Drum to Disc Conversion Info How to understand Fluid DynamicsRate Topic: [-](http://community.ratsun.net/index.php?app=forums&module=extras&section=rating&t=35687&rating=1&secure_key=880ea6a14ea49e853634fbdc5015a024&s=991e2f358d0d4e9d56be76e54e35b363)[-](http://community.ratsun.net/index.php?app=forums&module=extras&section=rating&t=35687&rating=2&secure_key=880ea6a14ea49e853634fbdc5015a024&s=991e2f358d0d4e9d56be76e54e35b363)[-](http://community.ratsun.net/index.php?app=forums&module=extras&section=rating&t=35687&rating=3&secure_key=880ea6a14ea49e853634fbdc5015a024&s=991e2f358d0d4e9d56be76e54e35b363)[-](http://community.ratsun.net/index.php?app=forums&module=extras&section=rating&t=35687&rating=4&secure_key=880ea6a14ea49e853634fbdc5015a024&s=991e2f358d0d4e9d56be76e54e35b363)[-](http://community.ratsun.net/index.php?app=forums&module=extras&section=rating&t=35687&rating=5&secure_key=880ea6a14ea49e853634fbdc5015a024&s=991e2f358d0d4e9d56be76e54e35b363)

[#1](http://community.ratsun.net/topic/35687-drum-to-disc-conversion-info/page__view__findpost__p__547866?s=991e2f358d0d4e9d56be76e54e35b363)**User is offline   [DailyDato](http://community.ratsun.net/user/6958-dailydato/?s=991e2f358d0d4e9d56be76e54e35b363) [Icon](http://community.ratsun.net/user/6958-dailydato/page__f__20?s=991e2f358d0d4e9d56be76e54e35b363)**

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* Advanced Member
* PipPipPip
* **Group:**Members
* **Posts:**139
* **Joined:**08-November 10
* **Location:**Franklin, Tn
* **Cars:**77 620 short bed, 84 King cab 720

Posted 15 September 2011 - 09:22 PM

I hope this is made into a sticky..............I have seen plenty of discussion going around about doing a brake conversion from drum to disc. Many people have discussions about installing a proportioning valve. Well here is the technical side of why your brakes suck when you convert, and to how to configure your setup and why you may or may not require a proportioning valve. I don't have the exact measurements of the parts others are using, so everything is in generic so to help people understand, and then you can use the formulas to reconfigure the answers afterward off the bore sizes of your own parts.  
  
1. Pascal's Law: "When force is applied to a liquid confined in a container or an enclosure, the pressure is transmitted equal and undiminished in every direction."   
  
2. From your brake pedal through the rod into your power booster, is a roughly a 5:1 ratio, so for every pound applied to the pedal, 5 times the pressure is applied through your booster, and the distance the rod travels is 5 times less the pedal travel.  
  
So for five inches of pedal travel of 100lb force, your master cylinder is applied 1 inch with 500lb force.   
  
500lb(F) is going to be assumed for all vehicles  
  
  
F = Force  
P= Pressure  
A= Area in sq. in.   
F= P x A (force is equal to the pressure multiplied by area)  
P= F / A (pressure is equal to the force divided by area)  
A= F/ P (Area is equal to force divided by pressure)  
  
**Hydraulic Pressure And Piston Size**  
If a mechanical force of 500lb is exerted by the brake pedal pushrod onto a master cylinder piston with 1 sq. in. of surface area, the equation reads as follows  
  
500lb (F) / (1 sq. in.) (A) = 500psi (P)  
  
The result in this case is 500psi of brake system hydraulic pressure  
  
However, If the same force is applied to a master cylinder piston with twice the area ( 2sq. in) the equation will read as follows  
  
500lb (F) / (2 sq. in.) (A) = 250psi (P)  
  
Doubling the area of the master cylinder piston cuts the hydraulic system pressure in half, Conversely, If the same 500lb force is applied to a master cylinder piston with only half the area (1/2in), the equation will show that the system pressure is doubled  
  
500lb (F) / (1/2sq. in,) (A) = 1000psi (P)  
  
So First I would like to say, that INCRESING your master cylinder bore, is not always the answer, it will only complicate things.  
  
  
  
  
**Application Force And Piston Size**  
  
While the size of the master cylinder piston affects the hydraulic pressure of the entire brake system, weight shift and bias require that the heavily loaded front brakes receive much higher application force the lightly loaded rear brakes, These differences in force are obtained by using different sized pistons in the wheel cylinders and brake calipers.   
  
