The Stamped-Steel Chassis

In slot racing's earliest days, a slot car chassis was simply those part(s) used to attach the other necessities of the mechanism, the motor, body, guide flag, wheels, and axles, to each other, often in as direct a manner as possible. Unfortunately, early chassis did not handle particularly well and slot cars had to be driven very carefully in the turns to keep them from deslotting.

As slot cars evolved, and inventive racers tested various chassis designs and materials, it became clear that a low center of gravity was a, if not THE, major factor in achieving a good-handling chassis. Stamped-steel was the ideal material for such a chassis: strong, malleable, cheap, and heavy. Once the importance of a low center of gravity became obvious, it was only a matter of time before stamped-steel would be utilized to create simple yet effective slot car chassis that would set new benchmarks for handling.

The Parma Flexi-Kar (now generally termed the Flexi-1) was the first great-handling stamped-steel chassis to hit the market. It handled so well that within only a few years every company producing slot car chassis had at least one stamped-steel two-piece chassis in the catalog. And the good handling qualities of stamped steel chassis quickly rendered other chassis materials largely obsolete. The introduction of the stamped-steel chassis was a boon for the hobby, in large part because it handled so well but also because it was cheap to make. And broadly speaking, the stamped-steel chassis diverted the hobby from the very appealing but obviously dead-end path represented by the scratchbuilt chassis.

In the 21st Century, 1/24 scale commercial slot car racing is divided into two basic categories: Wing-Car and Unwinged (or scale). It could just as fairly be divided into stamped-steel chassis and non-stamped, as stamped-steel chassis now dominate the commercial racing landscape in the Unwinged category.

Building the Champion Turbo-Flex Chassis

The Champion Turbo-Flex gets my vote as one of the best stamped-steel 1/24 slot car chassis ever produced. It isn't perfect for every track, but its adaptability to almost any track and its excellent durability have made it my first choice almost since the date of its introduction. The T-Flex is one of the stronger chassis and certainly one of the best slot car chassis just as it comes out of the package, but it can be improved enormously by careful assembly and by what is usually termed "blueprinting," that is, making certain all measurements and alignments are exactly what they should be for maximum performance. Any mass-produced product will vary from the designer's blueprints and correcting those variances almost always results in more effective operation, in this case, in a better-handling slot car. Additionally, certain other modifications will make this chassis more durable and give even better handling.

The following instructions and modifications were developed over fifteen years of successful competition on the local, regional, and national levels, on just about every style of 1/24 commercial track and using every type of slot car motor commonly used in commercial raceways. The depth and complexity of these instructions may deter some builders, but to compete and win against the best, this level of work normally is necessary. Will building a chassis as illustrated make you instantly a winner? Perhaps, but probably not. A large part of success in slot racing is having the knowledge and experience to know what is needed to “dial in” a slot car to the perfect setup for any given track on any given day. But there is no doubt that this material will keep racers from being held back or penalized by their chassis. Many of the techniques and considerations here also have application to other brands of slot car chassis.

The first step in building a Turbo-Flex chassis is to make certain the center section is completely and totally FLAT. When you can push down on any part of the center section without it tilting up anywhere else, then the chassis is flat. Use hammers, assorted pliers, the edge of a surface plate or table, and your hands to bend, tweak, and twist the center section until it is totally flat, i.e. no rocking at all on the surface plate. There will be lots of trial and error during this process, with frequent checking of the chassis on the surface plate. This degree of flatness is not easy to achieve, but it can be accomplished with the Turbo-Flex chassis if you’re patient, persistent, and know when to pound on it with the hammer!

(If you don’t have a big ultra-flat plate to use in building chassis, it is worth acquiring one, as it will help greatly in assembling slot car chassis. I use a 9-x 12-inch black granite surface plate bought for about US$20 from a tool and machinery parts vendor, but any perfectly flat plate of metal will work. You can also use a thick piece of glass but keep in mind that you can’t pound on glass plate.)

