

## **Steering Systems Tasks: (As of 9/3/09):**

### STEERING COLUMN & WHEEL DESIGN AND BUILD

Design Steering Column and weld to spline input shaft

### STEERING KNUCKLE DESIGN & BUILD

This will be a custom machined part that will be bolted into the upright. The steering knuckle must be designed so that it is offset from the upright the correct distance to cause an appropriate resultant steering angle. The steering angle controls the turning radius of the car require for the car to meet the minimum turning radius (16m) as specified in the race regulations.

The steering knuckle must also comply with Ackerman Geometry. This means that each steering will be designed in a way that each wheel will turn following the same turn circle.

## **Parts List (all stored in Bray):**

### RACK AND PINION:

For simplicity, we have chosen to purchase a pre-assembled rack and pinion unit.

The 14" Rack and Pinion Steering Unit is designed for mini dune buggies from Desert Karts (<http://www.desertkarts.com/item80862.ctlg>). The ratio of the rack and pinion is 12:1 this equals 1.5 turns of the wheel is 4 inches of rack travel "lock to lock". The 14" is measured from center to center of the adjustable rod ends. (Included)

### U-JOINT

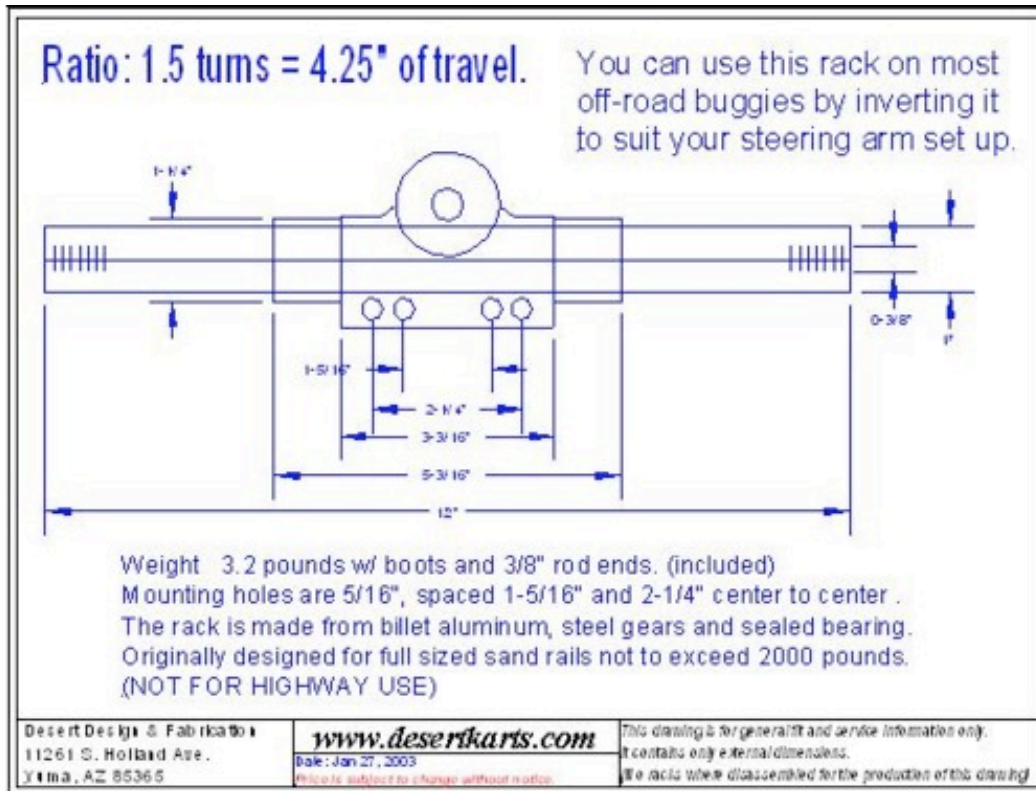
A universal joint is a joint in a rigid rod that allows the rod to 'bend' in any direction, and is commonly used in shafts that transmit rotary motion. It consists of a pair of ordinary hinges located close together, but oriented at 90° relative to each other. When the driver turns the steering wheel the U-Joint allows the rotational motion of the steering input shaft to turn the pinion. This allows the steering This U-Joint is splined to match the input shaft and rack and pinion.

### SPLINE INPUT SHAFT

For the specific rack and pinion unit we have purchased a 36 Spline Input shaft is required. The steering column (has not yet been designed) will be

welded to the spine input shaft.

