The Smokin'

Daniel Cooper finds out what went in to making Andy Robinson's Studebaker so successful on the drag race circuit

It's become known over the past few years as the car of three-times MSA (Motor Sport Association) British Drag Racing Champion, Andy Robinson. Since its first season in 2002, the Smokin' Stude, based on a 1953 Studebaker Commander, has won Robinson the championship in 2007, 2009 and 2010. This year Robinson and the Stude came in at a well-earned 7th place in the 2011 FIA European Pro Modified championship, and 8th in the 2011 MSA Pro Modified championship.

So the announcement that Robinson will be racing a brand-new car in next year's championship is a bitter-sweet one. On the one hand, we can look forward to seeing the 1969 Chevrolet Camaro that the Andy Robinson Race Cars (ARRC) team has built to replace the old '53 Studebaker. However, this means we are forced to bid a fond farewell to the old Stude, which has now been put up for sale by Robinson. With this in mind, we feel it is time to look back at the car that has taken Robinson to so many victories in the past.

Andy Robinson's Smokin Stude has been highly successful in the Pro Mod category, which exists within the five-event MSA & FIA Drag Racing championships. The MSA championship is held at the UK's Santa Pod Raceway, in Northamptonshire, while the FIA championship visits Sweden, Finland and Germany, with the opening and final events held at Santa Pod.

Andy Robinson's 1953 Studebaker Commander – the Smokin' Stude – consistently runs 6.1 s quarter-miles (Photo: Ivan Sansom)

Stude

Driver's seat and personal safety equipment

The Pro Mod class is the fastest 'doorslammer' class – retaining functional doors and a traditional sedan layout – and, while slower than the Top Fuel or Funny Car classes, the vehicles are impressive, hitting speeds of 230 mph and completing the quarter-mile in about 6 s. The class also exists in the American Drag Racing League, although vehicles raced in the UK/European championships tend to be unique, built and modified by individual racers, with the US championship being a touch more commercial in that cars are available on a production basis from some builders.

The Pro Mod class provides significant freedom in design and construction, with nitrous- and methanol-fuelled cars competing directly.

As can be expected from ARRC, the Studebaker's chassis has been constructed entirely in-house, at its Reading-based workshop. The chassis has been crafted using chrome moly steel tubing, taking full advantage of the CNC tube-bending machinery on-site. Another technique used during the fabrication process of the chassis is TIG welding, in conjunction with the use of mild steel filler rods.

Building the chassis

The construction philosophy of the frame began with the car's vital statistics, which included its wheelbase, track, caster, camber and ride height. Once these were all decided on, the frame was then built, starting from these fixed-wheel positions, and the chassis design progressed inwards, ensuring all elements remained within the body shell. At every step of construction, the team has been careful to meet all the relevant MSA and SFI regulations; these are used to determine such details as the minimum tube sections that can be used in the chassis in specific areas. The Studebaker's chassis actually exceeds the minimum SFI specifications in many areas.

This vigilance over safety in the chassis and roll cage design extends to the driver's safety, through the use of a custom-built Stroud seat, complete with a full nine-point harness, including a head-and-neck support device. In addition, the padding inside the roll cage is extensive, supporting the driver's head at the sides as well as from above and behind, to guard against any impact with the roll cage. Throughout the run, the driver is provided with a constant supply of fresh air through his helmet from a self-contained air cylinder. The driver's helmet is continually flooded with this supply so that, in the event of a fire, he is still breathing cool and uncontaminated air.

The driver also wears a meta-aramid Nomex fire suit that is thicker than you would expect to find in most other motorsports. This is primarily to take account of the extended 10 s egress time limit present in these drag racing championships. There is also a Firefox Industries dual 10 lb extinguisher system fitted.

There are several schools of thought when it comes to building a Pro Mod chassis. One of the main debates is that between a stiff or a flexible chassis. One view suggests that having a more flexible chassis should, logically, result in a smoother getaway and 'hook-up' – a good hook-up is where the level of traction generated by the car's set-up and the track surface is high enough to minimise wheelspin, although a little is still desirable. ARRC, however, uses a stiffer chassis to allow a more precise suspension set-up than would be possible on a flexible chassis, and as such allow for greater consistency between runs.

