead of just going with the flow I need to create the flow, I need to shoulder the responsibility and I need to be the flow that other people go with. This was taught to me partially by needing to deal with auto workers who tend to just take their time and also through having to sometimes bridge the gap between my parents as they were both helping me out but they also operate on different frequencies than each other. Another aspect of responsibility was taught to me through having such a big project on my shoulders. I think in the beginning and actually throughout a lot of my project I didn't quite realize how much I had to get done on my own and when things weren't exactly working out I tended to shy away

from them. Towards the end of my project I started to learn some lessons and I think I started to pick things back up again. I believe that this is something that goes way beyond my project and in a way it feels as if I was partially prepared to go out into the world on my own by embarking on this adventure.

Another aspect that I learned that is on a more physical level and I already talked about this earlier in the paper but for projects like these I just cannot stress enough the need to get all or at least as many parts as you can before you begin your project. You can clearly see in my paper that when I did my research and bought all the parts I needed before embarking on the big task that I needed to accomplish everything was just so much smoother. You'll notice that you get into a groove and once you're in there everything will get done so much faster.

The last thing that I learned about myself personally was actually told to me by my teacher Beth. She told me I essentially am a single beam person. What this means is that I am at my optimum capacity when I am purely focused and only working on one thing and although I don't think I would have really realized this if she hadn't said that but now that she did it makes so much sense. Looking back during times that I had a lot of school work, or basketball or just anything else important going on, the work was slow and inconsistent but now that I'm quarantined with little school work I can focus all my energy on it and things get done fast.

The last thing I'd like to touch on is the aspect of brotherhood in the car community. I would at this point classify myself as a "car guy" and up until this project my only other real experience with other "car guys" has been with my friends at school who were of course very helpful and always offering themselves up for a phone call to see if they knew what was going on, a tool that I needed to borrow, or just an extra set of hand to help work on it. Before this project I assumed that this was just because I know them well and because they are my friends and while I still have no doubt that this is partly the case I just want to highlight the point that

every single person I talked to about my car offered any information they knew about what I was doing as well letting me know that if I have had any trouble that I could call and they would try to help. They even seemed excited along with me, most of them even asked to send them a picture or video when the whole thing was over. Keep in mind that these are complete strangers one of them even lives completely on the other side of the states. This really cemented in my mind that although doing the whole swap by yourself is fun and hopefully will be gratifying. It's knowing the people in the community that really are genuinely interested and share the same passion as you that make me want to go out and try new car things and is 100% going to keep me with some kind of broken down car in my life that I'm always going to be.

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