Trial Truck Construction Tips

Floating axles, while requiring more engineering and reinforcements, offer lot of wheel travel: as much as ten studs, as seen on the 9398 4X4 Crawler.

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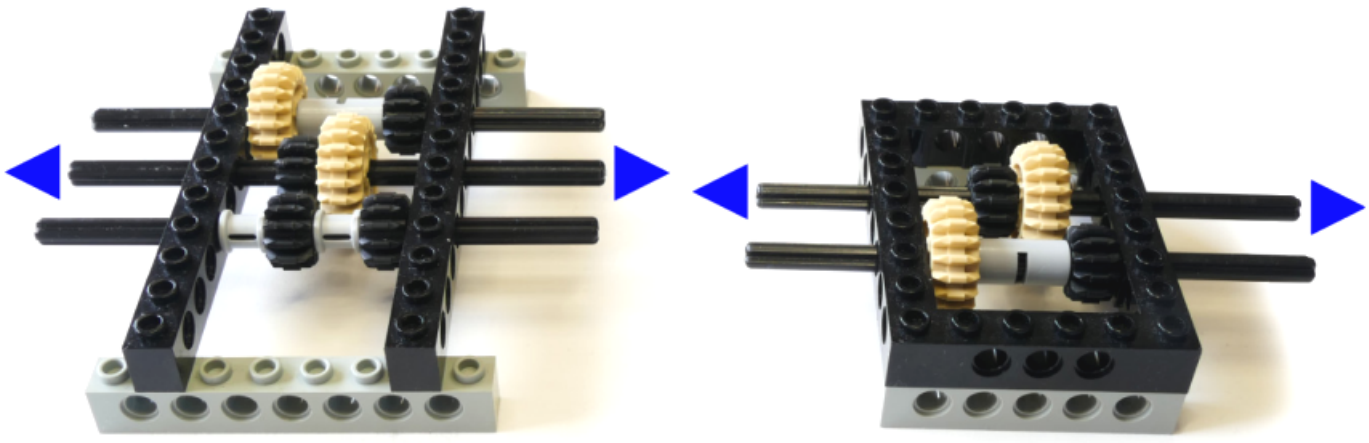
In recent years, truck trials have become increasingly popular among the Technic communities around the world. The combination of various skills and knowledge required for a good trial truck are an interesting challenge for many Technic builders. Of course, there is no single method for building an ideal trial truck, but the majority of successful trucks follow several rules. While the experienced competitors know these rules well already, in this article we will present them to the newcomers. Unsurprisingly, these rules are largely similar to those that real-world off road vehicles need to obey in order to perform well.

Drivetrain

Let us begin with the drivetrain. The more wheels are driven, the better (preferably all!); however, a common beginner's mistake is to exaggerate the drive power by using too many motors. While it may seem like a good idea, remember that it is a trial truck, not a race car. Unless the rules specify the number of motors or a minimum weight, overdoing it with the motors makes the chassis too heavy, complex,and fragile. It is much wiser to go with, for example, two XL motors and let the gearbox provide the pulling torque. Monsters with six (or even eight!) XL motors usually provide more force than LEGO® parts can transfer reliably anyway.

Although some can be done using a fixed motor-to-wheel ratio, many trials with varying terrain slopes require a gearbox. While it is tempting to build an advanced gearbox with plenty of speeds, in truck trial practice, reliability and sturdiness should always have a priority over features. Though that may seem poor by Technic standards, a gearbox with two speeds, both with lots of reduction, often does the job perfectly well. The actual challenge is in making the gearbox capable of transferring the torque reliably and without the gear skipping, rather than introducing many speeds. This means that the fragile 8-tooth gears should preferably be avoided, not only in the gearbox, but also along the entire drivetrain if possible.