As in so many other motorsports, there is always scope for weight reduction. ARRC's new car will be reducing the number of engine bay chassis members compared to the old Studebaker, and will be decreasing the gauge of other chassis members. When Finite Element Analysis was carried out on the old Studebaker's chassis, it highlighted the area of maximum stress as being at the mounting points for the trailing four-link rear suspension system. This means that the crew at ARRC can implement some weight reduction on the front chassis of next year's car. ▶

Jigged frame after welding, note tubes joined adjacent to nodes in some areas (base of main roll cage)

During the construction and assembly of the tubular space frame used on the old Stude, the tubes are quite often arranged next to nodal points, rather than placing them directly onto them. Spacing out the tubes, and placing them next to the nodal points, means they also act as crumple initiators, and so cause bending in chassis tubes during a crash. This goes a long way towards absorbing the energy of an impact, in much the same way that crumple zones work on a modern roadcar. By displacing the joints slightly from the nodal point, this also reduces the complexity of assembly and welding required.

In addition, offsetting some tubes also allows the team to alter the chassis' natural frequency, so they can avoid the harmonics associated with tyre shake. Tyre shake occurs when the frequency of vibration through the chassis/tyres matches a natural frequency, causing significant distortion in the tyre shape at that frequency. The vibrations transferred to the chassis can be so harsh that car damage may result.

Weight distribution

The panelling between the chassis tubes was originally made from aluminium sheet metal. However, this was later abandoned, and replaced with bespoke carbon fibre panelling produced on-site. The new body for next year's Chevy Camaro will be a complete carbon fibre shell made for the team by Cynergy Composites of Ontario, US, for whom ARRC is the European dealer.

The initial weight distribution run on the Studebaker came back showing a slight rear bias of 51-52%. However, over the Stude's long life, that has been shifted forwards bit by bit to provide a 52% weight bias on the front end. This was done with the aim of increasing the car's front-end stability to enhance steering control. This weight bias is counter-intuitive to those of us brought up on circuit racing, where rearward weight transfer aids acceleration by increasing the traction available at the rear wheels (traction being a function of the normal load on the contact patch). However, the large tyres used by Pro Mod cars provide such a natural bias towards greater rear traction – compared to circuit racing, where all four wheels are about the same size – that additional weight is found to be of minimal benefit, particularly as a small level of wheelspin is desired during launch.

Throughout its time on the track, the Stude's centre of gravity has been kept relatively low, and there have been no particular attempts to encourage a weight transfer to the rear wheels. This is primarily because the suspension runs with a very high degree of anti-squat, achieved through the four-link system, to avoid axle tramp, which is where the rear axle vibrates up and down at such a violent rate that rear wheels can leave the ground, causing the car to 'hop'.

Mounted in the front of the car is the mammoth air-cooled V8 powerplant. The use of front and rear high-strength aluminium mounting plates means the engine itself is able to lend a degree of lateral stiffness to the front chassis, making use of the engine in a semi-stressed capacity.

The powerplant itself is manufactured by Brad Hansen Engineering, and is based on a 521 cu in (8537 cc) V8 16-valve Chrysler Hemi, with overhead valves and pushrods, producing more than 2500 bhp with a Kobelco supercharger.

The engine burns methanol, so it has no requirement for liquid cooling; instead, being air-cooled, the front scoop provides the induction air charge, while the shape of the car's body shell allows air to flow across the engine block and within the engine bay.

Forged aluminium engine blocks are CNC-machined to tolerance although, because the engine is air-cooled, they are manufactured without water jackets. They also use cast-iron bore liners. The cam shaft provides a direct drive for the mechanical Waterman Big Bertha fuel pump, which provides up to 14 gallons of fuel per minute to the engine via the Acceleration Enterprises fuel system and which, in an emergency, can be isolated through the use of a ball valve.

The Smokin' Stude, undressed and rebuilt between runs at Santa Pod 2011

ARRC Spool casing and rear suspension

Between runs, the engine set-up is carried out during the top-end rebuild, which occurs for each run of the track. The set-up involves such aspects as altering the compression ratio, which is done by varying the head gasket thickness, which can be anywhere between 0.062 and 0.092 in thick. For runs in colder conditions, and therefore denser air, a thicker gasket would be used, whereas on a hot day a much thinner gasket is called for.