However, when equal pressure acts on unequal areas, as with different sized pistons, the brake application force will differ as well. The mechanical force (F) at the brake pedal pushrod is applied to the master cylinder piston area and converted into brake system hydraulic pressure (P). Brake calipers and wheels cylinders perform exactly the opposite. Hydraulic pressure applied to the wheel cylinder or brake caliper piston area (A) is converted back into mechanical force that is used to apply the wheel friction assemblies. Because the variables are identical, the same equation can be rewritten to explain how changes in piston size affect brake application force:  
  
(P) x (A) = (F)  
  
It is the piston surface area not diameter that affects force. If your brake pedal applies 500lb (F) on a master cylinder piston with 1sq. in. you receive 500psi, at the front wheels, the 500psi (F) is applied to a brake caliper piston that has an area of 4sq. in. the equation is as follows  
  
500psi x 4 sq. in. = 2000lb  
  
The 2000lb is mechanical force, not psi, it is still 500psi, just acting on 4sq in, converts to 2000lb force  
  
The drum brakes at the rear wheels of the same brake system uses wheel cylinders whose pistons have a surface area of 3/4in, While the pressure remains 500psi, the force is found in the equation as follows  
  
500psi x (3/4sq. in.) = 375lb  
  
Just as larger pistons increase the application force, this example shows that smaller piston area decrease it, The system pressure remains 500psi at all points, but the smaller piston is unable to transmit all of the available pressure. As a result, the mechanical application force is reduced to only 375lb.  
  
  
  
**Piston size Versus Piston Travel**In disc brakes, the mechanical force available to apply the brakes is four times greater because of the size difference between the master cylinder and the caliper pistons. Some of the hydraulic energy is converted into increased mechanical force. The tradeoff is that the larger caliper piston with the greater force will not move as far as the smaller master cylinder piston. The amount of hydraulic energy converted into mechanical motion is decreased. The relative movement of pistons within the brake system can be calculated with the following equation is as follows  
  
(A1 / A2) x S = M  
  
where;   
  
A1 = the area of the master cylinder piston  
A2 = the area of the wheel cylinder or caliper piston  
S = the master cylinder stroke length  
M = the wheel cylinder or caliper movement  
  
  
In the case of the disc brake example above, the equation would be as follows  
  
(1sq. in / 4sq. in.) x 1in = 1/4in  
  
The results show that, in this example, if the master cylinder piston stroke is 1in, the Caliper piston will move only 1/4 in.  
If the caliper piston area where reduced to only 2sq. in. the application force will increase to only 1000lb, but the caliper piston would travel 1/2in for a 1in master cylinder stroke.  
  
The equation for computing the difference in piston movement works for wheel cylinders as well. In the drum brakes example above, the amount of force transmitted by the wheel cylinder is less than the 500psi that exists within the hydraulic system. If the energy cannot be destroyed, the extra 125 psi of pressure must be converted into another form, the following equation for this problem explains where it goes  
  
1 sq. in / 0.75 sq. in x 1in = 1.333in  
  
The answer shows that if the master cylinder again travels 1 in. the wheel cylinder will travel 1.333 in. With a dual piston wheel cylinder the the travel is divded between the two pistons. If the wheel cylinder piston area is decreased to only 1/2in the application force will be further reduced to only 250lb but the wheel cylinder piston will travel 2in for a 1in master cylinder stroke.  
  
  
**Hydraulic Principles and Brake Design**When a brake system is designed, the hydraulic relationships discussed above play a major part in determining the sizes of the many pistons within the system. The piston sizes selected must move enough fluid to operate the wheel cylinder and brake caliper pistons through a wide range of travel, while at the same time they must create enough application force to lock the wheel friction assemblies.  
  
The pistons sizes chosen should also provide the driver with good brake pedal feel so the brakes are easily applied in a controlled manner. For example, a very small master cylinder piston can provide alot of hydraulic pressure with light pedal effort, but it will not move enough fluid the operate brake calipers with large pistons, In addition, a small piston will give the brake pedal a very touchy feel that makes modulation difficult, and leads to premature brake lockup. A large piston, however, provides less pressure and requires higher pedal effort, but it provides plenty of fluid volume and results in a less sensitive pedal feel that makes the brakes easier to control. Most disc brake applications have large master cylinder pistons to move the required volume of fluid, and a power booster to reduce the required brake pedal force.  
  
  
  
**The "Magic" of a brake system**   
  
  
The real magic of a hydraulic brake system is the fact that different forces can be created at different wheel cylinders. More force is necessary for front brakes than for rear brakes because, as the brakes are applied, the weight of the vehicle moves forward. Larger (area) pistons are used in wheel cylinders (calipers if front disc brakes) on the front wheels to increase the force used to apply the front brakes.  
  
Not only can hydraulics act as a "force machine" (by varying piston size), but the hydraulic system also can be varied to change piston stroke distances. On a typical vehicle, a driver-input force of 150lb is boosted both mechanically (through the brake pedal linkage) and by the power booster to a fluid pressure of about 1700psi.   
  
With a drum brake, the wheel cylinder expands and pushes the brake shoes against a brake drum. The distance the shoes move is only about 0.005 - 0.012in.  
  