The worst area, needing the most work, is the area around the stamping for the guide tongue. And this is also the most important area to get flat. It usually takes a big pair of linesman’s pliers to tilt down the "points" on either side of the guide tongue. Closely check the rear corners of the chassis, as the folding operation for the rear axle uprights tends to lift the rear corners. Sometimes it takes a few minutes to get a center section flat; sometimes it takes an hour or more. This step is done when you can push down vertically at any point on the center section's top surface without having the chassis lift off the surface plate at all, not even .001 inch.

Next use a small drafting triangle or other small square to make certain that all four axle uprights stand 90-degrees to the chassis. Use a pair of pliers to correct any that aren't square (and recheck for overall flatness afterwards). Then round off all sharp edges on the center section (and the top pan) with emery cloth or a fine file. Generously round off and taper the front lower edges and tips of the center section's "wings," to prevent them from digging into the track in the turns.

Another item to check on the center section is the front hook height. The hooks referred to are on the rear parts of the front axle uprights; the front of the top pan is captured by these hooks when installed. One hook usually will be higher than the other. Use a flat needle file to raise the shorter hook to the height of the taller one. Feeler gauges can be used to measure the hook height, but you can also stick a piece of .063 wire sideways into the hook and see how far you can lift it; when the lift is the same on each side, they're of equal height. The actual height of the front hooks doesn't really matter; just make certain both sides are the same.

Next, use a motor tool (Dremel makes a widely-used unit) with a grinding bit to "hog out" the rear motor mount bracket, leaving about 1/16-inch thickness on the top horizontal member and the two vertical members, and grinding the bottom horizontal member almost completely away, but leaving curved "gussets" going into the vertical members on the ends. This is legal by the USRA rules and it removes a lot of weight from the rear of the chassis.

Flatten the top pan, aluminum or steel, in the same way as with the center section. It is flat when all four edges of each side or pan stay on the surface plate when you push down anywhere on the pan's top surface. Because of the way the metal rolls up to the outer edge of the pan, it can be difficult to get the pan to be completely flat at this edge, especially on the steel pan.

Which top pan to use depends on the track and on the body being used: flatter track and lower downforce body usually means steel; "swoopier" track and higher downforce body usually means aluminum, but not always. A critical issue with the top pan involves the stamping operation used to offset the horizontal crossmembers that pass over the center section. These offsets are rarely stamped accurately. The ideal is to have the bottom surfaces of the side pans hang exactly even with the bottom surface of the center section, but on a new chassis the pans usually hang below the center section. To check this, assemble the two chassis parts and place them on your surface plate. Carefully pick up ONLY the center section; the top pan should rise off the surface plate at the exact same moment as the center section. Most of the time, the center section will lift first; as it rises and hits the crossmembers, then the top pan will lift off the surface plate.

Fixing this is a challenge. With the aluminum pan, you can re-bend the coined offsets, but it's a serious pain getting the pan flat after that. It is difficult to rebend a steel pan successfully. Another approach is to use various methods to take up the extra clearance between the center section and the top pan. You can use small tape squares on the center section as well as small Lexan squares of various thicknesses, stuck on with CA. Another method is to place solder dots on the center section, filing each dot to give the thickness needed. You will normally need four squares or dots, two front and two rear, as the crossmembers are rarely exactly parallel to the surface plate, though this can normally be corrected without too much trouble. Lately, my preferred method is to use layers of tape strips on the underside of the crossmembers to take up the extra clearance, either strapping tape or an adhesive Teflon tape (not the pipe-sealing Teflon tape) or both. If one side or corner needs extra tape, rebend the crossmember if you can and add a tiny square of tape where needed if you can't. Just make certain that the bottom surfaces of the top pan are at least perfectly even with the bottom of the center section, especially in front. If you can't get it even, make the front a little higher. The tape on the crossmembers seems to add a tiny bit of damping that helps, too.

Next carefully put very, very slight “up” bends in the in the outside front corners of the top pan, with the bend lines running from the inner corner of each side pan’s square front section and angling back toward the wheel. This keeps the front outer corners of the pan from digging into the track when the body rotates. For the same reason, use a fine file to chamfer the front edges and corners of the outer rails of the top pan.