Exhaust Gas Temperature (EGT) is constantly logged, monitored and used as a measure of the air-fuel mixture; a leaner mixture will generate a higher temperature than a richer mix. A lean-out mechanism is built into the fuel injection system, and a flow restrictor is used to alter the fuel pressure available and so adjust the mixture for set-up between runs. The fuel curve is based on clutch actuation points, and is timed throughout the run. Any spikes that appear in the EGT may be an indication of detonation.

Twin-disc clutch

The spark plugs are also monitored, as combustion will remove the cadmium coating on them. The limit of compression adjustment can be seen when the cadmium coating on the spark plug has been removed up to about three threads from the end of the spark plug, as the higher compression ratio forces the burning air-fuel mixture further into the crevice volume of the spark plug thread. Ignition timing is monitored by observing the condition of the earth strap.

The power from the massive Hemi engine is delivered to an 11 in twin-disc AFT clutch, which makes use of sintered iron discs in conjunction with a steel floater plate, which itself is coated in sintered bronze. Clutch pressure is applied by six fingers and coil springs; significant adjustment of the clutch pressure is available, and can be done by varying spring rates and heights from anywhere between 500 and 1400 lb of force, with an additional 500-600 lb being created centrifugally. More refined clutch adjustments are possible by setting the base clamping pressure on the springs, working in adjustments of about 3 g. As the powertrain accelerates, clutch pressure – and therefore wheelspin – is determined by the pre-load of the springs, and then the spring rates, up to the point of 'lock-in' on the fingers, at which point zero clutch slip is achieved.

The clutch then transfers full power to a three-speed, epicyclic Lenco-manufactured Shur-Shift gearbox. The modular system works by modifying the input shaft speed, providing an underdrive on the original input speed. There are three epicyclic modules connected in series, with each module applying an underdrive ratio to the output speed of the previous module. When the car is in first gear, all three modules are engaged; as the car shifts up through the gears, successive modules will be 'locked out' to provide the next gearing ratio by reducing the amount of underdrive being applied to the input shaft speed.

The gearshifts themselves are achieved through the use of a pneumatic solenoid, which is powered by an onboard compressed air cylinder, and is actuated by the buttons attached to the gearshift lever. The lever itself selects between forward, neutral and reverse by placing it in the front, centre or rear positions respectively. All three of the forward gear ratios are available in reverse if the driver desires.

Gear ratios are often altered between events to suit differing track conditions. For example, if relatively high traction is available from the surface of the track, a shorter gear ratio is desirable, to avoid tyre shake. First gear is normally set at a ratio of 1.98:1, but it can be adjusted for anything between 1.82:1 and 2.13:1, providing quite an extensive range to choose from.

However, it is rarely as simple as picking the right gear ratio for the track and away you go. Quite often it can be difficult to get the best out of the engine for every track, as almost every driver found at Santa Pod Raceway this year at the FIA Finals, where resurfacing on the track had left two different levels of traction between the initial start and the main run. This meant that setting up the gears for the start lost you speed on the main straight. To set up for the main straight, however, would mean sacrificing time and speed on the launch. Also taken into account when setting up the gear ratios is a keen appreciation of the need to preserve the engine – it is always worth being kind to the engine, as you will not get anywhere if it is punished to the point of destruction!

Clearly all this power has to go down somewhere, and that somewhere is of course through the rear axle. The Smokin' Stude's rear axle uses a spool, which is more fundamental in its operation than a differential. A spool has a solid rear axle, mounting a bevel or ring gear, which is driven directly from a pinion gear on the end of the prop shaft. Unlike a roadcar, this means the axle is driven as a single piece, with no permissible difference in rear-wheel speeds, ensuring a more uniform traction to aid rear stability. The spool, which is manufactured by Strange Engineering, is wrapped up inside a custom-made ARRC casing.

The spool delivers the final drive through to the 16 x 16 in aluminium American Racing rear wheels, on which are mounted the 34.5 in tall, 17 in wide Hoosier tyres, secured by a bolt-together beadlocking system. Next year's Chevy, however, will feature brand-new wheels from Weld Racing, again aiming to reduce the car's weight, which is of particular benefit for drivetrain components as it reduces rotational inertia. The spool casing itself is constructed from three folded sections of steel sheet. Inside are internal stiffening webs and chrome moly axle tubes, and the casing contains about a gallon of 250W gear oil.

