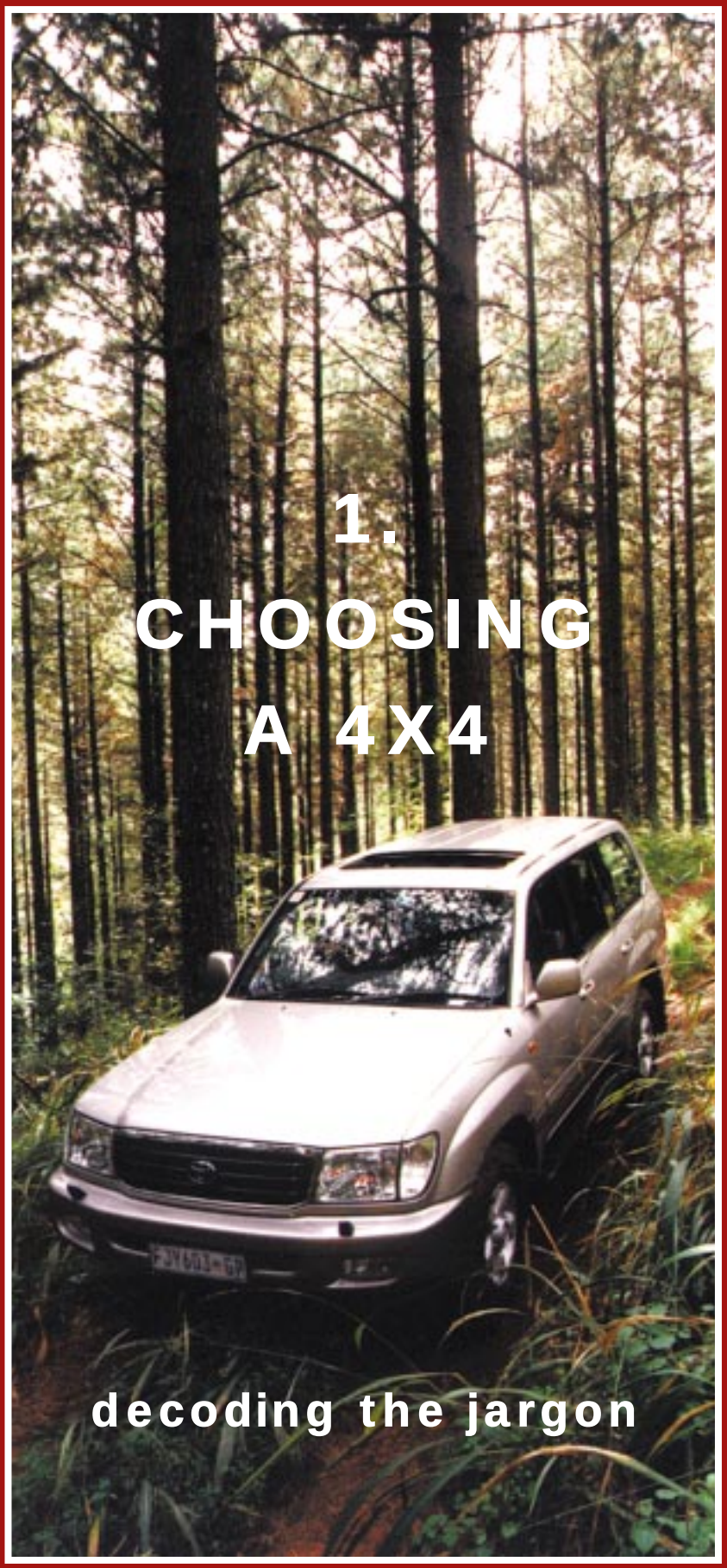
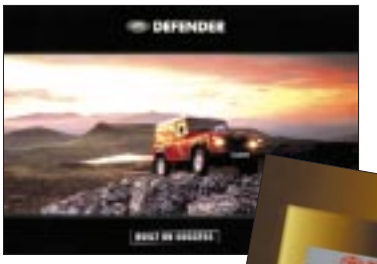
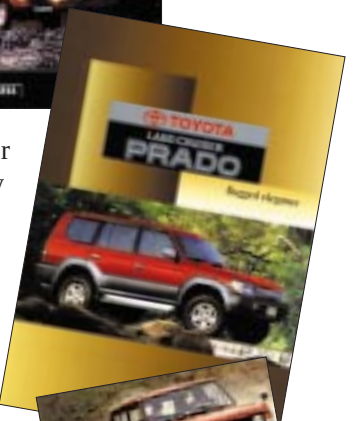
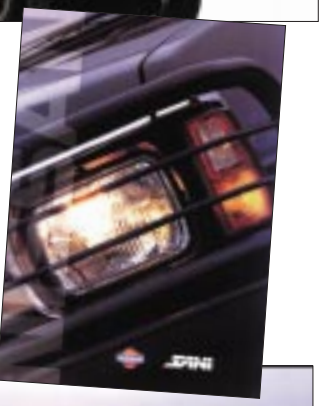


1.
CHOOSING A 4X4

decoding the jargon







The four-wheel drive vehicle has changed a great deal since it was first produced in any number, but at no time has this change been as swift as in the past 15 years. Between 1948 and 1968, vehicles like the Jeep CJ, Toyota Land Cruiser and Land Rover changed very little – they remained utilitarian, functional machines. In the late 1960s and early 1970s the market changed and Jeep built the Cherokee with power steering, Toyota produced a station wagon with wind-up windows, and Land Rover created the coil sprung Range Rover. Even the Range Rover, the leader in the leisure 4x4 market for decades, was a year and a half in production before any carpets were fitted.

Comparing the sales brochures of many of these originals with their modern equivalents reveals a completely different marketing strategy - vehicles that were once photographed climbing mountains are now seen in the polished environment of a studio. This illustrates how the image for most 4x4s has changed from rugged working machine to urban fashion statement. And now to compound the problem of choosing a suitable vehicle, manufacturers are creating 4x4s without true off-road ability and advertising them as off-roaders.

It is true that in the modern world comfort is as important as off-road working ability, but many four-wheel drives are becoming so sophisticated that while being brilliant off-roaders are totally unsuitable for wilderness travel. Sophistication makes servicing and repairs complicated, and not something to look forward to when in the bush miles away from civilisation.

As a result, all civilian four-wheel drive vehicles are a compromise between a town vehicle and an off-roader. Therefore, in selecting a vehicle designed for this double life, the buyer should ask this question: 'How much time will I be spending on tarred roads and how much off-road?' and 'If I intend to go off-road, do I want to travel into the wilderness?'

Every aspect of a four-wheel drive vehicle is compromised to some degree. What follows is a guide to variations in design and equipment that will be encountered when selecting a four-wheel drive vehicle.

ENGINES

The ideal powerplant for an off-roader is able to produce its power at low RPM. Engines that do this can be driven in higher gear ratios in difficult terrain which is advantageous because the higher the gear ratio, the less chance of wheel-spin and the more delicately the driver can control the engine's power output. Engines designed with long piston strokes tend to do this.

Good off-road driving technique calls for selecting the right gear for the conditions. If the gear ratio selected is too high, a more powerful engine may still have the torque to get through, but if the gear selected is too low, a big engine could, if not handled skilfully, cause excessive wheel-spin and bogging down. For a novice driver therefore, high power is often a disadvantage. For long distance travel, larger engines are more reliable than small ones because they rev slower – but the penalty comes in higher fuel consumption.