Now “double plate” the guide tongue by soldering a trimmed Slick 7 guide tongue atop the chassis’s integral tongue. Doubling the guide tongue gives several benefits: it greatly reduces the chance of bending the guide tongue in a crash, it adds a bit of useful weight in the proper location, and it seems also to reduce the incidence of sheared guide posts. The doubler and the chassis are first filed/sanded on the surfaces to be soldered (don’t use a Dremel here!) and then both are tinned completely, with the tinned sections being refiled flat after tinning. Use an old guide flag, spacers, and a guide nut to clamp the tongue doubler in place before soldering it along its back edge (where it was trimmed to match the circular coining of the chassis), then remove the guide to complete the soldering on the other edges.

Using an old guide as a clamp makes it easy to check that the guide angle is correct (which should be done before soldering the doubler, of course). At this time we want the guide parallel to the bottom of the chassis or ever so slightly tilted up. Also check that the guide tongue is not twisted, that is, doesn't have one side higher than the other. Tom Marsteller's trick of using a long bolt, nuts, and washers tightened to the guide tongue hole as a bending handle is the best way to correct this, if the problem is present. To achieve a complete solder bond between the doubler and the chassis, as a last step use a small torch to carefully reheat the doubler, making certain it doesn't move. This last operation "floats" the doubler on the solder, helping to make certain the top surface is exactly parallel to the bottom.

To further insure this, use a Magnehone diamond-coated guide tool and a guide with an uncut shaft to hone the top and bottom surfaces of the guide tongue after doubling it. Hold the guide in place from one side and use the projecting guide shaft on the other side to pilot the hone. You'll find that a lot of times the bottom of the tongue is not very flat and the hone will take care of this problem. Also slightly enlarge the guide tongue hole after doubling, using a small grinding bit in the Dremel, and chamfer the edges of the hole on both sides. Having the guide shaft fit loosely in the hole actually seems to help somewhat, but the main concern is to make certain the hole is smooth inside and that there are no sharp edges. Having a smooth-turning guide with no wobble or slop is VERY important.

At this time use the Dremel tool and an appropriate bit to grind the plating off the places on the chassis where you will be soldering: both sides of the front axle uprights, both sides of the rear axle uprights, the areas where the motor will be soldered on: the top inside surface of the motor bracket, and front and rear areas of the center section’s motor “box” (always solder the rear as well for the big races or main events), and between the rear axle uprights (where the upright brace will be soldered). All of these areas get tinned, using acid flux. Keep tinning until you have 100% solder coverage of these areas.

Next the car is placed in the chassis jig. Some chassis jigs have a strong magnet to hold the chassis in place; if your jig doesn't, use small pieces of duct tape to hold the chassis in the correct position while soldering the rear bushings. On a non-magnetized jig, you also can use a big spring clamp to hold the rear of the chassis firmly to the jig’s baseplate. Getting the rear bushings EXACTLY the same height on each side is the most critical operation in building a chassis. Use the most-accurate jig wheels you can buy and to test your work, use dial calipers to check that each bushing is exactly the same distance from the bottom of the chassis when you're finished. Install a straight axle and measure from the top of the axle, next to each bushing on the inside of the upright, to the bottom of the chassis.

It is also important to get the rear axle exactly 90-degrees to the centerline of the chassis. To achieve this 90-degree angle, carefully scribe a centerline on your chassis jig as well as at the rear of your chassis and line the two marks up.

When soldering rear bushings, try for a 360-degree solder bond; rotating the bushings while soldering them helps to achieve this. Having a 360-degree bond along with solder fillets completely around the bushings on both the inner and outer sides makes the rear uprights much stronger; just don't go overboard with the solder amounts for weight reasons. Use desoldering braid to remove excess solder if needed. (This braid also works very well for removing excess solder from the larger tinned areas, too, like the places where the motor is to be soldered in.)

The best way to align the rear bushings is to use the largest rear axle you can find that will still pass through the bushings. Use dial calipers or a micrometer to check every axle you have to find the largest one. Always oil the bushings heavily before soldering them in place; as the bushings cool that oil will be sucked back into the oilite mesh. It's best to use synthetic oil here, as the heat is not likely to damage it.