Four-link rear suspension with central track fixing link and machined aluminium rockers

The Studebaker's rear suspension has a pushrod configuration, mounting the Penske dampers and machined aluminium rockers high up, behind the driver, along with the Mark Williams rear anti-roll bar. The use of the pushrod rear suspension goes a long way towards enhancing the car's rear stability by placing the pick-up points as far outboard as possible on the axle casing, to the point that they actually sit within the rear wheel rims themselves.

Unusually for a UK Pro Mod car, the rear suspension uses a trailing four-link rear system, which attaches the spool casing to the chassis by four steel linkages and which are height-adjustable on the chassis end. A fifth link, with a single chassis side mount and two mounts on the rear casing, is used to fix the track of the car and prevent as much lateral movement as possible. The four-link system is advantageous to the car set-up, as it allows the car's instant centre – the imaginary point at which the upper and lower links would intersect at a particular instant in time, effectively the pivot point for rear suspension movement – to be adjusted. This is useful, as this adjustment allows for set-up of the car's anti-dive and anti-squat characteristics, and is carried out by moving the instant centre relative to the car's centre of gravity.

The Studebaker's front suspension, on the other hand, is a Macpherson strut and A-arm configuration. The upper ends of the dampers are mounted in threaded bosses, which in turn are directly attached to the chassis itself. This threaded arrangement means the front ride height can be adjusted with ease without it actually impacting on the 2.5 in of suspension travel available. This set-up means the adjustment of the ride height does not alter the behaviour of the front wheels during a run.

The car runs with between 0 and 0.5° of camber, 10-12° of caster and 0-20′ of toe-in. The front suspension allows for a maximum of 3.5 in of travel and a minimum of 2 in. The rear set-up, however, provides a whole 7 in of travel on the back wheels, though this is not always fully used. The ride height of the car as a whole is always set with 1.5 in of compression already applied to the suspension. Whereas the set-up of the engine, the gearbox and the clutch may well be changed between each event – and indeed between each and every run while at an event – the suspension, once initially determined and optimised, remains largely fixed to that set-up.

It is all very well having all this power cleverly constrained by a bespoke chassis, and kept on the track by a highly intelligent suspension system, but at some point you are going to want to stop. And the better the other aspects of the car, the sooner you will get to the end of the track and be in urgent need of rapid deceleration. With this in mind, the primary braking of the Smokin' Stude is achieved through the use of a parachute, provided by Stroud Safety. This initially gives an extremely high level of braking.

Preparing for a run

Obviously though, the effectiveness of the parachute system falls rapidly as the force of air pushing against the parachute itself falls with the speed of the car. Eventually conventional disc brakes are needed and, on the Studebaker, these are Strange Engineering brake calipers. On the rear there is a set of four piston calipers, as opposed to the single piston calipers on the front. All of them are matched up with grooved steel brake discs. By comparison, next year's Chevy Camaro will feature top-of-the-line carbon brake discs.

So what does this all boil down to? Ultimately, all this engineering, power and ingenuity comes down to one thing – 6 s or so of hurtling down a quarter-mile track at more than 200 mph.

Before any of that can happen, however, the car has to be towed to the track and pushed into position. The first stage of the run is, of course, purely for the sake of preparation. The driver conducts a moving burnout from the start line. In the Stude this is done by holding the front brakes on, using the alignment button on the top of the

Front suspension threaded mounting boss

Front Macpherson strut suspension

gearshift lever. This burnout deposits a layer of rubber on the track, providing a surface the tyres can grip easily during the launch. It also serves to clean the surface of any muck or debris. The driver is then guided back to the start line, using the reverse gears together with signals and radio communication.

For the launch, the Stude's revs are usually held at about 5200, depending on the base clutch pressure set-up, as higher revolutions increase the clutch pressure. If the engine speed is held too high for the launch, the driver runs the risk of 'jumping', which is literally where the car jumps, leaving the ground altogether. For the Studebaker, this happens at around 6000 rpm. Initially, however, the front wheels should be leaving the ground, although by only a few inches thanks to the car's heavy anti-squat set-up. For the rest of that quarter-mile though, the driver must be steering, to ensure that the car is piloted safely down the track without incident.