COMPARISONS: PETROL VERSUS DIESEL

PETROL ENGINES	DIESEL ENGINES
petrol engines are quiet	some models are very noisy
more mechanics understand petrol engines	fewer mechanics understand diesel engines
many multi-valve petrol engines produce top torque at high revs	diesel engines produce high torque at low revs
less frequent servicing required	more frequent servicing required
more complex electrical systems	more complex fuel systems
less economical, less range	more economical, more range
cheaper to service	more costly to service
fuel less pungent but more volatile	fuel more pungent, safer to transport

DIESEL ENGINES

As a rule, diesel engines produce their highest torque at low RPM. They are more economical than petrol engines and in many Third World countries diesel fuel is more readily available. Also, electrical problems caused by water, for example when wading, do not present a problem for the diesel engine. Although diesel engines are more fuel efficient than petrol, service intervals are shorter and in some cases will nullify any savings made by their lower fuel consumption. Regular servicing is especially important in Africa as the sometimes poor quality of diesel fuel can threaten engine life.

In Third World countries, fuel is frequently contaminated with dirt and water, with the result that fuel related problems cause more breakdowns than any other single factor. Ideally dual fuel filters systems should be fitted. At the very least, spare fuel filters must be carried.

Turbocharged diesel engines

Direct injection turbo-diesel engines have become a commonplace engine option with most four-wheel drive vehicle manufacturers. All turbo-diesel engines suffer from turbo-lag; the pause between

the time that the accelerator is pushed and power is applied to the wheels. The smaller the engine the more noticeable the lag. If the engine produces low torque before the turbo is working, driving very slowly at low engine revs will be difficult. If the engine produces high torque before the turbo is effective, then driving over obstacles at low engine speeds will be easy. This characteristic makes for a good off-roader. Some engines suffer from such severe turbo-lag that almost all off-road driving needs to be done in low-range first, and in this case vehicles tend to struggle.

As a long distance cruiser, turbo-diesels can be a real pleasure as they offer excellent on-road performance with superior fuel consumption, good torque for steep climbs, thick sand and mud. Another advantage of a turbo-charged engine is that altitude has less effect on performance than it has with a normally aspirated engine.

Some turbo-diesels are fitted with an intercooler, a radiator which acts to cool the hot air pumped by the turbocharger, which itself is powered by hot exhaust gases, before it enters the combustion chambers. They often increase power outputs by over 25%. As they are unsophisticated they are no burden for wilderness travel.

PETROL ENGINES

There are still many parts of Africa where diesel and leaded petrol are the only fuels available. Engines designed for unleaded petrol are therefore unsuitable for use as touring vehicles in Southern Africa. Poor quality petrol found in rural areas can also create problems with sophisticated high compression engines, clogging fuel filters and affecting sensitive fuel injection systems. Ideally, petrol engines in long distance touring vehicles should be simple to maintain and spare fuel filters should always be carried.
Unfortunately, modern 4x4s are being fitted with engines so complex that even basic servicing is designed to be done only at a dealer. I found out on a recent trip, after a deep wading incident had caused water to contaminate a Pajero's electrics, that special tools are needed to remove a Pajero's spark plugs. In this case the vehicle was abandoned and trained service personnel were taken to the stricken vehicle a week later. The petrol Pajero is not the only vehicle to fall into the category: 'If it breaks you will probably need professional help to fix it'.

Altitude also affects engine performance. A petrol engine with a compression ratio of about 8.5:1 will run well on 87 octane fuel above 5 000 feet or 93 octane at sea level. With a compression ratio higher than 8.5:1, a higher octane fuel would have to be used – 93 octane fuel at altitudes above 5 000 feet or 97 octane at sea level. It is important to consult the operator's handbook for recommended fuels. A fuel's octane rating is calculated from the rate at which the fuel burns. Running a low compression engine on high octane fuel will do no damage. In contrast, running a high compression engine on low octane or poor quality fuel could cause serious damage.

ENGINE MODIFICATIONS

Performance means different things to different motorists. For a 4x4, performance means flexibility; on-road power suitable for towing a boat, trailer or caravan, as well as low speed power and torque giving the vehicle the ability to traverse difficult terrain while maintaining low engine revs essential for driver control.

The four-wheel driver's vehicle has two kinds of life – on and off the road. However, different applications can affect performance; modifications to improve on-road performance may have detrimental effects on the vehicle's off-road abilities.

Vehicle manufacturers always strive to increase engine power without increasing the engine's size or weight. One of the ways of doing this is to improve the engine's capacity to breathe. Increasing the amount of air that can be consumed by an engine during the combustion cycle increases engine power. Fitting fuel injection, larger carburettors, free-flow exhaust systems or larger inlet and exhaust ports will increase this air flow.

Although the technology is not new, the trendy way to do this is to build engines with lots of valves. Multi-valve engines tend to have one thing in common: they develop higher power than similar standard valve engines, but at higher RPM, and this is a disadvantage in off-road driving. These engines have overhead camshafts, are normally fed by electronic fuel injection and are complex and expensive. They are built to withstand the stresses of running at very high revs, where they produce their maximum power. Maximum torque will also report for duty at higher revs.

Modifications to engine components to increase performance are many and varied. Some carburettor modifications are unsuitable for a vehicle expected to work in difficult off-road conditions, since many off-road vehicle carburettors are fitted with special float chambers which allow them to operate when tilted during steep ascents and descents. Fuel injection systems do not suffer when the engine operates at odd angles.

Fuel injection versus carburettor

Modern fuel injection systems are as reliable, if not more so, than carburettors and have the added benefit of lower maintenance requirements and better fuel efficiency. The drawback comes when a breakdown occurs. Fuel injection requires specialist knowledge to repair, unlike the carburettor, which is a relatively simple device requiring basic auto mechanical understanding to maintain or repair.

Beware of modifications that are unsuitable for off-roaders

Engine modifications which include increased breathing capacity, for example Brospeed conversions to Hilux, requires cutting a great big hole out of the air filter housing to increase air flow. This mod is not mentioned in the sales talk but renders the vehicle unsuitable for any (even shallow) wading. Many performance specialists are doing this and I have seen this mod on Land Rovers, Isuzus, Land Cruisers and Hiluxes.

Free-flow exhaust systems

Free-flow exhaust systems consist of big bore pipes and free-flow silencers. Standard engine exhaust manifolds are often cast iron, heavy, cheap to manufacture and inefficient. In the free-flow system there are big bore pipes bent and welded that allow the gas to flow more freely. The remainder of the exhaust is similar to the standard system but is made using big bore pipes and free flow silencers.

The advantages of free-flow exhausts are numerous:

- *They improve fuel economy and thereby increase a vehicle's range.*
- *They improve acceleration without negatively affecting the power and torque output rev-range.*
- *In many cases they are cheaper than a genuine factory part.*

Although not spectacular, individually these improvements are noticeable and make the vehicle more pleasant to drive. When fitted to my own vehicle, fuel consumption improved by about 1.5 litres per 100kms. I calculated that at today's fuel prices, for a new free-flow exhaust system to pay for itself in fuel savings, I would need to travel over ninety thousand kilometres!

If your existing exhaust system is due for replacement I recommend investigating fitting one of these systems. It is important to make sure that there are several mounting points and that the job is done well. Exhaust failures are common in rough country.

Electronic ignition

Electronic ignition systems are becoming very complex and in some cases ignition components have become unrecognisable. Familiar devices such as distributors are changing shape and, looking into the engine bay of vehicles like the Isuzu Trooper or Mitsubishi Pajero, I can no longer recognise half the components. Like complex fuel systems, complex ignition systems improve efficiency but make the vehicle impossible to repair by the humble garage mechanic found in remote areas of the country.