With a disc brake, brake fluid pressure pushes on the piston in the caliper a small amount and causes a clamping of the disc brake pads against both sides of a rotor. the typical distance the pads move is only about 0.001 - 0.003in   
  
  
  
**Proportioning Valves**  
  
A proportioning valve improves brake balance during hard stops by limiting hydraulic pressure to the rear brakes.  
  
A proportioning valve is necessary because inertia creates weight shift toward the front of the vehicle during braking. The weight shift unloads the rear axle, which reduces traction between the rear tires and road surface, and limits the stopping power that can be delivered. Unless application pressure to the rear wheels is limited, the brakes will lock, making the vehicle unstable and likely to spin. The best overall braking performance is achieved when the front brakes lock just before the rear brakes.  
  
Vehicles with front disc and rear drum brakes require a proportioning valve for two reasons.  
  
1. Disc brakes require higher hydraulic pressure for a given stop than do drum brakes. In a disc/drum system, the front brakes always need more pressure than the rear brakes  
2. Once braking has begun, drum brakes require less pressure to maintain a fixed level of stopping more than they did to establish that level. In a disc/drum system, the rear brakes will always need less pressure than the front brakes.   
  
A proportioning valve is used to compensate for these differences because it is easier to reduce pressure to the rear brakes than to increase the pressure to the front brakes.  
  
**The proportioning valve does not work at all times**  
During light to moderate braking , there is insufficient weight transfer to make rear wheel locking a problem. Before proportioning action will begin, brake system hydraulic pressure must reach a minimum level called the split point, Below the split point, full system pressure is applied to the rear brakes. Above the split point, the proportioning valve allows only a portion of the pressure through to the rear brakes. The proportioning valve gets its name from the fact that it regulates pressure to the rear brakes in *proportion* to the pressure applied to the front brakes. Once the system hydraulic pressure exceeds the split point, the rear brakes receive a fixed percentage of any further increase in pressure. Brake engineers refer to the ratio of front to rear brake pressure proportioning as the slope. Full system pressure to the rear brakes equals a slope of 1, but if only half the pressure is allowed to reach the rear brakes, the proportioning valve is said to have a slope of 0.50. the proportioning valves on most vehicles have a slope of between 0.25 and 0.50.  
  
  
  
The end result, If you are experiencing greater affect to your rear brakes after completing a front disc swap, the rear wheel cylinders bore and surface area are too small, your rear brakes are adjusted too tight, your calipers of choice have two large of a bore and surface area, adding a proportioning valve is meant to be used under hard braking applications, if you find it is required to use a proportioning valve just to have everyday brakes, your calculations are off, and need to be adjusted, If you are to complete a disc brake conversion using D21 Hardbody calipers, use the rear wheel cylinders, and there is no need for a proportioning valve, the stock wheel cylinders are too small bore and surface area, that the travel applies the rear brakes before the calipers can catch up to themselves.  
  
If you have any questions, please feel free to ask, If you have info you would like to add, please feel free as well.

**2**[#3](http://community.ratsun.net/topic/35687-drum-to-disc-conversion-info/page__view__findpost__p__547948?s=991e2f358d0d4e9d56be76e54e35b363)**User is offline**[**mklotz70**](http://community.ratsun.net/user/11-mklotz70/?s=991e2f358d0d4e9d56be76e54e35b363)**[Icon](http://community.ratsun.net/user/11-mklotz70/page__f__20?s=991e2f358d0d4e9d56be76e54e35b363)**

* [](http://community.ratsun.net/user/11-mklotz70/?s=991e2f358d0d4e9d56be76e54e35b363)
* Beelzebub
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* **Group:**Senior Member
* **Posts:**5,033
* **Joined:**21-January 07
* **Location:**Gresham, OR
* **Cars:**'64 Fairlane wgn, '11 Kia SOUL,'70 521(wife's), '72 521(daughter's)

Posted 16 September 2011 - 02:00 AM

very interesting. Great write up!   
  
If you have it, would you mind also including info about the combination valves used in newer vehicles. As I understand it, they hold off the front brakes until the rears have a chance to engage first. This causes the rear end to "squat" a bit before the nose dive occurs. On my wife's 521 (first one I put discs on) I used a combo valve out of a non-ABS S10 pickup and they've worked great. They've been on that rig for about 9 years now if I remember right.  
  
So...you're saying to put the rear wheel cyls from the same vehicle that the calipers came from. I haven't looked it up yet, but the caliper is the same for the 720's and the HB's.....if there's a difference in the rear cyl dia, would it be better to use the 720's since it more closely matches the weight?