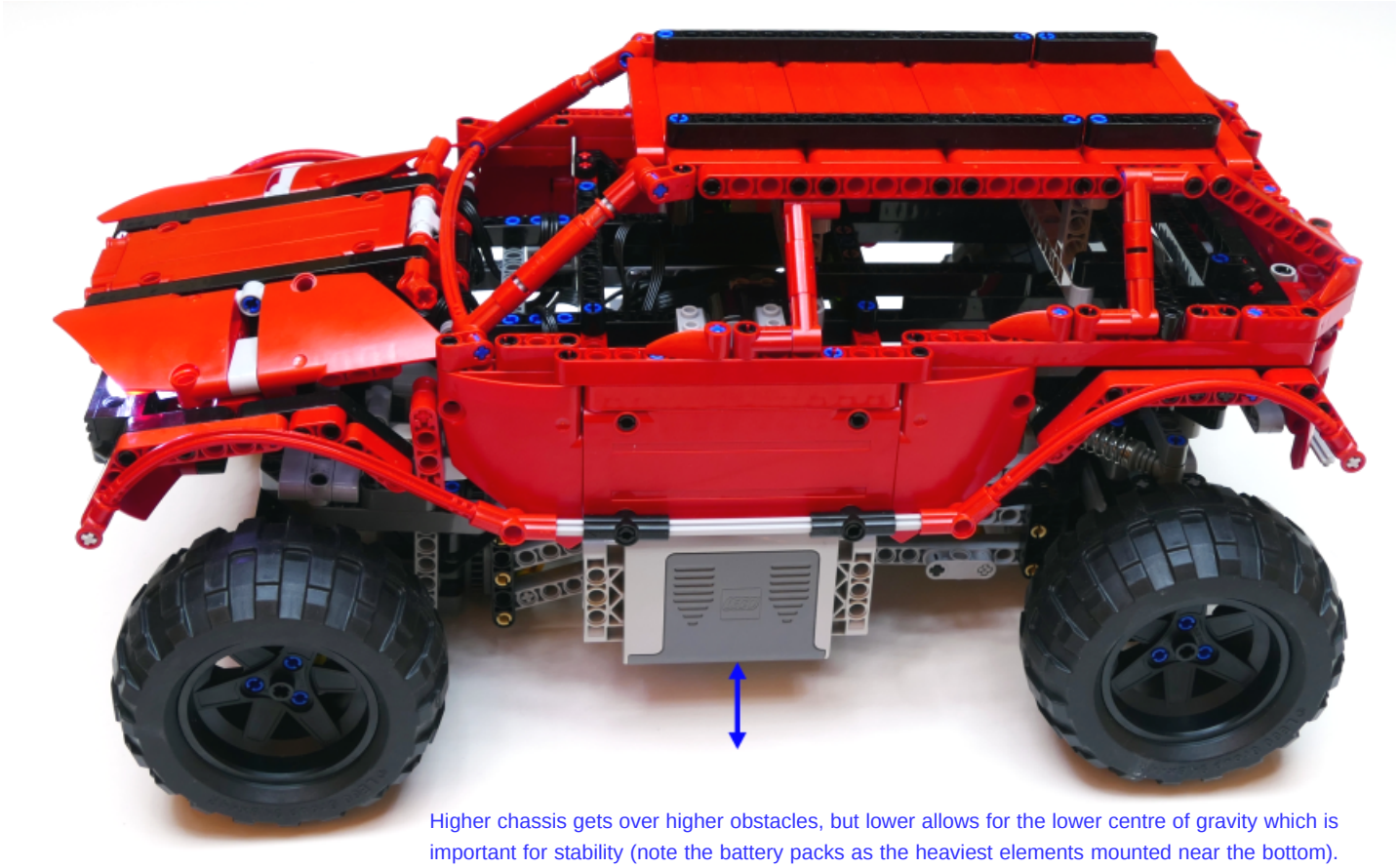
Two examples of very simple, but sturdy and reliable gearboxes. Truck trials rarely need more than two speeds.

Furthermore, the "classic" car-building experience tells us to use differentials, but the trial trucks usually perform just as well without them, i.e. with direct drive to the wheels. True, some wheel slippage may occur while turning, but the available torque should be high enough to overpower it easily anyway. Introducing a differential makes the chassis more complex, and more importantly, should any of the wheels get off the ground, the driving torque is lost. This may seem like cutting too many corners, but truck trial experiments repeatedly show that sturdiness and reliability regularly beat features and complexity, so if you want to use differentials anyway, make sure they are braced well. In theory, remotely lockable differentials would be the best solution, although they introduce too many mechanical compromises.

Chassis design

The chassis is just as important as the drivetrain, while suspension is arguably its most critical component. Successful trial trucks vary among many different suspension designs, so there is no winning design, but rather a well-judged compromise which wins trials.