Most modern 4x4s have an electronic ignition fitted as standard equipment and it is therefore essential that a workshop manual be carried in the vehicle in the event of breakdown. Even though you

Toyota Land Cruiser Prado 4-cylinder in-line 3-litre turbo-charged diesel is typical of modern turbo-diesel engines. It is superb for off-road use as it produces enough torque before the turbo boosts power to allow easy off-road manoeuvring at very low engine speeds.

may not be able to understand its contents, with any luck the mechanic you find, should you break down, will.

Electronic ignition has distinct advantages over the old fashioned contact breaker type. Briefly, contact breaker ignitions have components that wear and must be regularly adjusted or replaced. If you have modified your ignition system with an 'off the shelf' breakerless ignition system, I strongly advise you to carry spare parts of all the components that will allow you to replace your ignition with the original system.

Take a lesson from my own experience. In 1982 I replaced my Range Rover's troublesome contact breaker system with the very well-proven Ilumenition electronic type. Early one morning, six months later while camped in central Botswana the engine failed to start. After a brief check I discovered that the plugs were not firing and that the ignition system had failed. The system proved irreparable and the only solution was to refit the original system, the components of which I carried in my spare parts box. The safari continued without further problems.

Turbo chargers

As already mentioned when we discussed multi-valve engines, improving the breathing ability of an engine will result in increased power. Turbo charging is a highly sophisticated way of doing this, except it goes one step further – it actually forces air under pressure into the inlet manifold. This is done by fitting a turbine that uses the pressure of the exhaust gases to push air under pressure into the combustion chambers. The fitting of turbo chargers is highly technical and should be left to the specialist. A turbo charger cannot simply be 'bolted on'. Normally the engine has to be rebuilt with a lower compression ratio. The exhaust, as well as numerous other components, have to be modified to install the turbine.

Advantages of turbo charging:

- *Combined with petrol engines, turbo-chargers offer enormous power increase for little extra weight and little loss of fuel efficiency.*
- *Combined with diesel engines, turbo-chargers offer increased power, remarkable fuel efficiency and excellent driveability.*
- *Power is less affected by altitude.*

Disadvantages of turbo charging:

- *Throttle lag can be a problem which is sometimes difficult to overcome. A time lag on the throttle can make off-road driving very difficult.*
- *If the system is not well fitted or not well designed, the result could be severely increased engine wear.*
- *Complicated – learn about the system fitted to your vehicle before you leave home.*

FOUR-WHEEL DRIVE
TRANSMISSION SYSTEMS

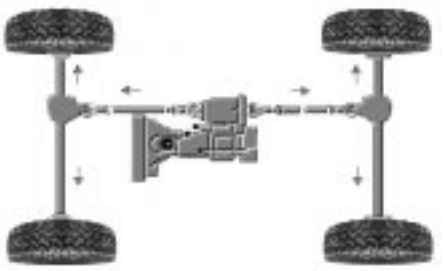
Transmission systems for off-road vehicles are unique. Unlike a normal road vehicle where the gearbox is a single unit, off-road vehicle gearboxes comprise two, three and sometimes four units:

1. The main gearbox
Similar to a normal road vehicle's gearbox but built to withstand heavier torque loads.

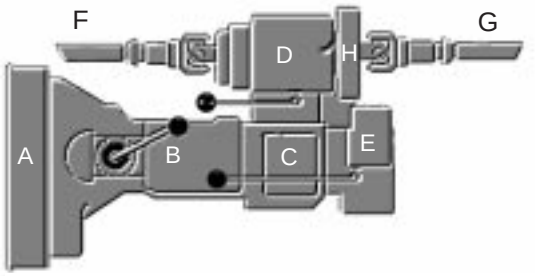
2. The transfer gearbox
Power from the engine is transmitted via the main gearbox to the transfer gearbox which is a two-ratio unit reducing the overall gearing. The result is two individual sets of forward and reverse gears. The lower gear ratios are used for off-road work or starting off on a steep slope when towing heavy loads. From here power is transmitted to the front and rear propshafts in the case of part-time four-wheel drive vehicles and to the centre differential in the case of permanent four-wheel drive vehicles.

3. The centre differential
Located between the front and rear propshafts, this third differential is only fitted to permanent four-wheel drive systems. They require a locking device that, when engaged, locks the front and rear propshafts together and is used when the vehicle traverses difficult terrain.

4. The overdrive unit
Fitted as optional equipment to some older vehicles, the overdrive is a gearbox that adds an additional high gear ratio to extend the legs of vehicles for highway use. Overdrives are built for the relatively light duty of motorway cruising and must never be used in conjunction with low gear ratios.



Four-wheel drive transmission layout



A. Bell Housing
B: Main Gearbox
C: Transfer Gearbox
D: Centre Differential (full-time 4x4 only)
E: Overdrive (older 4-speed models - optional)
F: Front Propshaft
G: Rear Propshaft
H: Transmission (hand) brake (on selected models)

Four-wheel drive central transmission components

MANUAL VERSUS AUTOMATIC TRANSMISSION

Manual transmission is the obvious choice for a vehicle that will be hard working. It gives superior engine braking when descending slopes and better control when driving over rough ground. Automatic transmission does have some advantages when in difficulty though – it allows very gradual application of power to the wheels which would only be possible by slipping the clutch with a manual gearbox. In this way wheel-spin can be avoided when starting off on slippery ground. Also, the technique of 'rocking', as a method of getting a vehicle out of a near-bogged situation in mud, is made easier.

Automatic Gearboxes

Advantages: They make for more relaxed driving on road. For a novice off-road auto transmissions are a pleasure.
Disadvantages: Off-road, they are less versatile than manual gearboxes and are often a source of frustration to the experienced driver. With some vehicles, engine braking with an automatic gearbox is effective, but with others it is not and descending steep slopes can be difficult.

Automatic transmissions are uneconomical, they often overheat if worked hard in heavy sand conditions and fewer mechanics understand them. A vehicle with an automatic gearbox cannot be push started, nor can it be towed without causing damage to the gearbox – this is because the rotating wheels will turn the gearbox without it lubricating properly.

Electronic Hill Descent Control

Electronic Hill Descent Control (HDC) is a Land Rover invention which acts in conjunction with the anti-locking brakes (ABS) to slow a vehicle on steep descents. It is particularly valuable with automatic gearboxes which are not effective in transmitting compression braking from the engine to the wheels. Other manufacturers are developing similar systems such as that fitted to the Mercedes M-class. It is very effective and valuable with both manual and automatic transmissions, especially for novice drivers.

The Freelander's hill-descent control button is found on the gearshift.

Traction Control systems

Various systems developed by manufacturers to cancel out the effects of axle differentials to improve traction range from electronic traction control working with the anti-lock braking system in the Mercedes M-class and Range Rover and hydraulic power transfer systems or Quadra-drive system of the new Grand Cherokee are beyond the scope of this book to illustrate in detail. It is enough to say that they assist traction when wheels leave the ground or spin when the surface gets slippery. The most outstanding of all these systems is Jeep's Quadra-drive system.

Because repairing 4x4 gearboxes is expensive, make it a priority to ensure that it is sound. In this case the Range Rover's inside had to be stripped in order to remove and refit the gearbox.

PERMANENT VERSUS SELECTABLE FOUR-WHEEL DRIVE

Permanent four-wheel drive

Permanent four-wheel drive has been an option for the off-road motorist for many years but only in the last 20 has it been recognised as the most reliable and user friendly type of four-whee drive transmission. It has been fitted to vehicles such as the Jeep CJ 6 & CJ 7 and the Range Rover since the early 1970s, the Land Rover 110 and 90 since the early eighties, and the Mercedes Gelandewagen and VW Syncro minibus and the Toyota Land Cruiser in the 1990s. The Mitsubishi Pajero and Shogun offer a choice of part-time and permanent four-wheel drive with a system called 'Super-Select'.

