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Building A Race Car: Part 2

Learning to think like a crew chief

As we jump into our car construction, many issues come to mind. But, first let's get clear on some things. When I was very young, an uncle told me a story about interrogating Germans in World War II. He spoke German fluently, but many German officers refused to communicate with my uncle and he felt that his communication skills in a foreign tongue were doomed. One of the lead interrogators took him aside and explained that he spoke the language perfectly, but there was a difference in speaking in one language and thinking in another. He suggested he think in German. My uncle followed his advice and gained valuable inside information on many German objectives.

Racing is the same. *Talking* racing and *thinking* racing are two different things.

Race engineering has changed a great deal in just a few years. Winston Cup, Busch Grand National and Craftsman Trucks share a common chassis that has its roots in the 1960s. In the past, many successful crew chiefs built and campaigned cars, winning many races by using trial and error. Working once with legendary crew chief and chassis guru Herb Nab, I realized that it's possible to get good results without understanding the cause. Nab was preparing a Daytona car for an upcoming race by diligently aligning the front end and then pushing the car over a three-foot-wide strip of paper lying in front of the car. "If it wrinkles the paper it scrubs off speed," he said. I asked what caused it to wrinkle, and he answered, "I don't really know, but I got it to quit doing it."

The car led many laps in the July race with young Doug Heavron driving, and was leading when the flywheel bolts broke, putting the car out of the race.

Today's crew chiefs are more precise in documenting causes. As each cause is pinpointed, they use new technology to enhance results. To understand what's involved in choosing the chassis and building a certain type of car, and to understand what crew chiefs do to enhance performance, you need to be up to speed on technical terms and their history. For that matter, you need to know these words just to follow race telecasts.

Here's a good shot of the rear of your average downforce car. Notice the upper surface area on the quarters. Spoilers this size produce plenty of downforce. Spoiler size and angle often are mandated by NASCAR.

Chassis Terms:

Front steer — a term used to designate the location of steering components relative to front wheels.

Bump steer — the amount of change of toe in or toe out when suspension travels up or down.

Ride height — the designed height for a chassis to race at. This height is measured at frame corners.

Rake — the amount of change in ride height from left to right and front to rear.

Center of gravity — an imaginary line that runs front to rear at the car's perfect center of mass.

Footprint — the amount in square inches that each tire touches the earth. Larger footprints enhance tire grip to track. Four equal footprints with equal applied forces would promote great tire wear and vehicle handling.

Upper A-Arm — the link that fastens the spindle top to ball joint as an assembly to the chassis.

Lower A-Arm — the other link for the lower part of this independent front suspension. The length and location of these A-Arms establish the perimeters known as front-end geometry.

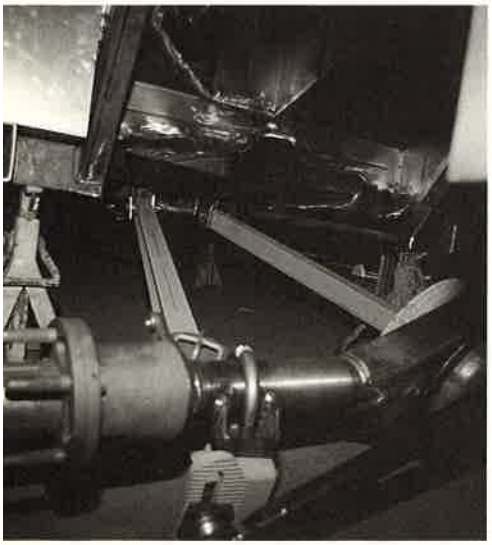
Camber gain — the amount of angle change in front spindles as suspension travels inward or outward from the center of the car. Camber changes can be used to maximize footprint when needed.

Static camber — the amount of camber set in the vehicle initially when the front end is aligned. Camber settings change from track to track, depending on weight transfer, track surface, loads on the chassis, etc.

This fabricator is fitting the A-pillar on a Taurus downforce car. Note the width of the A-pillar base and flatness of the front fenders. Below: This is a normal truck arm setup: The truck arm is an I-beam using a spherical bearing to attach to the frame. It mounts solidly to rear with U-bolts.

Caster — the angle of a spindle frontward or rearward. Caster stagger is the difference between the static caster settings; it affects the amount of pull to the right or left a driver experiences. The more caster stagger, the more the vehicle pulls or steers.

Spindle — the component the front hub assembly attaches to, which allows the wheel to bolt to the hub. Spindles not only suspend the chassis from the wheel, but also turn, allowing cornering. Spindle height, steering arm location, pin height and king pin control many perimeters in the front end.