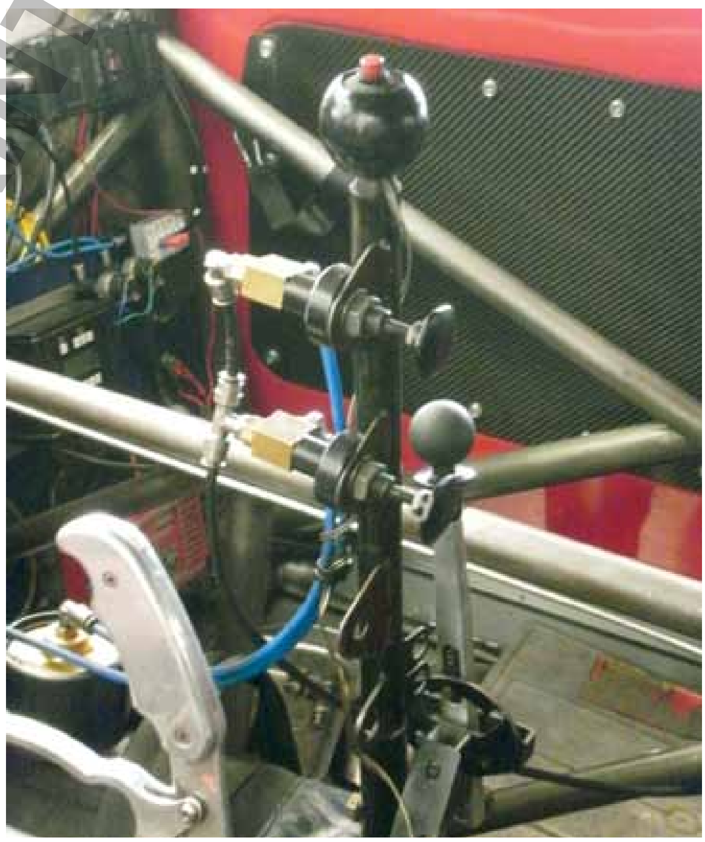
Starting and stopping

During the run itself, the car should be held with a slight level of rear-wheel spin. This prevents the tyres from tripping over themselves – known as 'paddling' – and as such it smooths out the ride. Paddling occurs when the contact patch has complete traction but the wheel speed is too high, and the leading edge of the contact patch is rolled or folded before the tyre overcomes the distortion in its surface. This generates vibration and instability, so to prevent this and ensure the tyres rotate smoothly, a minimal level of wheelspin is desirable, such that the tyre stands up, resulting in the optimum tyre profile in terms of a more efficient run.

On the Stude, clutch lock-out will occur at about 8600 rpm, and the driver will then continue on to the engine's maximum power, between 8000 and 10,000 rpm. The driver will shift to second gear in response to an LED shift indicator light that will come on somewhere between 9800 and 10,000 rpm. Pressing a button on the gearshift lever will actuate the pneumatic gearbox solenoid. If the shift is engaged too early, it will lead to increased clutch slip, which can overheat the clutch and which would then prevent it from achieving lock-out later in the run, compromising the top speed of the car for that run. On the other hand, shifting too late would mean that the engine would then hit the rev limiter. If this occurs, there is always the risk of valve bounce and other side-effects that would result in costly engine damage.

For the Pro Mod category, the driver is allowed one final shift, moving up into third gear. This must be done to achieve the car's top speed, but the risks associated with changing into second gear are also present at the shift into third – too soon and you will lose speed; too late and you can risk damaging the engine and reducing your acceleration. However, the faster you go, the greater the effect of the rear wing that should be felt, as more air is forced over it as the speed increases. The more air that is passing over the wing, the more downforce it creates, which works to maintain the stability of the car at these speeds.

Once the race has been run – and, hopefully, won – the need to decelerate becomes the most important thing on a driver's mind. As discussed earlier, braking is carried out by a marriage of two systems, the parachute and conventional disc brakes. The parachute is actuated via the use of a lever, mounted on the cockpit ceiling. As the effectiveness of the parachute diminishes, the driver can then bring the conventional foot brakes into play, slowing the car further and finally bringing it to a gentle halt at the end of the track, to be towed and pushed back to the garage so that the driver and his team can start making all the preparations for that vital next run. ■



Gearshift lever with two pneumatic shifter buttons and red brake hold button