Most permanent four-wheel drive vehicles have a centre differential located between the front and rear propshafts to prevent wind-up caused by the different rotation speeds of wheels on sealed surfaces. (In the case of the VW Syncro bus and Range Rovers with automatic gearboxes it is a hydraulic viscous coupling). This differential can be locked for off-road work and with some vehicles, such as the Jeeps with the 'Quadra-Trac' system, the vehicle needs to be reversed to unlock this diff.

The advantages of full-time four-wheel drive transmission are numerous. It is very reliable and is highly suitable if the vehicle spends a lot of its time in difficult conditions. The driver does not need to make a conscious decision to go into four-wheel drive – it is there all the time, and if conditions are really tough, he may decide that centre diff-lock is needed which can be engaged while on the move. If the wheels are spinning at different speeds, the differential lock will not engage owing to safety mechanisms built

into the system to prevent transmission damage. In these situations, gently releasing the accelerator will allow all of the wheels to rotate at the same speed and the diff-lock to engage.

In any vehicle with the transmission locked in four-wheel drive, there is a tendency to display noticeable understeer. With a permanent four-wheel drive vehicle with the centre diff unlocked, the understeering tendency is less pronounced while traction is far superior to a vehicle in two-wheel drive.

On-road performance is also enhanced by the permanent four-wheel drive system. Try comparing the handling of a standard two-wheel drive VW Kombi with that of the four-wheel drive VW Kombi Syncro on a wet surface – the difference is staggering. Or, drive a Range Rover with the front propshaft removed – thoroughly unpleasant!

Contrary to popular belief, the permanent four-wheel drive system decreases tyre wear and does not affect fuel consumption greatly. Although there is no rule for the increase in fuel consumption caused by four-wheel drive while cruising, from the reports I have heard it may be as much as 5% – hardly significant considering the increase in safety it provides.

Selectable/Part-time four-wheel drive

This system is less expensive to produce owing to the absence of a centre differential, which is not required, since the front propshaft is disengaged when engaged in two-wheel drive.

When a vehicle with selectable four-wheel drive is engaged in four-wheel drive, it is equivalent to a permanent four-wheel drive vehicle with its centre differential locked. With selectable 4WD systems, because the rotation of the front axle side shafts and propshaft do not serve any purpose when travelling on firm surfaces, free wheeling hubs disconnect these components and will improve fuel consumption. Free-wheel hubs are covered later in this chapter.

Part time 4WD vehicles pay a penalty in that the rear tyres (those used for driving the vehicle when in two-wheel drive) wear out before the front. This is especially true of vehicles driven in rough conditions where 4WD should have been engaged but was not because the driver did not feel it was necessary. Frequent tyre rotation is therefore recommended.

Super-Select four-wheel drive

Super-Select four-wheel drive is found in the Mitsubishi Shogun and Pajero. This system gives the operator the full range of traction options: part-time four-wheel drive (as in the older Pajero, Hilux, etc.) or permanent four-wheel drive with a centre differential which can be locked (as in the Discovery and Lada Niva etc). In some respects this is the ideal system. Its most serious disadvantage is drivers not using the system to its best advantage and not engaging four-wheel drive when they should. Unless this expensive and complex system is used properly, the buyer has spent his money on a gimmick rather than a system that will benefit the driver.

HYDRAULIC VISCOUS COUPLING

The hydraulic viscous coupling is a fairly new technology and solves all of the problems of axle wind-up while at the same time operating as a non-slip differential. It replaces the centre-differential on vehicles like the automatic Range Rover, VW Syncro and Jeep Grand Cherokee. The hydraulic viscous coupling works like a centre differential which is permanently locked but still absorbs all wind-up caused when driving on firm surfaces.

The viscous coupling is a sealed unit containing a series of interleaved slotted steel plates. A second set of plates is attached to the drive shaft. The two sets of plates run equidistant to each other and allow a certain degree of slip between them. However, as this difference increases, the special silicon fluid inside the housing causes the shear forces to lead to a progressive locking of the plates. The result is a progressive locking of the coupling and the drive transferred to the axle which needs it most. Undoubtedly due to cost factors, these are not widely used in off-road vehicles.

DIFFERENTIAL LOCKS: CENTRE, AXLE LOCKING AND LIMITED SLIP

The subject of diff locks is one of the most confusing and misunderstood aspects of four-wheel drive vehicles. This is illustrated by many 4x4 magazine buyer's guides which indicate in their expansive charts if a vehicle is equipped with a diff lock. Indicating a 'yes' or 'no' is too simplistic and confuses the issue because not all diff locks have the same function. What a diff lock does depends on which differential is being locked AND what kind of 4x4 transmission is fitted.

For example, a Land Rover's permanent four-wheel drive is equipped with a diff lock. An Isuzu Frontier's part-time four-wheel drive also has a diff lock. And yet when both of these vehicles are in four-wheel drive with their diff locks engaged, the configuration of the drive to the wheels is different. This is because the Land Rover's diff lock is locking a centre diff, thereby locking the front and rear propshafts together and the Isuzu's diff lock is located on the rear axle locking the left and right rear wheels together.

1. Part-time four-wheel drive transmissions have two differentials; one on the front axle and one on the rear axle.
2. Permanent or full-time four-wheel drive systems have three differentials. One on the front axle, one on the rear axle and one in the centre dividing the front and rear propshafts.
3. A differential lock on an axle prevents differential rotation between the two wheels on that axle.
4. A differential lock in the centre, or between the front and rear propshafts, prevents differential rotation between the propshafts.
5. Some permanent four-wheel drive vehicles also have locks on their rear axles. These vehicles therefore have two lockable differentials - centre and rear axle.
6. A few permanent four-wheel drive vehicles have all three of their differentials lockable - on the front axle, rear axle and in the centre. Examples are the Toyota Land Cruiser 100 GX and the

On steep hill climbs where the track turns sharply, like this one in the Western Cape, a rear axle differential lock is a valuable piece of equipment. In this case we accused the driver of 'cheating'. He had engaged both the rear and front diff locks and the Cruiser drove up as if it was looking for parking.

Mercedes Gelandewagen. When all these differentials are locked this is the ultimate configuration – all four wheels are rotating at the same speed no matter what. These various concepts are illustrated in more detail below.

Centre differential lock

Vehicles with permanent four-wheel drive need a differential between the front and rear axles to prevent transmission wind-up caused by the different rotation speeds of the front and rear wheels when cornering. Wind-up on rough surfaces will be taken up by slight wheel slip that would not be possible on a sealed surface.

When these vehicles are taken off-road, the differential must be locked to prevent wheel spin occurring on a single axle, ie a front wheel spinning while a rear wheel remains stationary, or vice versa. The differential lock will then lock the propshafts, and therefore lock the front and rear axles together.

Differential locks on individual axles

These prevent wheel-spin on opposite wheels on the same axle. They help tremendously in sticky situations particularly when two wheels on the same side drop into a trough and the axle is grounded, or when opposite front and back wheels leave the ground when traversing a ditch at an angle. Without axle diff locks, the two airborne wheels spin helplessly.

Axle diff locks can be a hindrance when engaged on flat ground where the surface is slippery but traction is similar on all four wheels. This is because a locked axle differential always causes understeer. Understeer causes disturbance and therefore increases the rolling resistance of the tyres which can cause a vehicle to bog down. Typical terrain on which this occurs is the beach. It is not uncommon for the inexperienced driver, who tends to use every tool at their disposal to prevent difficulty, to create more problems for themselves by locking an axle differential.

When diff locks are fitted to both the front and rear axles it is imperative that the rear lock is operated first. A vehicle moving over slippery ground with a locked front axle and an unlocked rear diff will want to spin out and may become very difficult to control.