## RACK AND PINION UNIT



UNIVERSAL JOINT



DesertKarts.Com

SPLINE INPUT SHAFT



DesertKarts.com

# Background on Steering

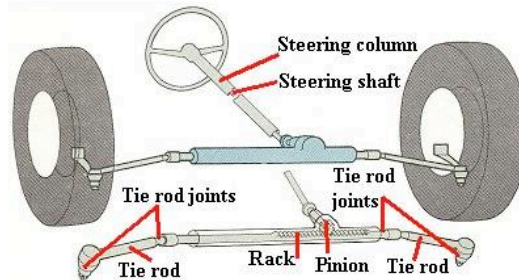
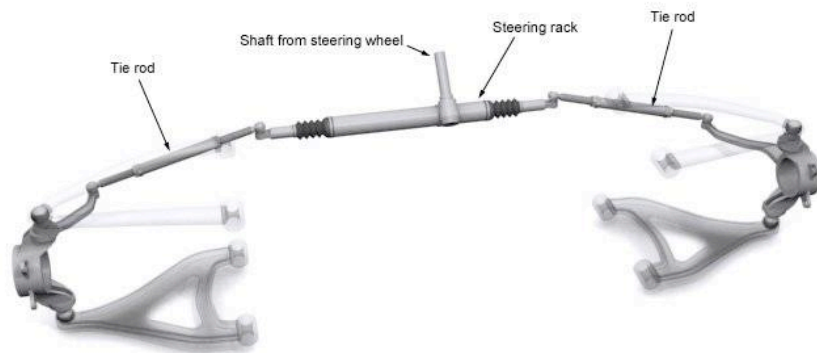
To steer the car we have decided to use a manual rack and pinion system.

Benefits of Rack and Pinion:

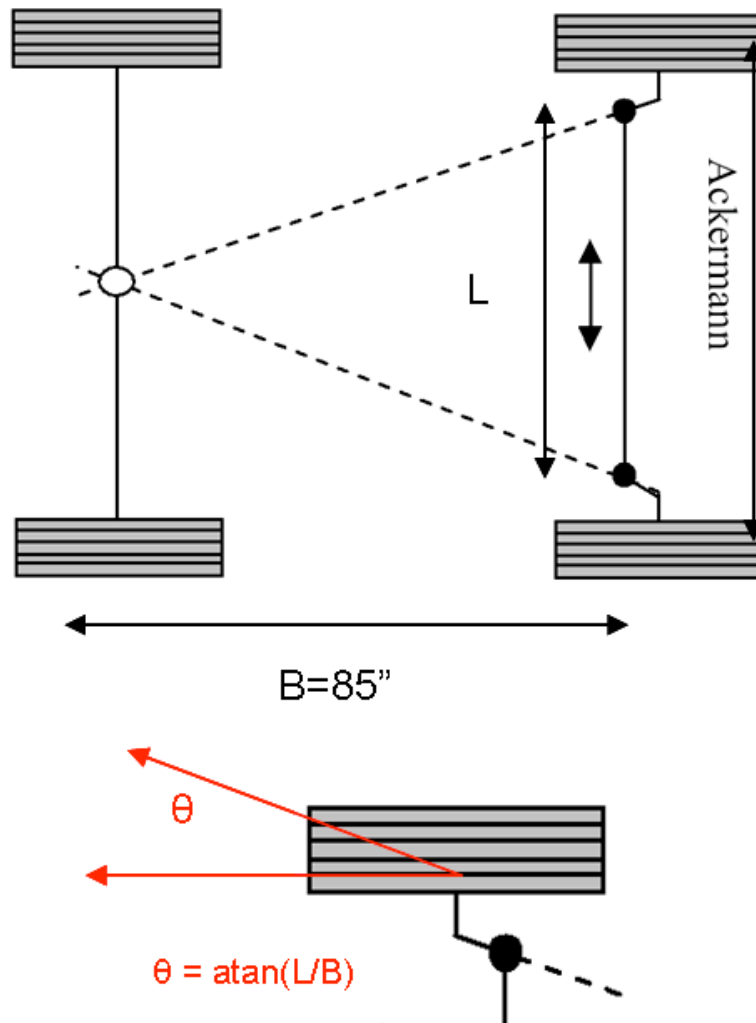
- Simple construction
- Cheap and readily available
- High mechanical efficiency
- Reduced space and weight requirement

## Rack and Pinion Setup for Normal Car

[www.carbibbles.com](http://www.carbibbles.com)



## Ackerman Steering Geometry



The equation shown in red explains how to calculate theta, the angle the steering knuckle is mounted relative to the wheel. The wheelbase,  $B$ , is 85 inches for our design. We have currently set the track to 52 inches, from center to center. To determine  $L$ , the distance between the mounting locations on each of the steering knuckles, the distance from the center of the wheel to the upright mounting location must be determined. Each wheel is 2" thick. We are estimating that the rotor and hub will need

approximately 3 inches of clearance between the upright and the inner wheel. We are also estimating that the upright will be approximately 2 inches thick and the steering knuckle will mount in the center. This means that L will be (52"-(1"for wheel thickness)-(3" for hub and rotor) -(1" for upright)) **This calculation will need to be reevaluated once the exact hub, upright and lower control have been machined.**

