Hoppers Stoppers
Guide and Considerations for Designing Brakes for Modified Cars.

As a general policy when embarking on designing your brake upgrade kit we ensure we work with in the guidelines of DOTARS National Code of Practice for Light Vehicle Construction and Modification (NCOP) Vehicle Standards Bulletin 14 section LG.
This document is an excellent guide for anyone contemplating building or modifying a vehicle and can be viewed at
http://www.infrastructure.gov.au/roads/vehicle_regulation/bulletin/pdf/NCOP5_Section_LG_Brakes_3Feb2006.pdf

Having been in the industry for a while now we see both "amateurs" and "professionals" do things in the name of saving time or money, and yes, we have made some of these mistakes ourselves, but we aim to learn and improve our product at every opportunity.

The following are typical things you might like to think about if buying or building a brake conversion or upgrade.

Rating of brake conversions to match car Weight and Power.

A good starting point when designing a brake conversion for your car is to compare the weight and power of the donor vehicle to the car you are fitting to. If the brakes you intend to use are designed to pull up a modern 2 tonne car then they should be fine for your old 50's 2 tonne car. For example HQ type brakes on 68 Chevies; that was all we had in the old days, and certainly better than drums, but if you want your Yank Tank to stop like a new car the brakes have to be able to take it.
If you can demonstrate to your Engineer that the brakes you intend to use are off a similar size and weight car he will be more likely to pass the plan

Disc Rotors

The thickness and diameter of the rotors should match the calipers. For example if the caliper is intended to run on a 28 mm thick rotor and you have a 22mm rotor, such as a VT caliper on a VS rotor, the pads will slip out of their cradles well before the pads have worn to minimum thickness, resulting in total brake failure. Similarly some VE calipers are intended for 30mm rotors so using them on 28mm rotors is not wise.

It is not generally acceptable to drill extra holes in disc rotors, particularly four holes amongst five where two are very close together, as this can lead to rotor fracture and explosion. Some factory rotors have five anoungst five, which sets a precedent, but your Engineer may still need convincing this is good practice. Drill blanks where possible.

It is certainly not wise to thin down the mounting flange where the rotor fits the hub, and as a general policy any machining that reduces the strength of the rotor should not be performed. Welding inserts into cast iron e.g. to reduce a diameter to make a handbrake fit is just plain dangerous engineering, but we have seen it done.

Calipers

As a principle it is not acceptable to weaken a caliper by grinding or machining any structure such as the cast cradle or the body. These parts have been designed by the OEM/Brake Company to transmit the designed loads including fatigue lives and once this is changed the durability of the calipers may be compromised. A slight clean up of casting flashes may be ok but wholesale machining such as taking several millimeters off cradle webs is not a good thing. The plugging of cradle holes and re-drilling new holes half into the plugs is also to be avoided as the plugs do not replace the strength that was removed.

Here in Australia our modified cars require Engineers Inspections, and being conservative souls they look very hard at where the substituted brakes have come from. If your choice of caliper is off an ADR Approved car of comparable weight your Engineer will most likely be happy.
If it's an aftermarket type that has never been installed on a production car he has nothing to compare to, and might not approve.
Calipers that do not have dust boots are debatable and the ADR pressure requirement for 3000 PSI test pressure is unlikely to be met on some lightweight alloy aftermarket items.

Brake Pads

It is important that brake pads run fully on the rotor, sometimes assembly tolerance may cause a pad to sit right to the edge, but if the pad sits several mm off the disc something is wrong and the manufacturer should be consulted, e.g. we see this if our Torana kits are fitted to HQ stubs, so don't let this happen, call and have the parts exchanged.

With respect of rotors, calipers and pads, these are considered wearing parts. It is best to keep these standard so that future replacements are easily purchased.

Conversion Hubs

These should be designed to use existing bearing and seal parts numbers if possible, so that replacements are readily available. Generally hubs are made of high quality steel for strength and economy. Aluminum alloy is used where light weight is required but this must be high strength alloy with allowance for thermal expansion around bearing fits. Only use sleeves under bearings if there are no other alternatives as these have been shown to affect long term durability due to misalignments.

Wheel studs should be attached using recognized automotive methods, eg press fits or screwed from behind so they cannot inadvertently come out. Stud size should be at least same as the original vehicle used, or of larger size and quantity if extra power or weight is a factor.

Mounting Brackets

The brackets used to attach the calipers should be of sufficient thickness with material around holes sufficient to transmit all braking loads. As these loads are often unknown a comparison of sizes on OEM brackets or testing to prove the strength is required.
The bolts used to attach the caliper to the bracket should be the same size and grade as the OEM used, and the attachment to the spindle should use the factory points for original calipers or minimum three holes out of four on drum brake backing plate flanges. Always use self locking nuts, spring washers or other locking devices on fasteners. Some OEM's use Locktite or safety wire as well.