Gearmax differential locks can be fitted to any South African-made rear axle.

Limited slip differentials

A limited slip rear differential does the same and gives the same advantages as a lockable differential but, as the name suggests, the advantage is limited. There is some slip, which can be an advantage and a disadvantage (see table on following page).

In most cases limited slip differentials are fitted on the rear axle only. This is usually advisable, for when fitted on both front and rear axles, some limited slip differentials can alter the vehicle's handling characteristics and even cause instability at speed. Modern examples are the Hydratrak LSD which incorporates a cartridge type fluid coupling which smoothly increases torque transfer to the wheel with slower rotation, and the Detroit Truetrac, which is claimed by the manufacturer to be suitable for fitting to the front axle of a 4x4 without causing the handling problems previously mentioned. These units are available in South Africa from Gearmax Parts and Service. See 'Post-delivery differential locks' on page 16.

ARB locker differential (top) and compressor (bottom).

COMPARISONS:
LOCKING DIFFERENTIAL vs LIMITED SLIP DIFFERENTIAL

LOCKING DIFFERENTIAL	LIMITED-SLIP DIFFERENTIAL
Engage/disengage controllability from inside the cab	No controllability
Misuse can lead to handling difficulties and excessive tyre wear	Misuse is not possible
Full locked position gives the best possible traction as the two wheels are locked together	Some compromise to traction as wheel slip can still occur, although far less than an ordinary differential
Additional wear and tear is negligible	Modern limited slips do not need regular rebuilding as do older types
Fairly costly	Less costly

* Automatic locking differentials are discussed below

Vacuum/Pneumatic differential locks

Until fairly recently the most common type of locking device was the air-locking diff, so called because it required a compressor to actuate the locking mechanism. These systems are still available and come from the USA, Australia and Great Britain. The ARB air-locker is one of the best available, especially if it is fitted to a front differential. This is because the mechanism disengages rapidly, very important when steering becomes difficult due to a locked front diff. Differential locks are also made in South Africa by Gearmax. They are engine-vacuum powered. They are simpler, less costly but because they rarely disengage on demand are unsuitable for front diffs.

Post-delivery differential locks

Don't fall into the trap and believe that a four-wheel drive vehicle must have an axle diff lock before it will be effective off-road. It is true that there are some obstacles that only vehicles with a lock-able diff will negotiate with ease, but these can in so many cases be overcome with driving skill. However, if you intend tackling the very toughest off-road conditions then axle differential locks are essential. An axle diff lock is a 'nice to have' and not a 'must have' item.

The ultimate configuration is diff locks on the front and back but it is essential that the back diff is locked before the front. The best axle diff locks are the manually operated type and are a desirable addition to any vehicle expected to traverse very difficult terrain. Diff-locks are made in Australia by ARB and in South African by Gearmax Parts and Service.

Automatic locking differentials

Auto-lockers such as the Detroit Locker are automatic locking differential devices that lock when traction is needed, and disengage when a wheel needs to rotate at a different speed due to the vehicle turning on firm ground. No conscious decision has to be made to lock the differential – maximum traction is permanent. Automatic diff locks are a disadvantage in soft sand when the vehicle is turned, as the locking rear axle tends to cause drag on

the outside wheel hampering progress. Contrary to what the manufacturers claim, I do not advise fitting an auto diff lock to a front axle as it can cause severe handling difficulties on slippery surfaces. Because they cannot be manually disengaged, when steering becomes difficult, they are unsuited to front axles.

Auto and manual free-wheel hubs. Their only function is to save fuel on the open road. They must be engaged (manual) at the front wheels before the vehicle can be driven in four-wheel drive

FREE-WHEEL HUBS

Fitted to part-time (selectable) 4x4 vehicles, free-wheel hubs fit on the front wheel hubs and enable the side shafts and propshaft to be disconnected from the wheels. The one and only purpose behind free-wheel hubs is to prevent these components from rotating unnecessarily and thereby reduce fuel consumption when driving at speed on a firm surface.

Can free-wheel hubs, if engaged and operated on the road, damage the transmission? This is a very common question. The answer is no. However, the opposite is true; if hubs are left unlocked for long periods the following damage can result:

Bearing damage

On some vehicles the lubrication of the front hub bearings depends partly on axle rotation which sends oil to the bearings. With the front hubs disengaged, the axle remains stationary and the hub is not effectively lubricated.

Spline shaft damage

Spline shafts are located in the side shafts (in the case of vehicles with independent suspension) and in the propshafts (in the case of vehicles with solid axles) that allow for suspension travel as the vehicle moves over uneven ground. In conditions where the drive shafts are rotating, wear will be spread evenly over the splines. Should the drive shaft or propshaft remain stationary for long periods, as will occur if the hubs remain disengaged, the splines wear on a single plane. If serious uneven wear has occurred, drive shaft vibration will result. It is therefore important that, should you have free-wheel hubs fitted to your vehicle, you engage them once in a while and drive around.

If free-wheel hubs are not offered as standard equipment and you wish to fit them, do not skimp – cheap units fail when the going gets tough.

AUTOMATIC FREE-WHEEL HUBS

Portal axle on a Unimog.

Automatic free-wheel hubs engage the front wheels automatically when the front propshaft rotates under power, i.e. when 4x4 is selected in the cab. Old types of automatic free-wheel hubs did not lock when compression braking (descending steep slopes) or moving in reverse. Modern auto free-wheel hubs do operate when moving in reverse and down steep slopes.

Modern auto hubs are engaged simply by engaging four-wheel drive.

Auto-hubs have improved and have become as reliable as the manual types. For this reason many manufacturers are fitting these in preference to the manual types. Toyota, with their new Hilux elected to stay with manual types. The reason is that many fleet operators, already familiar with manual types, would not have to learn new techniques for new equipment. Many serious off-roaders still prefer manual types.

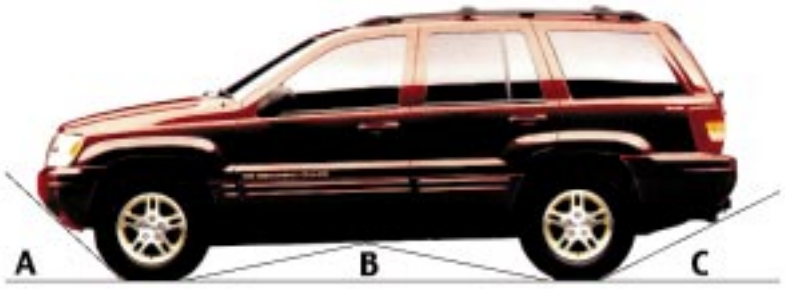
PORTAL AXLES

Reduction gearboxes fitted at each wheel hub serve to increase axle ground clearance. They are fitted to specialist off-road vehicles such as the Mercedes Unimog, Steyr-Daimler-Puch Pinzgauer and the Toyota Mega Cruiser.

GROUND CLEARANCE

Ground clearance is important not only under the vehicle but in front of, behind and between the axles as well. The front and rear overhangs (approach and departure angles), wheelbase in relation to wheel size (break-over angle) and centre of gravity (roll-over angle) are important factors which affect a vehicle's off-road ability. It can be seen by the following diagrams that a vehicle with a 'wheel in each corner' configuration, a short wheelbase and large wheels will be most effective off-road. However, this 'ideal' often gives the vehicle poor on-road handling characteristics.

When clearance specifications are given in data sheets issued by vehicle manufacturers they are normally the measurement taken from the lowest part of the vehicle to the ground on a flat surface. When a vehicle moves over ground this clearance moves constantly, more so if the suspension is of the independent type.