Ackerman — a term used to describe the difference in turning radius of each front wheel. Simply, the left will turn more than the right wheel, allowing for the difference in corner radius.

Scrub — the amount of force exerted on the tire footprint due to the different location of tire center or pivot and the actual pivot of the spindle.

Wheel offset — the back spacing from the hub surface to the rim of the wheel. All NASCAR touring divisions have four and one-half inches back spacing.

Wheelbase — the length between axle center line and spindle center line front.

Lead — a term associated with wheelbase, indicating that one side is longer or leading the other.

Track bar — a locating device that centers the rear axle in the chassis.

Truck arm — a torque arm-trailing arm combination that evolved from the early Chevy pickup. The truck arm pivots freely at the cross member and solidly on the rear end.

Steering ratio — determined by the amount the steering wheel turns in relationship to the wheels. Drivers often get used to turning the steering wheel a certain amount. Turning more or less disrupts rhythm; therefore many ratios have been developed for different length turns.

Roll center — a dynamic point determined by geometry, relative to the center of gravity in a car.

Front roll center — the angle of A-Arm projection points, combined with center of tread projection points drawn to a common point. After establishing left points and right points, the connecting points are the actual roll center of the car. This point can be right or left of center, low or high, and can be changed by upper A-Arm angles, lower angles, ride height, component lengths, tire size, wheel spacers and tread width. All affect handling characteristics. Drop snouts or raised snouts define the location of the front clip to the side rails of the chassis and determine component location and roll centers.

Rear roll center — located simply at the center of the track bar from the ground and center from the right to left mounting points. Roll centers are measured from the ground, but are relative to center of gravity. Higher roll centers exert less mechanical advantage, so lower spring rates can control roll or weight transfer.

At this point, somebody needs to slap Benny Parson's; he's talking way too much. Now, that was a quick lesson in chassis terminology, but you also need to know body talk.

Car Body:

Downforce — the amount of force exerted downward on a car by wind force. It is related to speed.

Drag — the force that uses up energy as horsepower as an object is propelled though the wind.

Balance — a term that aero engineers use to describe downforce, front to rear. Balance also is used to explain the situation in a perfect world when the

least amount of drag is produced for the most downforce exerted.

Air dam — the front valance of the vehicle that produces downforce while directing air flow around the car.

Spoiler — a device located on the rear of the car's deck lid. Subtle changes in spoilers can affect a car's total balance. Downforce cars are specially built to produce maximum downforce while traveling through the air. Virtually all cars with the exception of restrictor plate cars are versions of downforce cars with small changes for each track type.

A-pillars — the body pillars located next to the windshield.

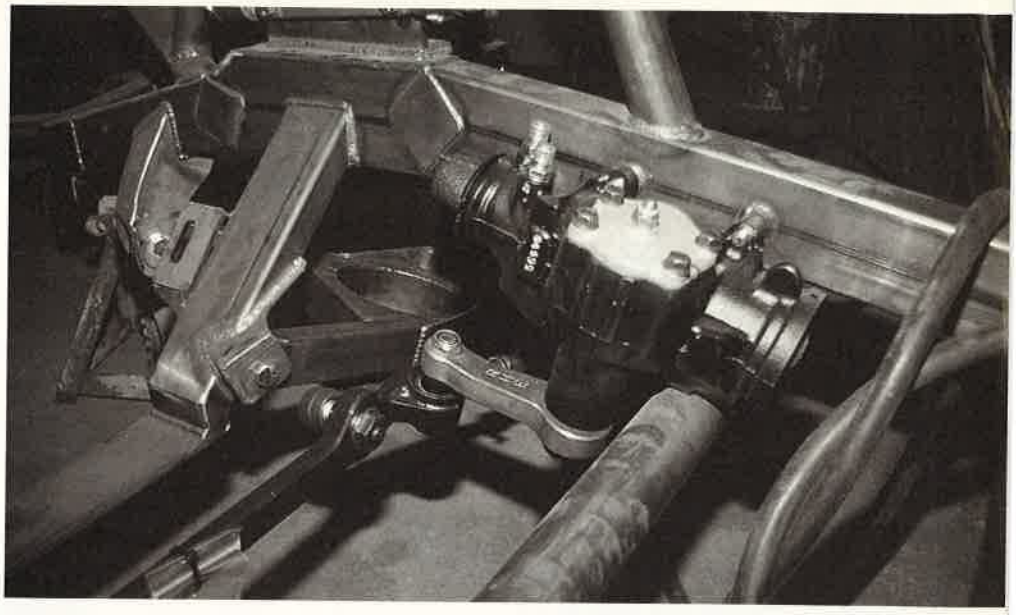
B-pillars — the body pillars located behind the side window.