Don't have to be too bright to be me!! :D  
Sadly, I prove this nearly everyday!!! :(  
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[#4](http://community.ratsun.net/topic/35687-drum-to-disc-conversion-info/page__view__findpost__p__548422?s=991e2f358d0d4e9d56be76e54e35b363)**User is offline   [DailyDato](http://community.ratsun.net/user/6958-dailydato/?s=991e2f358d0d4e9d56be76e54e35b363) [Icon](http://community.ratsun.net/user/6958-dailydato/page__f__20?s=991e2f358d0d4e9d56be76e54e35b363)**

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* Advanced Member
* PipPipPip
* **Group:**Members
* **Posts:**139
* **Joined:**08-November 10
* **Location:**Franklin, Tn
* **Cars:**77 620 short bed, 84 King cab 720

Posted 16 September 2011 - 11:18 PM

Well, Im not too sure on the bore size of any of the brake systems yet, still doing research, but that was a lot to write. Yes, I can get you the info on the newer valves, but I do believe that all the valves allow the rear brakes to function first, its all about the spring pressure inside the valves, but I might be mistaken, but if one was to upgrade a vehicle from four wheel drum, to a drum/disc setup, for example, my 620, most of these small imports that support the H190 rear, instead of trying to swap just the wheel cylinder, why not just swap the whole backing plate, and upgrade the shoes and the hardware to a more "upgraded" design? Yea, it is a PITA to swap the axle shafts, but Im not to sure as to why you can't........ more research on the way

**1**

**[View Post](http://community.ratsun.net/index.php?app=forums&module=forums&section=findpost&pid=548422)DailyDato, on 17 September 2011 - 12:18 AM, said:**

Well, I’m not too sure on the bore size of any of the brake systems yet, still doing research, but that was a lot to write. Yes, I can get you the info on the newer valves, but I do believe that all the valves allow the rear brakes to function first, its all about the spring pressure inside the valves, but I might be mistaken, but if one was to upgrade a vehicle from four wheel drum, to a drum/disc setup, for example, my 620, most of these small imports that support the H190 rear, instead of trying to swap just the wheel cylinder, why not just swap the whole backing plate, and upgrade the shoes and the hardware to a more "upgraded" design? Yea, it is a PITA to swap the axle shafts, but Im not to sure as to why you can't........ more research on the way

Because the axle housings and axle shafts are a different length. However, it may be possible to use the 620 housing/shafts with the later model brake system if you did the change at the wheel bearing(if they are the same). By just changing the newer design backing plate assembly over to the older axle shaft/housing. Not sure if this will work or not though. And i have no reason to try it either.

76 620, VG30, 5spd, D21 V-6 front disc brakes, 3.90 rear gears:D.  
  
Jason  
  
Link to my yello620  
[http://community.rat...page\_\_hl\_\_yello](http://community.ratsun.net/topic/3521-my-yello620/page__hl__yello)  
Link to my VG conversion  
[http://community.rat...\_\_1#entry212685](http://community.ratsun.net/topic/15744-620-vg-conversion/page__p__212685__fromsearch__1#entry212685)

**0**[#7](http://community.ratsun.net/topic/35687-drum-to-disc-conversion-info/page__view__findpost__p__548823?s=991e2f358d0d4e9d56be76e54e35b363)**User is offline   [wayno](http://community.ratsun.net/user/5657-wayno/?s=991e2f358d0d4e9d56be76e54e35b363) [Icon](http://community.ratsun.net/user/5657-wayno/page__f__20?s=991e2f358d0d4e9d56be76e54e35b363)**

* [](http://community.ratsun.net/user/5657-wayno/?s=991e2f358d0d4e9d56be76e54e35b363)
* Datsun Mechanic
* PipPipPipPipPip
* **Group:**Senior Member
* **Posts:**2,970
* **Joined:**16-June 10
* **Location:**vancouver washington
* **Cars:**1969 521 KC, 1971 521 dually, 1967 2000 roadster, 1976 leyland mini, 1953 MGTD

Posted 17 September 2011 - 10:33 PM

Very good article, the only drawback/problem we have is we are buying products that will fit are application, if we need a rear wheel cylinder that is 15/16" bore, but only13/16" is available for the application, then we make due with a proportioning valve. Also when you mentioned using hardbody calipers, and rear wheel cylinders(maybe with the hardbody backing plates), would you not also use the hardbody master cylinder, then and only then would it be correct, but that is a pipe dream, it just isn't going to work/happen 90%+ of the time. The spring I believe you are talking about in the "valve"(master brake cylinder=MBC), is in between the front and rear pistons in the MBC, correct? I am dubious on how well that spring works, the lighter the vehicle, the better it would work I suspect. I think if even half of us could grasp your article, we could make an educated guess on what master brake cylinder bore size we need to use after converting to front disc brakes. Some of us have the choice of using 1985-86 720 rotors and calipers on the front of our 520/521/620 trucks and can use the complete 1985-86 720 3rd member because it is narrow enough to fit under our vehicle with our earlier stock rims, and the proper offset aftermarket rims, then we might have the choice of getting the proper MBC bore size, but whether it will work with the way the rest of our brake system(master brake cylinder choice/power brake booster/lines/load sensors/etc.) is set up is questionable. I really like articles like this, it makes me think, and I learn things, even though I didn't get/understand some of your article, I did learn from it. Keep writing these articles, I will read them for sure. BTW, the numbers I put in this reply are just numbers I grabbed out of the air, I just used them to get a point across.