A. Approach angle; B. Ramp breakover angle C. Departure angle.

APPROACH ANGLE

This is stated as the maximum angle a vehicle can approach an obstacle without any part of the vehicle striking that obstacle.

DEPARTURE ANGLE

This is stated as the maximum angle a vehicle can leave an obstacle without any part of the vehicle striking that obstacle.

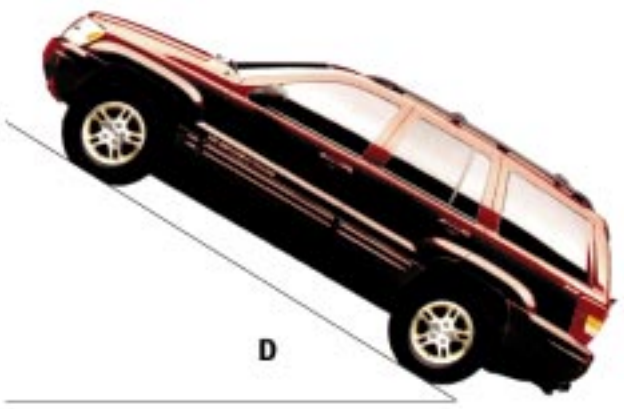
BREAK-OVER ANGLE

This is stated as the maximum angle a vehicle can ride over an obstacle without striking the obstacle between its axles. The longer the wheelbase the larger this angle becomes. On some vehicles, parts of the transmission protrude below the chassis and this also has a detrimental effect on the break-over angle. These components are prone to damage and the closer to the centre of the vehicle they are situated, the more vulnerable they are.

If you are fitting protective equipment or towing apparatus to your vehicle, consider the effect it may have on these angles.

UNDER-CHASSIS CLEARANCE

Vehicle specifications supplied by manufacturers offer a minimum ground clearance figure. This is measured from the part of the



D. The maximum climb angle, which can be represented as degrees from horizontal or a percentage of a one-in-one slope (100% = 45°) Figures supplied by manufacturers are based on a vehicle moving on a traction-perfect flat surface. In the real world, things are very different.

vehicle, excluding the wheels and tyres, closest to the ground. Some manufacturers hide poor clearance figures by measuring from the lowest part of the chassis ignoring suspension components which jut out lower. Critical to this figure is that the measurement is only true when the vehicle is stationary on a flat surface. The instant the vehicle moves, this figure changes, especially when the vehicle moves over uneven ground. Therefore this figure does not necessarily represent the vehicle's ability off-road.

When a wheel on a solid axle rides over an obstacle and lifts, it lifts the differential (normally the part of the vehicle closest to the ground) with it, thereby increasing ground clearance and clearing the differential over the obstacle. With independent suspension, the axle is independent of the differential and it is left in a vulnerable position closer to the ground. A second advantage of a solid axle is that it keeps the wheels perpendicular to the road surface during the increased roll caused by the high centre of gravity of an off-road vehicle when cornering. This improves road holding and handling. But, because solid axles are very heavy, independent suspension reduces the unsprung weight and this contributes to ride comfort on-road.

With a low centre of gravity and well-tuned suspension such as the Mercedes G-wagen has, at no time during this axle-twisting obstacle did the vehicle feel as if was going to roll over. If this vehicle had been equipped with a roof-rack I would not have attempted this obstacle. Note the rear wheels firmly on the ground.

ROLL-OVER ANGLE

This is the angle at which a vehicle will roll when traversing a slope at right angles. This value is a result of the distance of the vehicle's centre of gravity above the ground. Some manufacturers supply this figure under vehicle specifications.

WHEELBASE

The choice of wheelbase should be determined by the kind of work the vehicle is likely to undertake and the loads to be carried. Long wheelbase vehicles can carry heavier payloads and have a higher seating capacity. They handle better on the road and handle better on corrugations and on fast unsurfaced roads.

Short wheelbase vehicles, however, have the edge when driving off-road. The break-over angle is better and they are lighter to steer and more manoeuverable. They are generally lighter and this means that smaller engines can drive them. They are also therefore more economical.

SUSPENSION

No compromise made to improve off-road ability or on-road comfort is more noticeable than those made to the suspension. The type and rating of the springs, the configuration of the axle location and the axle design all have a significant effect on a vehicle's ability and comfort both off and on the road.

AXLE ARTICULATION

No single compromise to the suspension system is more noticeable than axle articulation. Axle articulation is the suspension's ability to allow the wheels to move vertically, to drop into deep ruts and follow the contours of the ground without ever leaving it and thereby losing traction. Articulation is therefore very important to an off-road vehicle but to a road cruiser it is a curse because it allows the body to roll as the vehicle is cornered.

A very good comparison can be made in this instance when two very similar vehicles are compared – the Land Rover Discovery and the Mitsubishi Pajero. The Discovery has beam axles and coil springs all round with light-duty anti-roll bars. The Pajero on the

The original Range Rover's axle articulation is the best of any vehicle in its class and makes the vehicle very easy to drive over rough ground. The downside is high body-roll when cornering. Full-time four-wheel drive compensates for this by ensuring negative steering and outstanding road holding

other hand has independent front coil springs and a solid rear axle, also on coil springs. It is also fitted with rather heavy anti-roll bars. Off road the Discovery is superior, due principally to its excellent axle articulation and solid axles. The Pajero suffers from a lack of axle articulation but scores on the road in every respect.

AXLE DESIGN

Two types of axles are fitted to off-road vehicles – independent and live/solid beam axles.

Springs

Two types of springs are fitted to off-road vehicles – coil springs and leaf springs. Solid beam axles are either fitted with leaf or coil springs while independent axles are fitted with coil springs or torsion bars, or both. Another system, based on pneumatic cylinders in place of springs, permits variable ride-height adjustment from the cab and is fitted to the new Range Rover. This highly sophisticated system is controlled by a computer.

Solid/live axles versus independent

If the vehicle is going to spend most of its time in the bush or will be worked hard in very rough country, rigid solid beam axles, also known as 'live axles', are stronger and more reliable than independent suspension. Solid axles are also better suited for difficult off-road conditions. Although independent suspension is able to offer superior axle articulation because the axle is independent of the differential, this is not the case with the current range of vehicles available today, with the possible exception of the giant Toyota Mega Cruiser. In general, vehicles with the best axle articulation are those with solid axles and coil springs front and back.

Coil versus leaf springs

Coil springs make for a better ride both on and off the road. This is because they absorb vibration better than leaf springs and suspension designers can take advantage of unrestricted axle articulation offered by coil springs.

Coil spring designs require axle location arms to locate the axle to the chassis – a job which leaf springs do themselves. These arms come in the form of radius arms at the front, trailing arms at the rear and panhard rods or similar to locate the axle laterally. These suspension systems can absorb irregularities in the road surface so efficiently that vehicles get damaged often long before the driver realises the damage he is doing. One of the philosophies behind maintaining the production of 4X4s with leaf spring suspension for so long was the fact that an uncomfortable ride limits the driver's endurance before limiting the vehicle's. With the smooth ride given by coil springs, vehicles are driven faster and often with excessive speed over rough ground.

Axle straps

Some vehicles, often those equipped with leaf springs, have heavy duty nylon straps attached to the chassis and looped around the

axle at each hub. These prevent spring breakages where suspension travel over uneven ground allows the axle to drop too far.

Shock absorbers

Shock absorbers correct the oscillation of the road springs. When operating off-road they work harder than on-road because the axle travel is greatly amplified. Because of this they are a vital part of the suspension system and in most cases, those supplied by the vehicle manufacturers are the minimum required for safety and vehicle controllability. If you are considering improving the ride and handling upgrading the shock absorbers is the first thing to consider. These and other suspension modifications are discussed in chapter 3, 'Auxiliary Equipment'.