Pay close attention to the fact that the bushings should be located by the axle passing through them, NOT by piloting on the chassis holes. Once you have used a grinding bit on the rear chassis holes to set the bushing height for your desired tire size, put the chassis on the jig with the axle and jig wheels in place, and make certain that the rear axle bushings will slide into position without touching the chassis except at the bushing flanges. You want a tiny bit of clearance between the bushing's small diameter and the chassis all the way around and if it's not there, grind some more but only just enough to achieve a flange-only fit. By the way, it is worth testing a selection of rear axle oilites for weight and running clearance; there is quite a bit of variance in these parameters among brands. It is a good idea to run the lightest rear oilites you can find, as long as they have reasonably tight running clearances.

Brace the rear axle assembly using a Slick 7 rear upright brace (or a homemade piano wire brace), but trim its "up" legs so that the brace can be installed directly beneath the rear axle. Again, sand every surface of the brace and tin it completely before soldering it in place. You want a small solder fillet on every edge of the brace where it touches the chassis. On banked tracks, running fast C-can motors, a rear upright brace is necessary to keep the rear axle from binding in the banks; the rear of the chassis will flex under the loads it sees. You can usually see this yourself on an unbraced chassis: space the motor from the axle with a piece of paper when soldering it in place, and then take a black magic marker and color the axle for about 1/4 inch at the point where the can is nearest the axle. After racing a while, you will usually see that the can has been touching the axle, as evidenced by a silver stripe rubbed into the black marking.

For the front axle, cut a piece of .063 piano wire to the length that will position the wheels inside the front wings on each side by 1/16-1/8 of an inch. This will "hide" the front wheels behind the wings, giving them a bit of extra protection from bending, but also giving a shorter, lighter front axle. I normally use the upper holes to mount the front axle, as it is easier to check a straight axle for bends and this gives more room under the axle for the lead wires.

The front axle-to-upright solder joints are the most critical joints on the chassis in terms of strength; these joints will break if you don't get them strong enough. Sand and tin the front axle completely, tip to tip; this helps the joint strength, it helps to keep the axle from rusting, and it helps to keep the front wheels from seizing due to corrosion. Install one Slick 7 .063 wheel collar to gusset the axle on the inside of each front upright. Solder this joint with StayBrite, Speedshop, or other brand silver-bearing solder for extra strength, making certain to use enough acid flux and heat to flow solder into the spaces between the axle and the collars, and between the axle and the chassis, with moderately-large solder fillets on both sides of the uprights. Use Paul Ciccarello's trick of taking the o-rings off the wheels and soldering the wheels to be level with the bottom of the chassis. This makes it easy to rebend the front axle to the proper location after crashes; just flip off the o-rings and bend the axle to place the wheels level with the bottom of the chassis. Run the lightest front wheels you can find; right now the flat, drilled Kelly front wheels fit that bill, though they will bend if you crash hard enough. A stronger wheel that will not bend is the Parma PSE drilled front, but it is heavier. Front wheels are installed with a Slick 7 .063 wheel collar on each side.

This completes the construction phase. Be certain to wash the chassis with dish soap and a toothbrush under hot water to remove the acid flux residue, unless you just happen to like the color of rust!

The next step is to check for movement amounts. Install the top pan and its cotter pin on the chassis and check for front and rear upward movements. The front lift is determined by the hook heights. How much movement desired here is a function of the track, your driving style, and the body being used. Make certain there is some clearance, as using tape under the front crossmember may raise it enough to take up all of the clearance, in which case you will need to file the hooks to allow some movement here. Some tracks want a lot, some not. Adjust the front lift using small squares of strapping (or other type) tape placed on the top surface of the front crossmember, between it and the hooks. Shoot for about .010-inch movement here as a start and measure it using feeler gauges. If less movement is desired, add another piece of tape. For more movement, take the tape off, or if necessary, remove the top pan and file on the hooks.

At the rear, lift is adjusted using .005 and .010 Teflon guide spacers under the cotter pin. The rear lift can vary enormously between center sections due to the way the cotter pin tab is manufactured (the cotter hole is punched before the tab is bent up). And in some cases, having a large amount of lift at the rear of the pan works really well. Normally, you want to shoot for .010-.015 of lift at the rear, but if you have more than this, decrease it only after track testing.