[#8](http://community.ratsun.net/topic/35687-drum-to-disc-conversion-info/page__view__findpost__p__548955?s=991e2f358d0d4e9d56be76e54e35b363)**User is offline   [DailyDato](http://community.ratsun.net/user/6958-dailydato/?s=991e2f358d0d4e9d56be76e54e35b363) [Icon](http://community.ratsun.net/user/6958-dailydato/page__f__20?s=991e2f358d0d4e9d56be76e54e35b363)**

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* Advanced Member
* PipPipPip
* **Group:**Members
* **Posts:**139
* **Joined:**08-November 10
* **Location:**Franklin, Tn
* **Cars:**77 620 short bed, 84 King cab 720

Posted 18 September 2011 - 11:38 AM

If you work through the numbers, the stock master cylinder will work for doing a front disc swap. I’m curious to know as the why everyone up sizes the master cylinder bore, it causes a harder pedal, and the brake booster cannot properly correspond to the over sized master, I build high performance cars for a living, and for example, use the 05 Saleen Mustang we just finished, we upgraded to 6 piston Brembo front calipers, and 4 piston rears, didn’t touch the master, at all, its all about the surface area of the pistons in the parts that you use, if you use stock hardbody calipers, it depends on which ones you use though, the 4wd pathfinder and hardbody use a different bore size than the 2wd ones, it does make a difference in the braking, but the larger bore calipers will only make the rear wheels lock up quicker, it you run such a massive front caliper, the surface area versus pressure will not allow the caliper to " clamp" efficiently over the such small bore rear wheel cylinders, the high pressure and small bore causes such a great distance for the rear cylinder to be pushed out and apply the rear brakes first, I’m gonna try and edit my post with some pictures, I’m sure it will help everyone make more sense of what i have written, it kinda blew my mind when I started learning all of it to get my ASE's, but I caught on after reading and looking at pics.  
  
Wayno, you are correct about the spring inside the master cylinder, but it has a completely different effect than proportioning the brakes, its a failsafe built into the master, if you lose fluid in your rear reservoir, the spring will push the front plunger to apply the brakes instead of using rear fluid pressure, its a pretty stout spring too, Ill get up some pics of things and explain a lot more things, I’m just trying to come up with the time to get it all done, might get some time tonight, we'll just have to see.   
  
  
If someone can provide me the bore sizes of various calipers and master cylinders that work on say the 520/521/620, as well as stock rear cylinder bore sizes, Ill make an additional write-up about how to work out the math, and teach how it works, it’s not hard, it’s just tedious

I certainly wasn't the first to put discs on a 521. Guys like Epperly did it quite often back in the day, but they typically changed the shock tower and swapped over a 620 disc setup. I put discs on the kingpins back in 2004 and was probably one of the first to document it. The thread is still available, but the pics are gone :( Anyway.....  
  
The biggest reason for the m/c upgrade was because the 521's and older only had single reservoir m/c's. The guys with the 620s didn't really need to upgrade, but Datsun said they had the proportioning built into the m/c......so if you switched to disc/drum, it seemed to make sense to upgrade to a disc/drum m/c.

Don't have to be too bright to be me!! :D  
Sadly, I prove this nearly everyday!!! :(  
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[#10](http://community.ratsun.net/topic/35687-drum-to-disc-conversion-info/page__view__findpost__p__549308?s=991e2f358d0d4e9d56be76e54e35b363)**User is offline   [DailyDato](http://community.ratsun.net/user/6958-dailydato/?s=991e2f358d0d4e9d56be76e54e35b363) [Icon](http://community.ratsun.net/user/6958-dailydato/page__f__20?s=991e2f358d0d4e9d56be76e54e35b363)**

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* Advanced Member
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* **Group:**Members
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* **Joined:**08-November 10
* **Location:**Franklin, Tn
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Posted 18 September 2011 - 11:44 PM

OK, so far, this is what I have to show, this is the way the brakes work for my stock four wheel drum brake setup on my 77 620, the front wheel cylinders measure 3/4in bore, the rears are 5/8, and the master cylinder is 3/4in bore as well  
  
If you take your foot, and press on your brake pedal, with 150lbs of force, through the pedal assembly into the master cylinder, there is a approximately 5:1 ratio built into the pedal and bracket assembly, the pressure of your foot increases to 750lbs on your master cylinder, suppose you mash your pedal down 1/2 in, the master cylinder piston will travel only 0.005 in (keep in mind the 5:1 ratio) 0.005in is close for a properly working brake system, it’s a generic number, in actual terms, a master cylinder will generally move only 1 teaspoon of fluid to activate brakes, keep that in mind that the 1/16 distance referenced   
  