SUSPENSION CONFIGURATIONS

These diagrams illustrate the variations in suspension systems fitted to off-road vehicles.

Front coil springs and a solid axle are always combined with a similar setup on the rear, the illustrations being of the new Nissan Patrol. This setup offers the best combination for off-road ability. Examples: Land Rover 90,110 and 130, Mercedes Gelandewagen & Unimog, Toyota Land Cruiser FJ80, some imported Land Cruiser FJ75s, Nissan Patrol and old Range Rover.
(diagram 1 courtesy of Nissan)

Rear coil springs and a solid axle are also combined with independent front suspension such as the Mitsubishi Pajero/Shogun and Isuzu Trooper.
(diagram 2 courtesy of Nissan)

Front independent coil springs or torsion bars are found on vehicles such as the Mitsubishi Pajero/Shogun Isuzu Trooper, Ssangyong Musso and bakkie-based vehicles like the Nissan Tracker, Sani and Hardbody, Ford Courier, Mazda B, Isuzu KB and Frontier.
(diagram 3 courtesy of SsangYong)

Rear leaf springs (diagram overleaf) and a solid axle are found on all bakkie-based 4x4s such as the Nissan Sani and Hardbody, Ford Courier, Mazda B, Isuzu KB and Frontier, early Pajero. (diagram 4 courtesy of Toyota)

Leaf springs on a front axle are found on older designs such as the Land Rover series I,II & III. Toyota Hilux, Land Cruiser FJ40, FJ60, FJ75, FJ60 and

earlier models, Suzuki SJ40, Jeep CJ, old Chevrolet Blazer, old Nissan Patrol, SVM, Asia Rocsta, Mahindra and Jeep CJ. They are always matched with similar systems on the rear.

An all-four independent suspension configuration is found on vehicles such as the VW Syncro Bus, Toyota Mega Cruiser, Styre-Puch Pinzgauer and Haflinger.

OTHER FEATURES TO CONSIDER

LOADING CAPACITY

When travelling through remote or unpopulated areas, food, water, fuel, tools and camping equipment will have to be carried. Therefore your vehicle should have a large enough loading capacity in terms of volume and weight. Water weighs one kilogram per litre and fuel almost as much. Heavy duty suspension should be fitted to those vehicles asked to carry loads close to their limits over rough ground. Heavy duty shock-absorbers will also assist.

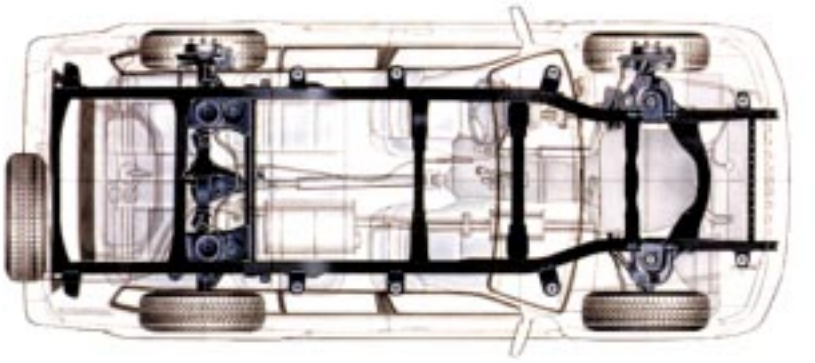
When selecting a 4x4, it is worth asking how much weight can be carried on the roof. Unfortunately I have never seen this specification published in a sales brochure, so this information may be hard to find.

4x4 station wagons make great family cars. They don't only show their mettle when off-road.

Loading any roof rack too well forward will cause overloading of both roof pillars and front springs, which are not designed for this and structural failures from overloading show themselves in the form of cracks appearing in the windscreen. If you also have a winch, bull bar, power steering and air conditioning fitted, your front springs may well be pushed beyond their weight carrying limit. Overloading a vehicle's springs will quickly result in serious structural failures in rough terrain.

DISC VS DRUM BRAKES

All-wheel disc brakes are an advantage off-road. Apart from not being affected by water, like drums, they operate effectively in reverse. This is where the disadvantage, which can be significant off-road, comes when drum brakes are fitted on the rear wheels. Picture the following situation: a vehicle stalls while moving up a very steep climb. The vehicle must be secured before the clutch is depressed and the engine restarted or the reverse-stall manoeuvre performed. The foot brake and handbrake are used to hold the



True off-road vehicles are built to carry a load over punishing terrain and have a chassis built for the task. (diagram courtesy of Toyota)

vehicle. With the drum brakes on the rear axle doing almost all the work, and with the stalled engine and no brake-boosting assisting the effort, it may be impossible to secure the vehicle with brakes alone. In this case the vehicle must be left in gear and rocks packed behind the wheels to assist the braking effort before the clutch can be depressed.

Although all drum brakes are less effective in reverse than discs, not all drum brakes are totally ineffectual in reverse. Generally speaking, the older the vehicle, the worse they perform.

POWER STEERING

In the city, assisted steering is a great advantage when driving a heavy 4WD vehicle, but in the bush it adds mechanical complications should something need repair and it adds weight. Although it does make a large vehicle easier to manoeuvre, power steering lessens the driver's 'feel' and can make driving over uneven terrain more difficult. I have also found that power steering is less comfortable at high speeds. Power steering remains a personal choice.

VEHICLE RANGE

A vehicle that will be required to undertake journeys into unpopulated areas needs a good range to be effective. Otherwise, a payload capacity large enough to enable substantial additional fuel to be carried will be required. The adventurous traveller will need a range of no less than 1000 kms between fuel stops. Few standard vehicles will cover this distance without additional tanks or without jerrycans. Auxiliary fuel tanks are discussed in the chapter 'Auxiliary Equipment'.

High-lift jack points on a Prado

BUMPERS

One of the most useful auxiliary items for the vehicle that is going to drive off-road is the high-lift jack. It requires a suitable flat jacking surface on the vehicle for efficient use. Modern designs tend towards curved rounded body shapes and rounded bumpers. These are cosmetic changes done without much consideration for the off-road motorist. If you are purchasing a new vehicle and intend to take it off-road ensure that the bumpers are adequate in both shape and strength for use as jacking points and if not, suitable adaptations can be made so that a high-lift can be used with the vehicle. These modifications are rarely available from the manufacturers themselves but are often designed and fitted by off-road vehicle fitment specialists.

EASE OF ATTACHING ACCESSORIES

Do some homework to establish if the accessories you may want are easily fitted to a vehicle. For example, because the Land Cruiser 100 has no roof gutters, it took some months after its release before 4x4 fitments centres developed a roof rack for the vehicle. The fitting of high-lift jack points is another worthwhile question to ask. Fitting them to a Pajero can be tricky and often an air-jack is a suitable alternative. With the Prado they fit nicely, but simply looking at the two vehicles one could be forgiven thinking they are the same as they are both endowed with large wrap-around plastic bumpers.

GREY IMPORTS

Anybody selling a new vehicle who is not an authorised dealer will, most likely, be selling a grey import. These vehicles are imported without the permission or approval of the local manufacturer or distributor. There are some serious pitfalls in this practice.

The pitfalls of grey imports:

- *Local distributors will not service the warranty and spare parts will often have to be specially ordered.*
- *Because local agents (the reputable ones) have to service a warranty they don't mind spending time and money researching new models for new markets.*
- *Original manufacturers rarely sanction grey imports.*
- *Similar vehicles imported by the manufacturer have modifications to engine and gearbox, auxiliary equipment and design adaptions for local conditions. This may seem unimportant but consider just a few: differing sulphur/lead content and octane rating of fuels, air filter size, fuel filter type, road springs and clearance. The complete list is a long one.*
- *The advantage is a saving in the cost of the vehicle. In the long term it is unlikely that the vehicle will perform as well and will not last as long.*
- *Why not support local industry instead of another country's?*

BUYING SECOND-HAND

Buying a second-hand vehicle of any kind is a risky business and to do it successfully requires some know-how.