## ***Terms and Research***

### *Steering Ratio*

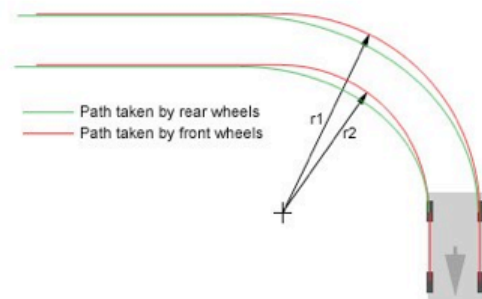
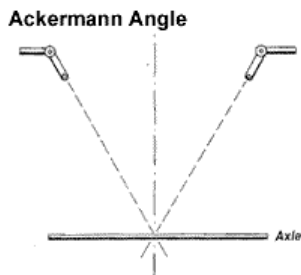
- The ratio of turns the steering wheel makes compared to the amount the wheel rotates.
- 12:1 in selected rack and pinion unit

### *Turning Radius*

- The radius of the smallest turn the car is able to complete
- The basic formula is  $2 * (L / \sin(A))$ , where L = length of wheelbase, and A is the angle of
- The Using this formula if L = 80" (in current design), wheels must be able to turn at least 20 degrees.

### *Ackermann Steering Geometry*

- the placement of the steering arms (when viewed from above), in relation to the chassis, and the rear axle. Ideally, lines projected through the center of the King Pins, and through the bolts holding the track rods, should meet at the center point of the rear axle.



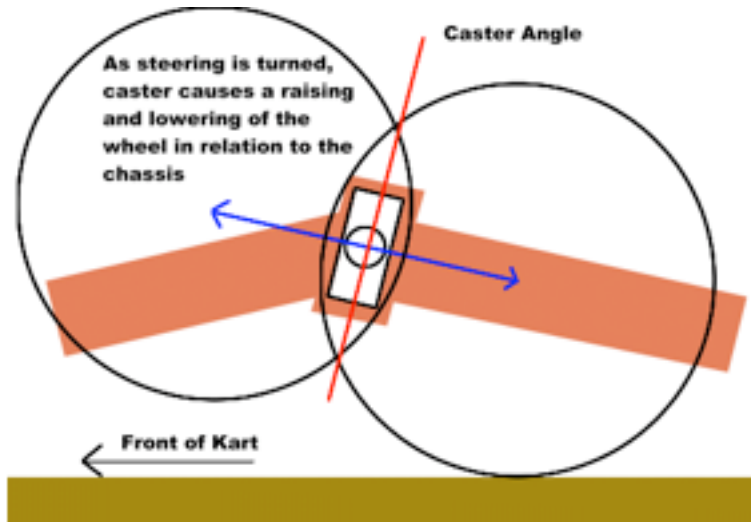
Picture credit:

### *Camber*

This is the degree to which the front wheel lean in (or out) from each other. A camber setting of 0 means that both tyres sit flat on the track. Maximising the amount of rubber on the track is one of the aims of kart setup.

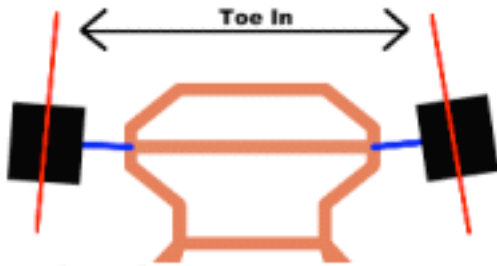
### *Caster*

This is the angle of the kingpin, which is the point around which the stub axles rotate. This is one of the most important settings for inducing wheel lift during cornering.



### *Toe In/Out*

This is the angle at which the front wheels either point in towards each other, or away from each other. Zero degrees toe in/out means that the wheels are parallel. Toe in/out is set by changing the length of the tie rods.



### *Scrub Radius*

This is distance from the centre of the tyre to the point where a line down the kingpin axis intersects the ground. Along with caster this affects wheel lift during cornering. Scrub radius is set using spacers on the stub axle.

### *King Pin Inclination*

This is the inward lean of the kingpin, and it modifies the amount of camber change caused by the caster when steering. It is not usually possible (or necessary) to adjust the KPI although some camber adjust systems may let you do it.

### **Resources**

[How Stuff Works - Steering](#)

[Car Bibles - Steering](#)