To accurately figure the PSI pressure, not LBS force, you have to convert your 3/4 MC bore to surface area, you do that with the formula A = 3.14 x (1/2 D)squared (I can’t insert the tiny 2) where D is bore or 3/4 or .75, So A = 3.14 X (.375 X .375),   
  
A = .442sq in   
  
Your 3/4 bore master cylinder surface area is now .442sq in  
  
  
So you use this formula, P = F / A so fill it in, P = 750lbs / .442sq in  
  
Your master cylinder exerts a pressure of 1697 PSI and that is without figuring the additional force of the power brake booster,  
  
Because every engine is different, and idle at different speeds, cams are different, the amount of vacuum the engine pulls on the booster varies greatly, all these figures are without figuring the booster, but it will only increase theses numbers greatly, so if your booster works, there is no reason the give the headache of explaining how a power booster works with vacuum right at this moment, it will only further confuses everyone, just skip it  
  
OK so now what you ask, Well a 3/4 bore master cylinder exerts 1697 PSI,   
  
To figure the LBS force to each wheel, you need to figure the surface area of the front and rear wheel cylinders,  
  
We know a 3/4 bore MC surface area is .442sq in..... So is a 3/4 bore wheel cylinder  
  
A 5/8 bore WC is figured the same way  
  
A = 3.14 x (1/2 D) squared or A = 3.14(.3125 x .3125)squared  
  
A = 3.14 x (.3125) squared  
  
A = .307 sq in  
  
  
So if you can still follow me, a….  
  
3/4 bore MC has a surface area of .442 sq in  
3/4 bore WC has a surface area of .442 sq in  
5/8 bore WC has a surface area of .307  
  
All three of the surface areas have 1697 PSI on them  
  
Okay?? What does that mean??  
  
Take your PSI and multiply it by your individual surface areas, and it gives you the mechanical force of your brakes at each wheel, like this  
  
F = P X A   
  
F = 1697 X .442  
  
F = 750  
  
So as you can see, that the pressure acting on your front wheel cylinders converts to 750 LBS WHY??? your master cylinder and wheel cylinder have the same bore and same pressure, it just converts back and forth between PSI and LBS so your answer should be really close to your starting force depending on how you round your decimal places.  
  
Rear  
  
F = 1697 X .307  
  
F = 521  
  
You just need to understand how the same pressure (PSI not LBS) acts on the different surface area, making the WCs travel different distances.  
  
this is mind boggling if you can’t visualize, so I’m gonna try and be very generic  
  
So, lets recap,  
  
Total system PSI is 1697PSI  
  
MC surface area is .442 sq in and we call this A1  
Front WC surface area is .442 sq in. call this one A2  
Rear WC surface area is .307 sq in. call this on A2 also  
  
Your foot travels 1/2 inches toward the floor. This is general reference and important, but not used other than to calculate the depression of the master cylinder  
Master cylinder is depressed .005 Call this one Stroke, or S and we want to solve for the outward movement of the WCs so we call this M  
  
OK, so to understand everything we just went over, you use this formula  
  
(A1 / A2) X (S) = M  
  
Just fill it in  
(.442 / .442) X (0.005) = M  
  
(1) X (0.005) = M  
  
(0.005) = M  
  
So your front wheel cylinders move outward 0.005 in @ 749.99LBS  
  
Now for the Rear  
  
(.442 / .306) x (0.005) = M  
  
(.1.44) X (0.005) = M  
  
(0.007) = M  
  
Your rear WC move 0.007in @ 519.23 LBS force  
  
And you end up with your "60/40" split braking with drum brakes, hopefully everyone can still follow along, I’m about to convert just the front WC to 93 2wd Hardbody calipers, they have a bore on 2.253in, everything else will stay the same, I’ll give you the end result.  
  
Convert 2.253 to SQ IN   
  
A = 3.14 x (1/2bore)squared  
  
A = 3.14 x (1.127)squared  
  
A = 3.14 x (1.269)  
  
A = 3.98 sq in  
  
Now find the force of your new calipers  
  
F = P X A  
  
F = 1696.83 X 3.98  
  
F = 6753.383 LBS force quite different from the 749.99 we found with 3/4 bore WCs  
  
Now we look for how far the calipers move   
  
(A1/ A2) x (S) = M where A2 is now 3.98 and not .442  
  
  
we find   
  
(.442 / 3.98) x .063 = M  
  
.111 X .063 = M  
  
.00055 = M  
  
So now we see, that a 3/4 bore MC depressed 1/16in will now move front calipers .00055 in and the rear WC move .009 but still at the original 1697 PSI and that converts to no front brakes and all rear brakes, Typical drum brakes will move between .005 and .012, and calipers operate between 0.001 and .003.  
  
