FORMULA GRAVITY

Suggestions For A Build

There is a National Technical Specification for Gravity Racers. If you build to this then you have entry to the national open events. A few small local events may vary so check.

The Space Frame

Ideally plastic coating is good but in schools or colleges if it is damaged it is hard to patch up. We have used undercoat and an enamel spray that can be easily touched up if needed.
One of the latest requirements is a tow hitch on the front so that you can be towed up hills at events by rope.

The floor

This needs to be strong as we attached our weights to this. We used aluminium sheet. It could be curved up at the sides. We put the spaceframe onto a sheet, drew around it and then cut it out using a jig saw. (Tin snips were used to trim up).
The spaceframe was turned upside down and we drilled and then pot riveted about every 100 mms. Using 4mm drill bits and rivets. (We used this size through out the build) To finish we used a hammer to bend the outside of the floor around the tube frame.
(Check event rules for weight regulations. We have found that weights are best with their centre of gravity about a third of the way from the front. This gives better steering and grip on corners.)

The steering

The steering column should ideally collapse in the case of an accident hence protecting the chest of the driver. If the driver is held in place by a 4 point seat belt this should in reality be enough to retain the driver and the collapsing column be unnecessary. (Check national and event regulations for this)
The steering column we made from two bits of steel tube, one bit fitted exactly into the other telescopically. This gave us a collapsible column in case of a crash.
To join them we put the tubes together with about 120 mms of the smaller tube into the larger one. We then used a grinding wheel to remove a section of both tubes for about the 120 mms. This gave us a flat section. The two parts of the column were then joined by a U bolt that had a central grub screw. We got this from the Caterham Car Company. I think it would be very easy to make one of these.
The column then had a screw bolt welded to the bottom so this could be inserted into a rose bearing that had already been bolted onto the plate on the spaceframe. The screw bolt was then put into the rose bearing and secured with a lock nut.
The top of the column was secured by a nylon bush onto the two mounting brackets on the spaceframe. We again used a bush that we got from Caterham. This could again easily be made.

To attach the steering arms we welded two 50 mm steel uprights onto the column. These were exactly two rose bearings apart. We then drilled a 10 mm hole through these uprights 35 mm from the column. We then bolted our two rose bearings in place so that we could attach the steering arms. This is just the same as on a go cart.
By attaching the rose bearings 35 mm from the column we achieved a 1:2 ratio with the arm on the front uprights which was 70 mm long.

To attach the steering wheel we welded on a circular flat plate onto the column onto which we secured the steering wheel. (Again make sure that in the case of an accident the chest can not be damaged)
We adapted some bicycle handlebars for steering with a 100 mm circular disc in the middle as chest protection. Go cart steering wheels are good and available.
Our steering arms were made of solid steel rods. We attached male 10 mm rose bearings each end by drilling and taping. We put in a left and a right hand screw thread on so that we could adjust the length, and hence toe in or out, by just turning the steering arm. Make sure that you get the right locking nuts for the rose bearings from the supplier.

The suspension

Assuming that you are using our alloy cast parts. If buffed up these look incredible.

To attach these to the frame use 10 mm male rose bearings. Carefully mark out where you need to drill into the alloy suspension part. Use a punch to mark the centre of the mark. Drill using a pillar drill. We have had bad results using a hand held drill.
There are two options First you could drill and tap so that the rose bearing screws directly into the alloy. Secondly you could drill and then insert a Helicoil spring. You then screw the rose bearing into this and tighten up with a lock nut. We have used the latter. Adjust the length of the rose bearing screw thread into the suspension parts to adjust the suspension geometry. Make sure that you use lock nuts all around.
Our design has a suspension bar from the wishbones to the spaceframe. We have not supplied this. We have used the same system as the steering arms with solid metal rods and left and right hand thread rose bearings. The rear ones are 205 mm and the front are 125 mm long. These allow us to easily adjust the weight on each wheel and also the height of the vehicle by turning the rods.

The front uprights. There are three 10 mm holes that you need to drill in this, (Not including the one that takes the wheel) that is the two to pivot the upright and the third that is joined to the steering arm. These three holes should all be parallel to the face upon which you bolt the wheel.
BUT when a vehicle goes around a corner the inside wheel is going in a smaller circle. So to achieve this we have drilled the hole for the steering arm 3 mm towards the outside of the vehicle on both uprights. Our 3 mm was an educated guess. You might like to work on this. We have found that this works well for us.

The caster angle has been set at 8 degrees. This gives better steering control.

To attach the rear wishbone to the rear upright we have had professional aluminium welding. The rear upright is welded to the totally flat side including the plate to attach the callipers.

If you wish to construct your own suspension units we have already done this with steel. Contact us for photos of our system.

Brakes

These depend upon you budget and the wheels that you decide to use.
Remember that with the surface area of your tyres on the road brakes are only to retard speed. If you lock them you will destroy your tyres and then loose control.
Our rear uprights are designed to take bike callipers for disc brakes. You just need to drill two holes to secure them. (One calliper will point forward and the other will point backwards. This was done to save another casting.)
If you use hub brakes you may as well leave the calliper attachment plates on as you may change your minds later.
As yet brakes are only required on one axle but check event technical specifications. We put ours on the rear.

