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Building A Race Car: Part 8

Getting the right setup is crucial

story by Mark Davis

We just missed the setup. We hit the setup perfectly. This team has a strong setup for flat tracks.

The term setup is used loosely today to mean just about everything: preparation, luck, skill, strategy and even alignment. The word can describe each of these, but generally, setup deals with preparation.

In the mid-1980s, many teams assembled cars and brought in experts like Herb Nab, Jake Elder or Buddy Parrott to set up the cars. Some teams felt that there was *magic* in these setups.

Late in June 1985, I spent a day helping Herb Nab set up a car for Daytona. Nab's magic was in alignment. He checked every measurement, squared and set the front end precisely. His baseline was successful for many years.

While Nab's thing was alignment, Robert Harrington's focus was conservative, strong preparation with concentration on finishing races and making points. No trick spring combinations, alignments or high gear choices for him. Harrington often said, "For everyone that out-tricks us, we will out-prepare 20."

Mike Beam, now crew chief for Elliott Sadler's #21 Citgo Ford, experimented for years, looking for the ultimate edge. Beam spent hours designing and researching parts. Like a high-stakes gambler putting his money on the line, he only hit it big some days.

Today's setups are more involved than ever before, and teams have less time to judge the setup on the track. Fewer track testing sessions have eliminated days of prep time teams used to have to work on setups. With radial tires a driver has only 10 to 15 laps to decide what a car needs. Many shows limit practice to two hours before qualifying. That means all race decisions have to be made in Happy Hour, the final practice period before a race.

Then there are track variables. Many teams watch weather reports and opt for setups that complement the track conditions, which change with the cloud cover. Versatile setups that can be changed rapidly are the key to good qualifying and racing. Many teams will have five or more setups ready for the assault on a single track.

To repeat a setup that works, teams must keep complex records. Crew members record each spring combination, shock combo and alignment setting. Throw in sway bar, nose weight, cross weight, bump steer, tread width, and lead, and the combinations of all these, and there's a great deal to study.

Years ago when Beam started researching components and their effects, he had limited help. Today's teams take the time to study the data thoroughly.

With these thoughts in mind, let's start the setup of our car.

CHASSIS

The first thing is to set the chassis at ride height. Once the design ride height is set, the rear end tread width is measured and the front end width is mocked up. This measurement is dependent on front end alignment and is finalized with wheel spacers after alignment is set.

Tread width is established by design criteria, control arm length, rear housing width, chassis width, wheel width and spacers. Winston Cup tread width is set by

NASCAR rules and is 60 inches, plus or minus one-half inch.

Once tread width is set, rear end alignment begins. Squaring the rear housing in the chassis is critical. Misaligned rear ends account for 50 percent of all short track handling problems.

Measuring off the face of tires, the rear is centered in the chassis. Once centered, the rear is squared to the side rails of the chassis. Mounted on the right side of the trailing arm cross member is an eccentric (a bolt offset in a washer that works in a slotted hole) adjustment for squaring the rear. Misaligned rears can steer the rear end to the inside or outside of the track.

The term lead is never applied to rear alignment. Many teams set the track bar height, which establishes the rear roll center at the highest possible boundary and adjust downward to promote forward bite. Normally, teams will set track bar height at 12 inches right and left to start.

The front end alignment process is a lot more complex. First, camber and caster settings are roughed in. Getting these alignments close allows the team to measure off the chassis to square wheels. Steering is centered, adjusting the tie rods and drag link assembly.

At this point, the wheelbase is checked. NASCAR rules state that the wheelbase should be 110 inches, plus or minus one-half inch.

Lead is critical to turning. With lead, toe, rear end squared and front end aligned, the left side wheelbase can be lengthened to 110 and one-half inch. Remember, when the caster alignment is changed, it can affect wheelbase.

This process is called the chassis dance for a reason. When the wheelbase is set, the front end can be finalized and the bump steer process can begin.

Using the ride height as a baseline, the left and right suspension are measured to the thousandths. As tie rod, lower A arms and uppers travel, each has an established arc. These arcs have to be synchronized so that in travel, the wheels don't turn excessively.

When analyzing setups for a track, many times caster, camber, wheelbase and toe are changed to utilize handling. Each different combination in the front end changes something else. Prepared teams document each possible change so each can be accounted for. A one percent change in camber can change bump steer .060 of an inch. Camber initiates bump steer changes. Caster changes affect wheelbase, and so on. Remember, all these alignments and effects have been measured and documented on ride height blocks.

The next process is to spring the car and establish physical weight. A complete Winston Cup car, including engine, weighs about 2,850 pounds. NASCAR rules require the car to weigh 3,400 pounds. Ballast is put in the car with handling in mind.

NASCAR rules dictate a minimum weight total and right-side weight. The maximum left-side weight is critical for left-hand turns. Front-to-rear ratios enhance turning. On tight-braked tracks, front-to-rear ratios at 50:50 are best. High-speed flat tracks require 48:52 ratio. Each time the ballast changes, ride height has to be adjusted.

Wedge and bite have been used for decades in racing. These terms, which come from the 1940s and 1950s, actually refer to cross weight in a car. Cross weight refers to the relationship between the left rear and right front weights compared to the left front and right rear weights. Cross weight percentages change each time ballast is displaced.

First, baseline springs are installed. Once the springs are in place, the ballast totals and correct ride heights are adjusted, using jack bolts located on each corner of the car, on top of each corresponding spring.

Alignment and adjustments have been made at ride heights. While the car is on the scales, jack bolts adjust the total cross weight. Each time a spring is changed, the cross weight changes.

KEVIN THORNE PHOTO

Crew members check the tire temperatures in order to make adjustments in the setup. The temperature of each tire — taken at the inside, middle and outside edge — tells them whether the car is pushing or loose in the turns.

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Above is an inspection list initialed by NASCAR officials. Every car has to undergo a strict NASCAR inspection before the car can circle the track on race day. Top: Springs are critical in a setup. Changes in springs alter ride height and cross weight.

The only sure way to change springs is to document each combination, counting turns out or in for the spring changes. For example, a driver feels that a 900-pound left front spring should replace an 800-pound spring. The heavier spring changes ride height and cross weight. Two turns on a jack bolt counterclockwise adjust cross weight back to the desired percentage.

When a team sets up for a track, each possible spring combination must be scaled and documented for changes.

Shock combinations are installed, but are tuned at the track, following conditions. Sway bars, front and rear, are installed and adjusted last. One turn of a pre-load on a sway bar can change the cross weight 1/10th of a percentage point.

As you can see, teams need more than a ball of string, tape measure, and front end gauge to set up a car. More precise documentation and data acquisition are needed. In the next two issues, we'll cover the data acquisition process and track tuning for our setup.

Good equipment is the easy part. A team can have the best chassis and best engine money can buy, but not win a race. It's the setup preparation that makes a great race car.