  
What does this tell us, the rear brakes operate within limits, but the new front calipers are well under the normal operating limits, so you end up with rear brakes, and no front brakes  
  
Lets compare  
  
OG drum brakes front and rear, assuming adjusted correctly.  
  
Fronts move .005in with an outward force of 750LBS Rears move .007in @ 520LBS operating limits are between 0.005in - 0.012in so if you have your brakes adjusted properly, they will rub the drum quite a lot actually  
  
But with front caliper swap and stock WCs in the rear  
  
operating limits are 0.001in and 0.003in for disc brakes  
  
Fronts move 0.00055in @ 6753.83 LBS rears still 0.009 @ 519.22  
  
  
  
OK, so you say, Let’s put a 280ZX master cylinder on this thing and keep the calipers and rear WCs, I’ll keep this simple, let’s compare, stock pressure versus a larger bore 280zx master  
  
Stock surface area, .442  
  
Stock PSI @ 750lbs force 1697  
  
280ZX  
  
15/16 bore, converted to surface area .69sq in, and with 750LBS force applied, yields only 1087 PSI but the affect on the surface area of the calipers, raises the PSI to 4326 with the additional force of the booster, it goes way up there, you can use your stock master cylinder, but the pedal travel in increased due to more fluid requirements, that and the stock D21 bore is 15/16, so the 280ZX Master is able to bolt to the 620 booster with simple mods,  
  
  
  
The H190 axle has the same outer axle bearings between the 620, 720, and D21, so if you use the stock 2wd front calipers, you need to swap the rear backing plates, you then get access to larger rear wheel cylinders, easier to find and cheaper rear shoes and drums, as well as self adjusting rear brakes…..ooooooohhh self adjusting drums…..nice….. only thing I haven’t found info on is as to if the E brake cables will fit the newer backing plates, but if you swap to the rear wheel cylinders for a hardbody, here is the difference.  
  
  
  
Stock 620 5/8 bore WCs surface area of .306, distance of travel .007, @ 519.22LBS  
  
Stock D21 7/8 bore WCs surface area of .601, distance of travel .004@ 1019.79LBS  
  
  
  
So, to keep a decent pedal travel, the stock 620 master cylinder will work, it will have high pedal travel, and will need to be upgraded to something larger to remedy it, but the smaller the bore, the better brake response you will have, the fluid pressure will be higher, but the volume low. But that’s all in a new topic. It's 3:45 A.M, my brain hurts, and I'm tired, this topic is ending in the middle of a thought, but I give up, I cant do it no more, not right now, ill come back tomorrow or something.

/I see there have been some responses to Pete's question. This is an email I sent to him off list to explain the specific question about going to a smaller wheel cylinder diameter. I chose to post it here as it details the reason why braking force is reduced when going smaller.../

Okay...here is a calculation to help you make your decision...

Assume you press on your brake pedal with a force of 200 pounds...   
(I am using 200 # as a constant but I don't know how much force is typical)

15/16 = .9375" radius of .9375 = .46875 area of cylinder = (pi â€¢ r2)...   
                            3.14 â€¢ .(46875 â€¢ .46875)   
                            3.14 â€¢ .2197265625   
                            area =.69 sq inches

11/16 = .6875" radius of .6875 = 34375 area of cylinder = (pi â€¢ r2)...   
                            3.14 â€¢ .(34375 â€¢ .34375)   
                            3.14 â€¢ .1181640625   
                            area =.37 sq inches

Now, pressing on the pedal with 200 pounds of force per square inch, sends exactly 200#/sq. in. going into the cylinder...   
(I am not referring to the amount of pressure exerted from foot to pedal pad but to the amount of pressure at the input side of the master cylinder)

with the 15/16" cylinder being .69 square inches in area, you are putting 138# of pressure out of the cylinder   
        to the brake shoes...

with the 11/16" cylinder being .37 square inches in area, you are putting 74# of pressure out of the cylinder   
        to the brake shoes...

So if you make this change you will be reducing rear braking by (138# - 74#) = 64#   
(64# / 138#) = a reduction of 46% braking force in each rear cylinder.

You have to assume that the disc brake calipers which require more pedal force to stop the car would be causing you to press harder on the brakes each time you slow or stop. Maybe with the larger 15 /16" cylinder you would get too much rear braking making the rear brakes lock up and causing your car want to spin around if your steering wheel were even slightly turned.

Your front cylinders being of a 1" diameter... after doing the math =   
.785 square inch area With the same 200# pedal pressure produces 157# of pressure out of the cylinders to the front brake shoes.

So, Stock rates of pressure from the shoes to the drums with a 200# pedal pressure produce... 157# to front shoes 138# to rear shoes

for a ratio of 1.3 to 1 (front to rear) which is what you would want in that the front does most of the braking. I don't know if this is the   
"ideal" ratio for the 411 nor do I know if it is ideal for any car for that matter but I do know you, for sure, do not want more braking on the rear .