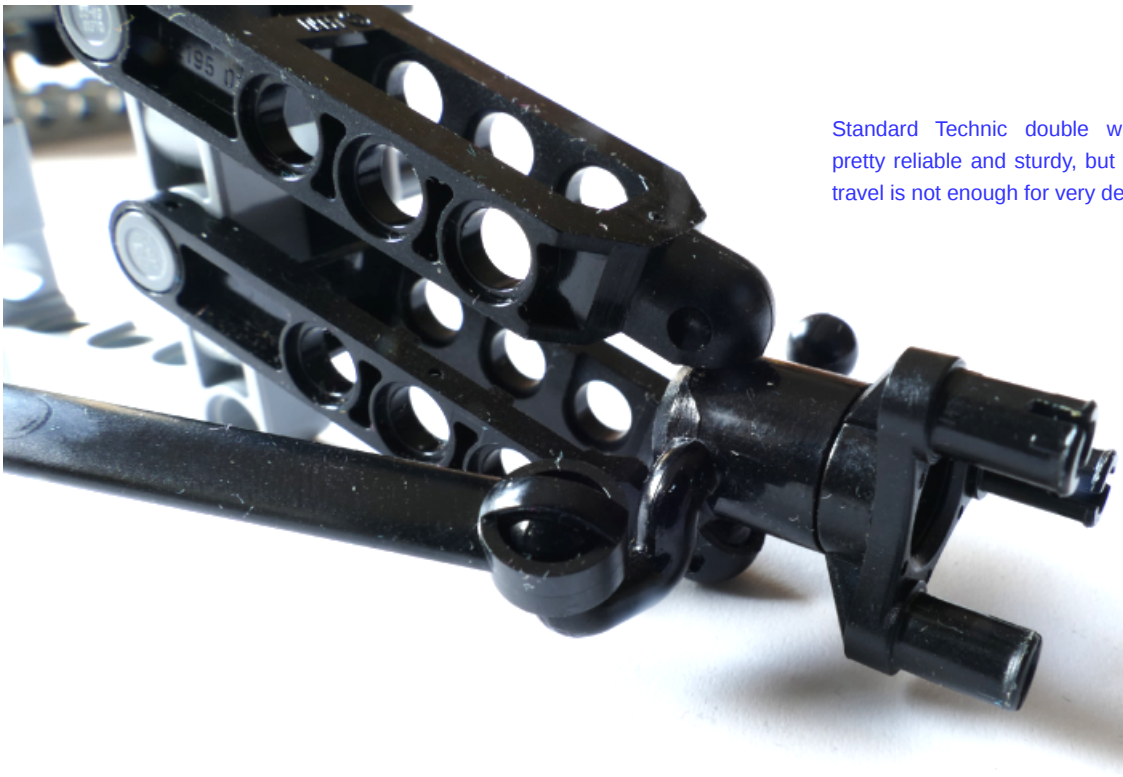
Floating-axle suspension, as seen on a the official 9398 Crawler set and other vehicles, is a pretty good choice. It allows a rather long wheel travel, ensuring the truck has grip on all tires as often as possible. However, it may be slightly fragile unless perfectly reinforced and is not easily controlled during the shocks (for example,driving off ledges). Pendular axles, where they are free to rotate only around a fixed axis, are noticeably more stable, reliable, and sturdy; however, they offer less travel and work only on trucks with four wheels.



Higher chassis gets over higher obstacles, but lower allows for the lower centre of gravity which is important for stability (note the battery packs as the heaviest elements mounted near the bottom). This crawler is rather low, more suitable for flattish, grassy courses.