It seems some fabricators have little feel for how much force is applied and what constitutes a well designed bracket. We have seen caliper brackets bolted to the small holes intended to mount splash shields, and even 6mm thick aluminum plate for mounting calipers. Very scary.

From our testing minimum thickness of 10mm plate is a good starting point for bracket design for full size cars. Most plate brackets have spacers between the spindle and the plate. Ensure the plate is rigidly mounted, with the bolts and nuts surrounded by sufficient material. A small weld might be used to keep a spacer in place, with a bolt through the lot, but plates should not be welded as a structural member. Ie do not transmit braking loads through welds, that is unless you are prepared to somehow prove the weld is strong enough and will get every weld certified by Xrays etc. Just saying you are an expert welder is not acceptable when it comes to brake or suspension fabrication.

Stub axles / Spindles /Struts

An old trick to fit discs to spindles that had drums with different bearing sizes was to machine the spindle diameters down to use the smaller bearings, eg Bedford Vans with HQ rotors. Having seen these break we can understand why the Dotars forbid it. The car companies design the spindles to take a certain weight so who are we to say it safe to reduce them.

Master cylinder and boosters

Some registration authorities are quite strict that the master and booster used in a brake conversion are off the exact same make and model as the rotors and calipers.
Whist this may sound foolproof it is not always practical and those with experience know that there are other brands that mix and match. The problem is of course having the experience.

A good starting point will always be to use the same bore master and booster regardless of where the rest came from, but you really have to go into it much deeper than that.

Car companies sometimes use smaller bore masters and reduce the pedal ratios to compensate.

A few examples to get you thinking.

Commodores VB to VR use 54mm pistons front, 38mm rear, 15/16 or 1 inch masters.
HQ to WB were 64mm front, with discs had 44mm rear, always a 1 inch master.
Early Falcons to XE 60mm front, 44 rear, 1 inch master. From XF 7/8 fast fill master.
From EF they got 38mm rear calipers, all on esssntially the same cars.
VT, AU and BA calipers are twin 42's which have the same area as a single 60 and use 1 inch masters fast fill.
Jags have equivalent of twin 48mm pistons in the calipers but 7/8 straight bore master so they have a different pedal ratio.

So its not always clear cut and experience and hard thinking is necessary.
eg
1/ If you were to use Commodore 54mm calipers on say a Mustang conversion you would have smaller pistons than its sister Falcon at 60mm with resulting less brake clamping forces, but this is a common brake kit.

2/ VB to VL Commodore rotors at 270 x 22 are smaller than HQ at 276 x 25.4, so hey guys, fitting some Commodore brakes on your HQ is actually reducing its braking capacity !

Front / Rear Balance

Cars vary a lot and once we modify them tyre sizes and engine placement can have an effect but a good rule of thumb is that we want around "two to one" front to rear balance to compensate for weight transfer.

This means on four wheel discs about twice the hydraulic piston area on the front to rear. But that's just a starting point and car companies do a lot of testing to refine this rule of thumb.

There are variables that effect every car such as wet, dry, gravel, snow, weight transfer under hard braking, loads, tyre wear, so there are already compromises in mass production cars let alone highly modified cars. A good example would be where Mitsubishi Magna's had larger rear caliper pistons on wagons compared to sedans but otherwise the same discs and pads.

So try to keep things sensible, DON'T fit front calipers on rear axles as this is sure to lead to premature rear brake lockup and a very quick exit into the shrubbery.
Just because that little Jap car booster and master is small and fits easily doesn't mean it will give sufficient volume output for those big car calipers.

Even car companies make mistakes, so if the car you intend to take your brakes off has a reputation for problems, be careful.

Some examples,
Most 70 GM cars like Camaro's had huge caliper pistons that were even wider than the pad backing and generally a very flexible caliper body. These cars inevitably have a spongy pedal feel that can only be fixed by changing to a better-engineered caliper. The Yanks may have accepted this but Aussies don't like it at all.

1967/83 Corvettes had big 300mm x 32 four-piston brakes on all four wheels, albeit with a dumb seal design. Then for some reason 1984/87 Corvettes had a 300 by 20 single piston front brake that was 99% VB Commodore and stopped about as well. This was on a high performance car, not a family sedan. What were they thinking?

I suppose we should not be surprised but those Russian Lada Niva's came with rear drums that had NO adjustment at all, except for pulling up the handbrake cable adjuster. When the shoes were worn you had to pump the pedal to get brakes, no way to fix this. How they ever let these cars into the country is a mystery.
I've got a hundred stories like this!

Hydraulic handbrakes.

I'll get straight to the point; they are not safe. If you are holding the car on a hydraulic caliper it might leak or will lose pressure as it cools down and let the car roll when no one is around. Totally mechanical mechanisms for park brakes, thank you.

Ok, there you go, a few of the thing we have learnt through our own or other people's mistakes. I'm sure there will be more to learn, and no one know its all, but as long as we keep trying to improve the quality of our work on Modified Cars the easier it will be to keep the people in power happy and our Hot Rods on the road.

Safe Motoring

Peter Koning

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