You really need to know the brake swept area of the shoes to get an accurate value of the actual pressure per square inch of braking force. The size of the drums and rotors also effect the braking balance as you get more leverage with larger rotors or drums...

If they are all the same size shoes and drums (front & rear) then the above calculations provide enough information to form an educated opinion as to your original question. In that you are only talking about changing the cylinders, you now know that you will definitely reduce the braking to the rear of the car.

You do not provide the size of the pistons on the front calipers. If you assume a diameter of 1.8" which is probably close, then the following is true... 2.5434 square inches of area \* 200 pounds of pedal pressure = 508# of pressure to the front pads.

The size of the master cylinders do not effect the pressures. 200#'s in is always 200#s out. Only the volume per inch of pedal travel changes. The larger master cylinder diameter is to compensate for the larger pistons of the calipers. You have to move more fluid to push them the same distance as brakes with a smaller diameter cylinder.

In that the front pads appear to provide less brake swept area of contact with the rotors, this seems appropriate to have so much more pressure going to the front brakes.

You really need to know the brake swept area of all of the components to do an accurate calculation of what is going on. Most people put larger brakes on their cars only in the front which tips the balance in favor of more front braking which is a safer situation but you can go too far and lose effective rear braking in the process.

It is also important to increase the size of the master cylinder if you go much larger than the stock caliper surface area or you can have a situation where the pedal has to travel too far to engage the front pads to the rotors. Install a larger master cylinder and you will reduce your pedal travel for the same braking effect but the pressure deal is always, what goes in is what comes out.

It is not as simple as most assume and I believe most people never do any calculations but only guesstimate what will work and base their final setups on actual use and feel of the systems.

I'm tired ... goin' to bed I hope you make an educated and safe decision... Later... Mario

Hi All. I am familiar with the Auto Restorer article Stanley is talking about, since I wrote it. http://www.chevytalk.org/fusionbb/images/smilies/wink2.gif The master cylinder I used was the CCP MCPV-1 unit, with a 1" master cylinder. I am very happy with it.It is good as far as pedal pressure, although the pedal travel is the upper limit of what I like with rear drums. Rear disks would result in less pedal travel.   
  
A 1 1/8" MC would be stiffer (less travel), but requires 27% more pedal force for the same stopping power. This means it will need more booster to work properly. Or more mechanical leverage from the brake pedal (from where the MC input rod bolts to the pedal lever).  
  
Since I wrote the AR article, I upgraded my car to a 9" dual diaphragm unit. I felt the car could benefit from more booster (which proved to be true). I needed an 8" dual booster for another project I am doing, so I bought a 9" dual and re-used the booster from the Bel Air on my new project.   
  
The 9" dual booster has a bit more brake assist, which is nice. It is comparable to an 11" single booster. It was not a night-and-day difference like the original brake mod in the article, but the car definitely likes the additional boost.   
  
If you go with the 1 1/8" master cylinder, you will need to use a big booster (9" dual or better) or more mechanical leverage at the pedal. It will work either way, but the secret is to get it all into balance. There are several folks on CT who have fully manual braks which work fine because they chose the right combo of parts the first time (and don't mind a heavy pedal).   
  
On the CCP master cylinder, only the rear cylinder is adjustable. The idea is to synchronize what the rear brakes are doing compared to the fronts, so the front brakes are regulated by your foot, and the rear brakes are balanced to work best according to what the fronts are doing.   
  
There is nothing magic about the CCP master cylinder - you can do the same thing with a combination valve and an adjustable proportioning valve. However, I really liked the idea of everything being packaged together into one unit. I really like it and would do it again. I have gotten several interesting questions at car shows about what it is. Seems self explanatory to me, but a lot of folks have been very curious about what it is! In terms of how long it took to dial the brakes in - it took 3 test drives and a total of 45 minutes to get the brakes the way I want them. In my book that is pretty darned fast! (It was the brake bleeding that busted my chops, but that is another story entirely!)  
  
Best of luck with your car and your braking system upgrades. None of it is rocket science, but the trick is to choose the right parts the first time so you are happy with the system and it works well. If you build it with some adjustability, you can dial in the brakes to where they work very impressively!  
  
Regarding the depth of the MC cup, for power you want shallow, for manual brakes you want deep. To keep everyone happy, most aftermarket companies make their MCs with the deep cup and provide an adaptor to shallow when using a power brake booster. It isn't a big thing, especially if you buy the booster and MC from the same place.

pedal ratio is determined by dividing the length of the arm [the pedal pivot to the pedal pad center] by the distance from the pivot to the master cylinder pushrod hole. the FARTHER away from the pivot point, the lower the ratio. you may be able to fix this by just drilling a new master cylinder rod attaching hole in your pedal. the thing to watch for, however, is that you don't bind the rod in the master at full stroke.