C-pillars — the body pillars located next to the rear glass.

Cowls — the closures that seal the hood to the base of the windshield. Air box openings are located in the cowl.

Aero push — an understeer condition caused when a car pulls closely into another car's air stream. Taking the air is a term used when the downforce is broken by a car beside or behind a car.

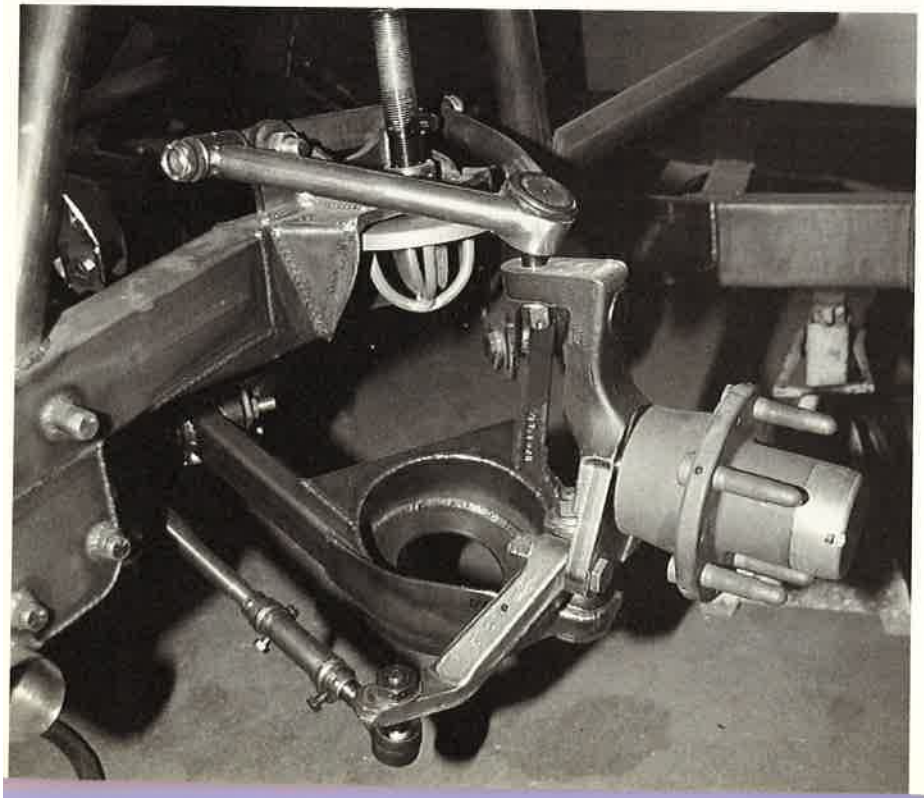
Drafting — a term used to explain the phenomenon that occurs when a group of cars hooks together in a train, fooling the air by breaking the wind with one surface, which lessens downforce and drag force because these are exerted over a number of cars.



This is the standard front steer configuration. This CJR steering box comes in many ratios from 12:1 to 20:1. Below: This is a typical Winston Cup independent front suspension assembly. Notice the components. Remember, the length and angles of each car change geometry totally.

Bump drafting — a version of drafting in which one car bumps another. The initial contact breaks downforce and drag forces momentarily, giving the lead car as much as 100 more usable horsepower, rocketing it away from the pack without totally breaking the draft.

Duct work — the enclosures sealing heat exchangers, radiators, oil coolers, etc. while forcing cool air to flow through each. Brake ducts direct cool air through hoses to cool rotors under racing conditions. The more openings in the front of the air dam, grilles, etc. lessen the amount of downforce produced and increase drag. Teams not only control critical water-temperature and oil-temperature numbers, but can tailor handling by the addition or subtraction of tape on noses.



As the car construction process starts, it is easy to see just by reviewing the terminology that weight management, roll centers, front geometry choices, body dynamics and component choices are all important decisions.

Next month we'll start the chassis construction. The car that we plan to build is a short, flat track car that will unitize standard frame perimeters used by many Winston Cup teams.

So, think about the terminology and see if you can decide what characteristics we will employ in next month's chassis construction.

Our thanks to Hutcherson-Pagan Enterprises and the Bill Elliott Racing Team for opening their facilities for photos.