KITCAR-CHAPTER TWO

CHASSIS PLANNING

With the planning of Chapter One behind us, are we ready to lay out the frame rails? Are we finally ready for that first step of our thousand mile journey? Well, not exactly. Just as in the first chapter, our journey begins with careful planning rather than the first step. Many things have to be taken into consideration before the first cut or weld and a little forethought here could easily save our sanity later.

Again drawing on true life experience, we would like to stress this point with a first hand example. Years ago, back in the pencil and paper days before CAD, while a draftsman at an architectural firm, your author was charged with the elevation drawings of a new university library. Although these were working drawings, the detail of the brickwork in the gothic style and it's arches made the drawings look like a work of art. Then the project engineer declared that the roof drainage was not sufficient and all of the side elevations needed to be changed to compensate. Granted we had electric erasers and granted we were paid the same to erase as to draw, but the frustration of destroying all of that beautiful work was apparently obvious. The boss walked by about that time, saw the obvious frustration, and said "Just remember, erasers are cheaper than jackhammers". Over the last 30 years, that lesson has proved to be well worth the temporary frustration. There are inevitably going to be some mistakes on this project but let us do our best to avoid the jackhammers.

So with all of that said, where do we start a chassis design? Let us start with the basic material. There are three categories, steel, aluminum, or composite monocoque. The skill and equipment needed for a composite is totally out of the question, not to mention the expense. Let us leave this to the Formula One cars at over one million dollars a copy.

This is also true with aluminum. Although not as difficult as composite, it is just too difficult and expensive. The advantage is weight but we but we are on a budget here and that just is not enough bang for the buck.

Steel falls into two sub categories, typical carbon steel usually referred to as mild steel, and alloy steel, usually chromium-nickel-molybdenum, known as chrommolly or even simply moly, when auto related. Why are Nascar racecars of mild steel and Top Fuel dragsters of moly? To understand, and dispel some myths, understand that mild steel is tough and moly is strong. That may sound like the same thing but it is not. Generally speaking mild steel will bend and give but rarely break. On the other hand, moly will take more initial stress but will break after less distortion. Because of this, moly is also more prone to stress failure than mild steel. Maybe that is one of the reasons the Nascar car which goes 500 miles on an average weekend is mild steel and the Top Fuel car which goes a maximum of 28 seconds on a weekend is moly.

To further illustrate this point of different metallurgy, let us consider an old tale of Richard the Lionhearted and Salidin. We are uncertain of it's truth, but it makes a great illustration. When the two leaders met on the battlefield, Richard drew his sword and sheared an iron bar in half with it. Salidin's troops were terrified as they had never seen a sword capable of that strength. Salidin then drew his sword and sheared a silk pillow in half. Richard's troops were equally terrified as they had never seen a sword capable of such sharpness. Do we want sharp or tough for our car? In the long run tough is desirable and we lean toward mild steel.

Another point is that moly is, by rule of thumb, four times the cost of mild steel. In keeping with our correct but not gold plated design philosophy, if mild steel is good enough for Nascar, it should be good enough for us.

Let us dispel another myth, that moly is lighter than mild steel. It is not. Some sanctioning bodies like the National Hot Rod Association allow a thinner wall tube to be used if it is the stronger moly. This is what allows the overall weight savings. For example, a linear foot of 1 ½ inch diameter .095 wall mild steel tubing weighs 1.426lbs. A similar piece of moly weighs 1.426 lbs. However, if a piece of .083 wall moly is allowed as a substitute, the weight is 1.256 lbs. That was an expensive fraction of a pound. Even with a typical chassis using several hundred feet of tubing, the return on investment is just not there. That is roughly four times the price to save about twenty pounds. Once more let us leave that to the expensive race cars.

Finally, it is not absolutely necessary to tig weld moly but it should be, as opposed to the much simpler mig welding of mild steel. Skill level is a consideration here and other factors such as stress relief and gas purging should be considered. Again, it is just not worth the effort.

Both mild steel and moly are further sub-classified. Most moly for automotive and aircraft use is 4130. Most mild steel is 1010. These numbers refer to their element content and the classifications are sub-divided even further than that. Aircraft Spruce and Specialty, a company specializing in homebuilt aircraft, has an excellent summation of this in their catalog available at www.aircraftspruce.com. They are also an excellent source of miscellaneous hard to find components, as the two industries share a great deal.

The mild steel found at the average steel supply is going to be 1010. No need to look any farther, this is sufficient but we need to look at the additional sub-classifications. The tubing from the average yard, whether it is round, square, or rectangular will likely say 1010ERW. That stands for electric rod welded. That means there is a seam in it, as opposed to DOM which means drawn over mandrel. For our purposes ERW is fine although we may want to consider DOM for our suspension pieces. Although it is stronger and thus more expensive, there is another consideration. Inside the ERW there is a bump where the seam is welded. Suspension components such as threaded inserts, designed for the inside diameter of the tube, are difficult to properly install because of this.