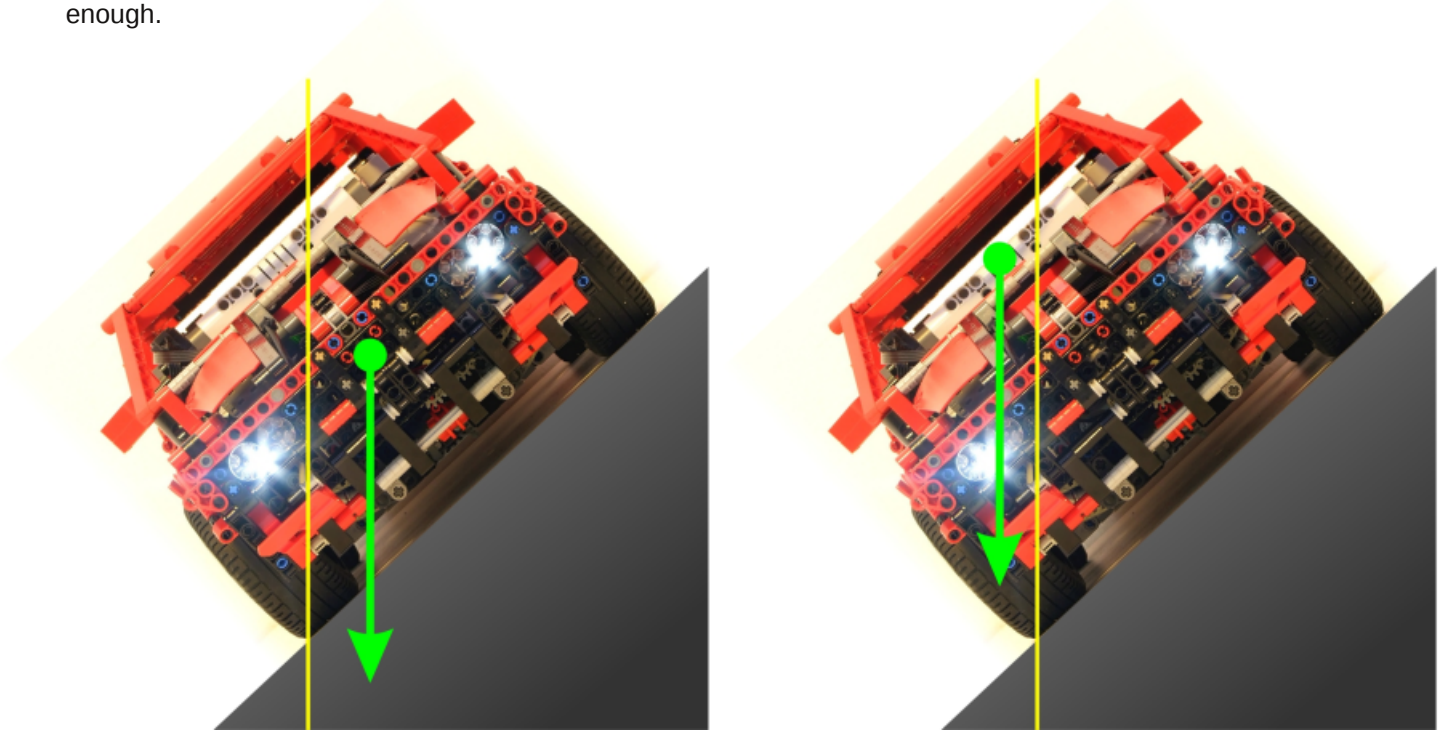
Fully independent double wishbone suspensions are easy to build using dedicated standard Technic parts and are also reliable for that reason. Their main drawback is a noticeably smaller allowed wheel travel, and even when ensuring the full suspension range is available calls for some pretty clever design. This is, however, somewhat compensated for by its stability and excellent performance on less demanding courses. If your planned trials include lots of terrain with only a few obstacles, keep this option in mind.

Whichever suspension you choose, make sure its suspension springs are not fully extended or retracted while the truck is static. A common mistake is building such a stiff suspension that it works only on very heavy obstacles. If the springs are pushed between one quarter and one half when static, you are on the right path. Sometimes during building it is impossible to predict how much the final truck will weigh. Therefore, it is clever to keep the springs easily accessible or even leave some space for the extra ones to have the option of tuning it accurately once the truck is complete.



Standard Technic double wishbone suspension is pretty reliable and sturdy, but maximum vertical wheel travel is not enough for very demanding courses.

Another important aspect of a chassis is its ground clearance, i.e. its nominal height above the surface. Clearly, the higher the better, as it allows the taller obstacles to be driven over. In the recent years, Technic has introduced parts specifically made for building portal axles which increase the ground clearance, although they alone are seldom enough.



The lower the center of gravity, the less prone is the truck to tipping over on inclines.