Bargains don't exist in used-car showrooms. When the value of these vehicles is calculated, the cost of the fountain of youth is included in the purchase price. The value of the probable guarantee claims is also added. The genuine mileage may not be genuine. I do not have a recipe for testing the authenticity of kilometre readings, nor can I tell you how and when to trust a used-car dealer. If a new car manufacturer puts its name behind a used-car, then you can be fairly sure that it will be covered by a worthwhile warranty.

These days, cars hold their value reasonably well and a well cared for 4x4 is no exception. For example my Land Rover 110 V8 lost 15% of its value in eight years; that is 1,87% per year depreciation (excluding inflation). With a second-hand 4x4, the mileage shown on the odo will not be an indication of how much life the vehicle still has in it. Due to the rough conditions that many 4x4s would have been subjected to, the wear and tear levels are difficult to estimate by simply looking at and driving a vehicle. The experience of the vehicle's driver is worth evaluating. The experienced driver would have put far less strain on components than the inexperienced driver.

To buy second-hand from private sellers or used-car dealers, you will need to be able to inspect and test drive the vehicle with a mechanical mind. Off-road vehicles that have had a working life will wear in specific places. Keep the following in mind:

If the vehicle has been used to tow and launch a boat, axle oils may have been contaminated with water and axle oil seals may be corroded.

If the vehicle has been used on the beach, rust will be a major concern. Even aluminium bodied vehicles such as Land Rovers suffer from chassis damage due to rust. No matter how good a vehicle

looks, if you suspect that it may have been submerged by an incoming tide, don't touch it!

If the vehicle has been used for towing, clutches and gearboxes, although normally heavy duty on 4x4s, will have been worked hard.

If overly heavy loads have been carried on the roof, the roof supports and windscreens often crack.

Bush work takes its toll on suspension components, such as bushes, bump stops, shock absorbers and springs.

Ask for a service record. A dealer service record will mean a well maintained vehicle and that means a great deal. In order to inspect a vehicle properly its body and chassis must be clean.

Your inspection should also include the following:

- *Look for oil leaks under the engine and around the gearbox – they could mean trouble. Axle hub oil leaks are given away by oil splashed on the inside of the wheel rim/s. These oil seals are fairly simple to replace although if oil has contaminated the brakes the pads will have to be replaced. Oil seepage around the front axle constant velocity joints (the shiny round thing on each front wheel hub) is normal, but the oil should not drip.*
- *Bounce and rock the vehicle on all four corners. The bounce should stop quickly. If it does not, the shock absorbers may be worn. Worn suspension bushes will cause clunks and knocks.*
- *Look for rust. Beware of a newly painted chassis – it may mean hidden rust. Some common places where body rust may be found are under the vent in front of the windscreen, the chassis near the suspension shackles and underneath the doors and door sills. Cracked paint on any part of the body could be caused by rust forming underneath. Establish if the rust is structural or cosmetic. If the surrounding metal is in good order then it may be repairable.*

- *Open and close all of the doors, the bonnet and the tailgate.*
- *Wind all of the windows up and down.*
- *Test all the lights and indicators.*
- *Climb under the vehicle. Look for damage to the chassis frame, cross members and floor panelling that could have been caused by careless driving over difficult terrain. If there is absolutely no visual damage underneath the vehicle, it is an indication that the vehicle may never have been off-road, or if it has, it has been treated with a care. Look for cracks in the chassis rails, particularly close to suspension location points.*
- *Inspect the exhaust pipe. If it is not well secured, it may have been this way for some time and have developed cracks.*
- *Inspect the tail pipe. If it is a petrol engine it should be medium to dark grey. It should not be sooty black as this could be the telltale sign of worn rings or valve guides. If it is a very light grey and has not just returned from a long run then the vehicle may have burnt valves caused by a too lean air-fuel mixture. Exhaust pipe colouration is no sure way to diagnose engine problems. Further tests, such as compression, or air fuel mixture measurements should be made if you are in doubt.*
- *Open the bonnet. The engine should be clean. The battery terminals should not have white powdery deposits, but should be covered by a thin layer of grease.*
- *It may be difficult to establish whether a vehicle has been involved in an accident. Tap the bodywork all around, and the sound will change if body putty has been layered on thick. A small magnet used as a metal detector will also be useful. (This will not work with aluminium body panels.)*
- *Find the engine and chassis numbers and compare these with the registration form held by the owner. Make sure that these numbers have not been tampered with in any way. If you suspect that this may have occurred, don't go any further. Legislation makes it illegal to own a vehicle whose chassis or engine numbers have been changed without appropriate documentation.*

Here is a guide to what to look for when test driving a used 4x4:

- *Start the engine. It should idle smoothly between 700 and 900 rpm.*
- *Warm up the engine. Have someone stand at the rear of the vehicle. Quickly push down the accelerator as far as it will go and then release it. There should not be excessive smoke from the exhaust. The engine should accelerate quickly and smoothly.*
- *Listen to the exhaust from under the vehicle. Listen for escaping exhaust gas from anywhere but the tail pipe. Do this by putting your foot over the end on the tailpipe. This forces gas to escape from any leaks. Rust at the tail end of the exhaust is common and not serious, but rust in silencers is a more expensive problem.*

- *Listen to the engine – does it clatter or are there any knocking sounds? Sounds like these can indicate worn bearings, cam chains, rockers, etc... If the engine ticks, it could mean a simple problem of valve clearances that require adjustment. It is advisable to have an expert take a look and have a listen.*
- *When the engine decelerates it should not smoke. If it does, it may mean worn valve guides.*
- *Check the air filter – an excessively dirty one will mean a poorly maintained vehicle.*
- *Driving a 4x4 is different to driving a normal vehicle. Because of the complex transmission, and the heavy clutch and transmission backlash, smooth gear changes can be a little difficult to handle at first on some models.*
- *Test the brakes. Drive at about 50 kph and when it is safe, push on the brake pedal until the vehicle comes to a halt. There should be no tendency to veer from dead-ahead. The brake pedal should not sink all the way to the floor. If it does, there could be fluid seepage inside the brake master cylinder or wheel cylinder which would require a brake system overhaul.*
- *After driving for a few minutes, check the water temperature gauge. If it is equipped with an oil pressure gauge, check that also. Low oil pressure could mean worn engine bearings.*
- *Take the vehicle onto the motorway and run it up to a reasonable speed. There should be no undue vibration. Vibration, depending upon how and when, could mean a simple problem such as wheel balance, or, at worst, an unbalanced propshaft which could have caused gearbox bearing and oil seal failure. A quick inspection of the gearbox at the propshafts for oil leaks may reveal the source of the problem.*
- *Test all gear ratios. Accelerate and decelerate sharply in all gears. Doing this may cause it to jump out of gear – a common problem with well used 4x4 gearboxes.*
- *If fitted with free-wheeling hubs, engage them and drive a short distance. Make sure that they disengage easily.*
- *Testing a 4x4 off-road is not easy. It is not fair to the owner to go crashing through axle deep mud to see if the vehicle can cope – especially if you are an inexperienced driver. The best way to do this is to look closely at the vehicle specifications and to compare them with other vehicles. Ask other owners of the same type of vehicle for their comments. Do this and you will have a good idea of what you are buying in terms of performance.*
- *Army surplus vehicles have normally been abused and will need a great deal of rebuilding work to get them into a reliable condition.*