Hydraulic brakes have given us problems with the plastic hydraulic pipes expanding especially in summer leaving us with spongy brakes. If you do want hydraulic we suggest metal brake pipes.
We have gone for wire bike brakes operated from the steering wheel, but given our time again I think that foot brakes are best.

Wheels

Most events require a minimum of 20 inch wheels.
20 inch seems to be the best and most available in different specifications. We have tried larger but have hit problems. Strongly suggest 20 inch.

Unlike bikes gravity racer wheels need to be able to take a sideways force. To get the best you need to think about the width of the hub, the sturdiness of the rim and the number of spokes. Cost can be a limiting factor here. You also need to attach the wheel from one side so you will need a wide stub axle. I can get some for Cannon Dale hubs if you need them.
I suggest that you contact a good supplier who can help. There are inexpensive wheels with hub brakes available.

If you can enclose the wheels your speed will increase. If you can not then just enclose the spokes.

Tyres are important as air friction is increased with tread. We usually only run in the dry so we have smooth tyres. We do take a set of tyres with tread as well. Again make sure that you have the correct width of tyre, 35 mm is usual but sometimes event regulations may be different from National Technical Specifications.
Despite the theory that tyres should be at 120 psi to reduce friction, we have found that 60 psi is the optimum because the energy is absorbed in giving you good road handling and speed rather than shaking your teeth out of your skull.
If you have active suspension then 120 psi would be good.

To line up wheels we use fishing line tied to marks between our front and rear bumpers. Well if the system is used by formula 1 then we should be OK with it!

The bodywork

A well designed and finished racer is everything. This is as important at an event as winning it.
You need to research streamlining and style together with materials. There are new materials becoming available all the time. The Technology Enhancement Programme (TEP) is a good source of information.
We built from 1.5 mm beech plywood. The effect was stunning; it was cheap and easy to work.
We found that it was best cut by using a small hand held angle grinder with a narrow disc. This avoided the jagged edges of a saw and was very quick. We also used tin snips. These were indispensable.
To make the patterns we used brown paper or newspaper. This was good to also get the left and right sides the same.
To attach the wood to the steel tube we first used a broad head self drilling screw using a hand held battery drill with a Phillips screw head. This helped stop the wood splintering and splitting. It was also quick. When the body work was in place we removed each screw one by one and replaced them with countersunk 4 mm pot rivets about every 50 mms. To join body work sheets we used rivets again with washers on the inside. When the body was finished we used car filler to cover over all joins and then used primer and sprayed as normal. The finish was as good as a car.
If you wish to use glue as well we used Gorilla Glue. It expands and sets quickly. It is also extremely strong and can be used to put patches on inside the vehicles bodywork for reinforcing or repair. Best using clamps. For damage repair at events try Gorilla Tape.

Trim from Motor spares shops really put a good finish on a racer and it is worth every penny. It also covers up sharp edges which are not allowed.
If you have sponsors ask for stickers for the racer. These also cover up scratches etc.
Before putting the body work onto the racer you could stick on some black vinyl on the inside so that it looks really nice inside as well. We did this by using spray adhesive.
Our canopy is edged in aluminium cut out from a sheet and riveted on. This stops the plastic from splitting.

If you are enclosing your driver you must allow the driver to open the canopy and get out by themselves. i.e. you can not screw them in. We used Velcro.

Nerf bars and bumpers

These may be required if the event is running racers together
Nerf bars are located between the wheels on the side of the racers. These prevent other racers getting their wheels entangled in yours. These would not be needed if your body work covers these areas and is strong enough.

We attached bumper 'horns' to the front of our racer. These were bolted to the front suspension mounts. Our side nerf bars we welded on and the rear bar was bolted on to the roll bar.

Safety belt

We use a four point seat belt. There are floor mounts on the space frame and there is a top bar on the roll bar to attach the upper belts to. Make sure that there are no buckles on the collar bone area of the driver. These should be worn tight.

Instruments

A bicycle Speedo is really needed. The radio wireless Speedos do not work as the distance is too great from the wheels to the dash board. Buy a wire controlled model Speedo. You will need to add a bit of wire in to go the distance. The Speedo itself will fit on the dash board or steering wheel with a few modifications. If you are really flash a sat nav will also be great. Blue tooth mobile phone can also give you communications. We are looking into further innovations in this area.

Seat

The frame is designed to take a go cart seat. Bolt it to the steel tubes on the floor. Your driver will be grateful for a little padding.

Health and Safety

Needless to say Health and Safety during the build is paramount. Some parts of the build you may need to get professionally done. If you are in any doubt check first with your school / college regulations. We would also be pleased to help with your Health and Safety requirements.

Finally do check entry technical specification and racing rules for any event that you are entering. These may change year on year.