This requirement needs to be counterbalanced with another conflicting one which is actually just as important. Namely, the center of gravity should always be as low as practically possible for a trial truck (and indeed for any vehicle, in LEGO® or real life). If it is high, the truck's distribution of weight will be very unbalanced on tilted surfaces — whereas the requirement of successful offroading always has as much of a similar load on each wheel as possible. Furthermore, a high center of gravity makes the vehicle prone to tipping over on even more serious tilts. In order to lower it, the most effective approach is to try mounting the heaviest parts — the battery packs and probably the motors — as low as possible while keeping the bodywork light and without any unnecessary reinforcements. For

the very same reason of wheel loading, the center of gravity should also be near the longitudinal center of the wheel span.

Other considerations

Whereas a good understanding of drivetrains and chassis plays a huge factor in designing successful trial trucks, there are other details worth keeping in mind, all of which play their additional roles once the truck hits the (off)road.

One of them is, obviously, the choice of tires. Of course, they need to be large and preferably have a prominent tread, but even with these constraints, there is a range of possibilities. The 54120 are used quite frequently — they are easy to obtain, sturdy, their rims can be mounted both on axles and triangular hubs, and they seem to work well in many off road environments, making them an obvious universal choice. On the other hand, some builders have enjoyed success with 3740, the "old" 24x43 large Technic tires. Although their rims allow mounting on axles only and tend to slip inside the tires, which requires fixing with a piece of double-adhesive tape or a spot of glue, they seem to perform well on dense gravel or softer, slightly muddy grounds. A 92912 (first seen on the Unimog) is similarly effective without the drawbacks, though it is unfortunately more difficult to obtain as it has appeared on the market in a relatively smaller quantity.

From left: the 54120 tyres are rather popular and are universally fine. The 3740 occasionally behaves better on difficult, muddy, gravely terrains. Flatter, slicker tyres such as 2997 are seldom used, though they are fine on tarmac and "clean" trials.

Then there is the question of steering. Steering arms controlled by ball joint links are convenient and compatible with most Technic hubs, but are more prone to detaching under strain than standard Technic arms and beams. If the expected course features many difficult corners, it may also be interesting to look into the option of implementing all wheel steering. Despite the complexity and weight, it reduces the minimum turning radius by half, in turn making the truck significantly more maneuverable.

Unless predetermined by the rules, the scale of the truck needs to be judged thoughtfully. Longer wheelspan and wider axles increase the overall stability and decrease agility through difficult, narrow trial gates. Width should not be more than about three quarters that of the gates unless specified by the rules.

Reinforcements are another point where a wise compromise is required. Generally, trial trucks need a much harder, stiffer chassis than do other LEGO® vehicles, but it is just as easy to exaggerate. Slight bending of the chassis, for example a few millimeters in the center of a 48-stud long wheelspan, is acceptable; trying to reduce it to zero would probably require lots of beams, which would significantly increase weight, leading to even more reinforcements, etc.

Finally, a general advice: do not try to design everything in your head and then attempt to build a successful trial truck on the first try. Though meticulous and wise planning pays off, building trial trucks is largely a repetitive process. Test your chassis as soon as it is driveable on a few simple homemade obstacles if not in the open, observe its weaknesses, and try to correct them. Be aware that you may need to repeat this cycle a couple of times before you may have a truly competitive truck. It takes some patience, but trial trucks — as well as many other mechanically complex systems — simply depend on too many subtle variables to have them all accurately pinpointed right from the start. Good luck!

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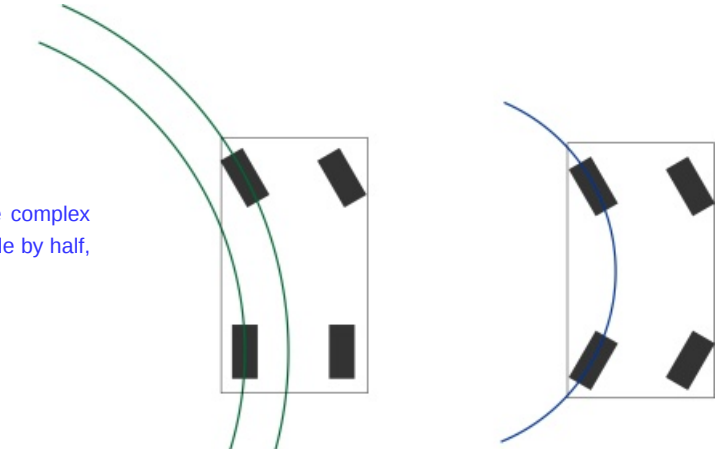

Four wheel steering is obviously more complex than two, but it reduces the turning circle by half, increasing agility.