The next topic is guide flag spacing and front ride height. Here's what is wanted: when the car goes into a turn and tilts, you want the front edge of the outside wing to touch the track along as much of its length as possible. When looking at the track dirt or grunge on the bottom of the chassis, you want to see it building up along the length of each front wing, not just at the tip. This requires a very precise guide flag spacer stack and in some cases it will require you to bend the front wings every-so-slightly up, so that when the chassis rolls a tiny bit, the wing it's rolling toward lays flat on the track. This works better than having just the tips drag. Having the whole edge contact the track won't tend to dig in and it also seems to stabilize the car better. This technique doesn't work as well on really bumpy tracks and/or on tracks with widely-varying braid heights and sometimes you will simply have to raise the car up above this setting.

It's worth mentioning that testing guide flag spacer height is extremely important. Once you get the spacer height you think is best, it is almost always worth testing spacer stacks of plus and minus .005- and .010-inch, as you will often find the car feels better or is faster with one of the other spacer heights. In general, we want the front of the chassis to just barely clear the track surface on the straights, about the thickness of a piece of typing paper. But again, the quality of the track will affect this, which is why you have to test guide flag spacer height on the track.

On the subject of weighting, it is best to build cars as light as possible so you can add weight to make them easier to drive. Ease of driving is almost more important than pure speed, as the winner is the racer with the most laps, not the fastest lap. Always give up speed for handling if necessary, as staying in the slot just one more time in a heat by giving up 0.1-second in speed means you’re going to make more laps than the faster guy almost every time. The Turbo-Flex seems to need a small piece of weight between the front uprights, perhaps 3/16-inch wide and the width of the uprights; all of my chassis are fitted with this weight. A small square of weight at the back of each pan, about half the side of a normal postage stamp, will really help if the car feels twitchy. This location provides the longest moment arm for resisting the tendency of the car to roll out of the slot. Putting weight at the back of the pans is very noticeable and can really settle a car down.

Random thoughts:

Motor angle is normally as flat as it will go, using a piece of paper between the axle and the can as a spacer while soldering the motor in place. If too much traction is an issue, angle the motor forward a bit to move weight toward the front and off the tires. Changing motor angle to adjust traction is something most racers never do, as many erroneously believe that such minor changes in angle will negatively affect the gearing, but this trick can be a godsend in certain situations.

Carefully bend the now-flimsier motor bracket to give maximum contact with the can before soldering that joint. Make certain bottom of the motor can fits tightly into the inside bottom angle of the motor bracket.

Put the spur gear as close to the axle bushing as possible; run just two .003 Slick 7 spacers between the gear and the bushing. The closer you can get the pinion-spur contact patch to the can bushing, the less the can bushing will wear and the less bending moment will be imparted to the armature shaft.

On tracks with a donut turn, it can help to offset the rear wheels to help punch that turn. On a King, for example, run one thick and one thin Slick 7 axle spacer between the RR wheel and the bushing, with as many spacers as needed on the LR side to make the 3-1/4-inch maximum width. This can hurt speed in the lead-on turn and if so, put a small piece of lead inside the left pan rail to help in that turn. Sometimes you will not want to run the maximum offset or any offset at all and you have to test to know this. On other track designs, you can offset in the opposite direction to help in a particularly troublesome or important turn.

For many years, I soldered my earring back for the lead wires atop or beneath the front axle (depending on whether I mounted the front axle in the upper or lower set of holes), but in the last year or so I've gone to placing the earring back atop a short piece of wire (I use the shaft of a straight pin) soldered across the chassis slot about 3/4-inch behind the axle, and to using "California loops" for the centering action. This keeps the wire’s weight lower and uses a bit less lead wire length. The centering action is also not quite so strong, which may help as well.