Stay away from any tubing with MECH in it's description. This is a very soft tubing used primarily for fluid transfer lines. The softness is to make the bending and shaping easier, not a characteristic desirable for our chassis.

Speaking of the diameter, a few notes are in order regarding tube sizing, but first know that tube and pipe are not the same. Cars are not made from water or any other pipe which is described with an outside diameter like 1 ½ inch and a thickness, such as schedule 40. The outside dimension is not a true

1 ½, only a reference, and if you try to put a 1 ½ pipe in a 1 ½ tube bender, you will have a second problem.

Tubing, on the other hand, whether it is square or round, is described by an accurate outside dimension and a wall thickness. The outside dimension is correct to within a few thousandths and the wall thickness may be listed as a fraction or as a gage thickness. Generally speaking, gage pieces come in 24 foot lengths and fractions in 20 foot sticks. Also generally speaking gage thickness is used below 1/8 wall, which is what this project will use.

The steelyard will usually make the first cut for free if hauling 24 foot sticks become a problem and it needs to be cut in half. This brings up an interesting point. The author has seen several forum questions about the yard cutting the individual pieces. They will not, at least not for less than a dollar a cut, and there are hundreds of cuts. A chop saw at my favorite Harbor Freight is $69.95. You do the math and you are going to need one anyway. They are probably not going to sell a foot off of a 24 foot stick either, but hopefully we have designed such that we do not need only a foot of a particular size. There will be more about that later.

It is our observation that there is a great deal of price range from one steel supplier to another, so shop around. Also, quantity makes a difference in price so do not purchase it a stick at a time. Some yards have free delivery and this may be a determining factor. Once a yard has been selected, stay with them. This is a relationship worth building, especially if they will let you access their scrap bin out back on another project when you truly do need only a foot.

With mild steel selected as the chassis material, one more determination must be made. That is whether to use round or square tubing, or even a combination of both. Circle track cars use primarily round while formula type cars use mainly square or rectangular. Your author has built over 400 race cars and he cannot tell you why this is. Any thoughts? We think it is just two different mindsets and two different evolutions. Round is thought to be stronger but that is not necessarily so with a properly sized rectangular piece.

We do know one thing, all other considerations being the same, square or rectangular is much easier to work with on the initial assembly and much easier to attach additional fabrications to. Joints where two pieces come together do not have to be “birdsmouthed” like round tubing. Also, a flat surface is much easier to attach items such as interior panels.

The defining argument for rectangular may be found in the Trans Am racecars of twenty years ago, arguably some of the finest pieces of racecar engineering ever built. They used rectangular from the top of the door down, then above this the rollcage of round tubing had a flat surface to weld to. The chassis below the cage was generic to any car make and model while the rollcage was custom to the particular body. For sheer ease of construction, let us decide on square or rectangular rather than round.

There is one possible downside. Round tubing is more easily bent. There are dies for square and it can be done, but they are much more scarce. This is something we should keep in mind during the actual design process, and it seems like a more than fair trade off.

The mention of the Trans Am car brings up two more interesting points. First the fact that it was designed generically for any body and only the “outrigging” is changed to accommodate a specific body is an intriguing thought. Since it is a possible intention to supply this final chassis design to the kitcar market for various bodies, let us keep that design concept in mind throughout the design process.

Second, it is quickly becoming a recurring theme here that technology is where you can steal it. We mean that in a good way. Good design looks at what already exists, takes the best of all the examples, and adds and improves on that.

Let’s explore the design process further. Whether we want to build an exotic car or a toaster, it is the same. We have some givens and they hint at the blanks that still need to be filled in. In a toaster’s case, we have bread of a certain size and a certain number of slices to be inserted. This begins to dictate the overall size and shape of it. Once heating elements are added, which have their own givens, the size and shape becomes more defined. It is the same way with our chassis build. We know that the wheelbase is 98 ½ inches, the front track is 60 ½ inches, and the rear track is 63 inches. The ride height, or distance from the ground plane to the bottom of the framerails, is 5 inches. www.lambocars.com is an excellent source for dimensional data on all models.

Now a word of caution here. Sometimes it is assumed that something is a given when it could be a variable. The toaster was used as an example because it is a classic industrial engineer school project but consider the case of the gasoline powered margarita machine. Ever seen one of those that looks like a blender tied to a weedeater? Maybe we wanted our toaster to be gas powered. Or possibly we want our car to be electric powered.

Think of the design process in another way. It is like filling out a crossword puzzle. The known words are inserted and they hint at the missing words. The more that are known, the more clues you have for the blanks, or in our case a properly engineered blank. With all of this in mind, let us move on to the specifics of the chassis design.