Use wide bronze or steel guide spacers, rather than Teflon, though using a .005 Teflon spacer directly under the guide nut is fine. Stacks of Teflon spacers are not good, as Teflon "cold flows" under pressure. Always use the widest and tallest guide nut you can find, as most short ones have barely two threads engaging the guide shaft. The drilled Koford guide nuts are my favorites, when they are available, as they have almost three threads and are quite wide where they contact the tongue. Also, many commercial guide nuts are not “true”, i.e. the flat bottom surface is not exactly 90 degrees to the centerline of the threads. To correct this, spin the guide nut onto a long machine screw and use the Magnehone diamond-coated guide tool to grind the bottom of the guide nut. For maximum accuracy, screw the nut as far down as you can on the machine screw without having it bottom in the Magnehone guide tool.

To set guide tilt, install the largest set of tires you will use on the chassis; for me, this is normally .765 or .760 tires on a chassis set for .750 tires. Bend the guide tongue so that the guide is exactly flat and it will then have some tilt when .750 tires are fitted. Having the guide almost flat is the best, though up to 5-degrees or so of tilt can help on certain tracks. To check for guide tilt, tighten the guide nut firmly to eliminate play, then push straight down on the guide itself to flatten the braid hard against a tech block (this only works if the guide has braid in it and assumes the guide is lower than the front wheels). The rear wheels should lift evenly off the tech block between roughly 1/32-1/8-inch depending on the track. If one wheel is higher than the other when lifted, then the guide tongue is twisted (or the two braids are of different thickness). Learn to read the contact pattern on your braid and strive for having as much of the braid flat to the track braid as possible. Any degree of downward guide tilt is a VERY BAD THING and will make the chassis handle terribly. Clean your braids with lighter fluid and then crosshatch them with a black magic marker before running a couple of laps and you will easily see the braid contact pattern.

To dampen the movement of the top pan, strapping tape is used on the underside of the chassis to join the two chassis pieces. My normal tape job is a single piece of thin strapping tape 1/8-3/16-inch wide at the front of the chassis, centered on the square front notches of the center section between the front wheels, running edge to edge of the pan. Use shims in the front “slots” between the center section and the pan to hold the pan at the middle point of its range of side-to-side movement before adding the tape. This way the tape works to return the pan to the centered position on the straights, which helps the chassis to handle equally in both right and left turns. Again, this is something that you want to test, as it will not help on every track. Sometimes you will find that taping at the rear works better, or taping just one side, rather than all the way across. Sometimes no tape is best. Again, testing is necessary to learn what the chassis wants on any given track.

This is getting way too long, so we won't go deeply into body mounting, except to say that lightest is best, though some reinforcement is necessary for most bodies. Look at ways to accomplish the reinforcement needed with the least amount of weight. One method is to cut 1/16-1/8 strips of Lexan bulletproofing; run these along the lower edge of the body (especially on the front of GTP/GT1 bodies) and to use the same strips angled up into the rear corners to reinforce there.

Clips are the lightest way to mount the body to the chassis and they also allow by far the fastest body removal and reinstallation when thrashing between heats. Use small squares of Lexan bulletproofing to reinforce the clip holes (or run the reinforcing Lexan strips over the holes); enlarge the holes in the bulletproofing with the tip of a hobby knife so the clips have the proper movement. Place the point of the body clip facing forward, after bending it about 30-45 degrees toward the centerline of the chassis to ease body installation and removal. Adjust the rear “latch” of the body clip so that it snaps firmly into place but with a small bit of movement to allow the clip to “rattle” or to move slightly front to back when fully seated. Tape the clips to the body but never tape the body to the chassis, as the movement between the chassis and the body is beneficial.

A chassis built from these instructions is very strong and can be driven very, very hard on most tracks, much harder than the average stamped-steel chassis and much harder than a Parma Flexi-1, for example. It will corner better under power than during coast and on a banked track can be driven more like a wing car than a normal scale car. Quick blips will be all that most banked turns require and with high-downforce bodies certain banked turns can be punched in some lanes. For example, this chassis with a high-downforce GTP body will run the finger turn on most Kings punched, at least in the outer three or four lanes, and on certain Kings it will only require one blip a lap on black and purple!

These instructions are provided free of charge to help racers be more successful. All I ask is feedback as to how well these tips work for you, once you’ve built a chassis and raced it. Hopefully, most won’t feel this “fee” too costly…