

STEERING PRINCIPLES

Ackerman Steering Principle

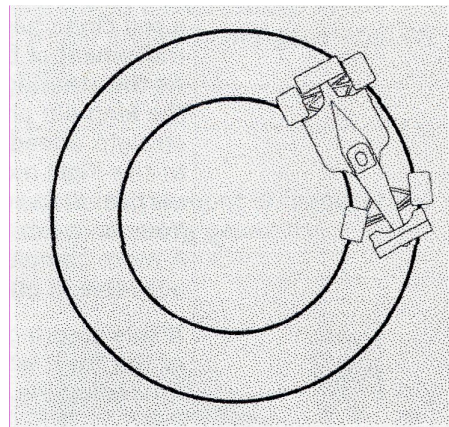
The Ackerman Steering Principle defines the geometry that is applied to all vehicles (two or four wheel drive) to enable the correct turning angle of the steering wheels to be generated when negotiating a corner or a curve.

Before this principle was developed the vehicles of the time (horse drawn) were fitted with parallel steering arms and suffered from poor steering performance. A Mr Rudolf Ackerman is credited with working out that using angled steering arms would cure these vehicles of such steering problems.

Why & How?

The animation on the right depicts a car travelling around a corner. The lines represent the path that the wheels follow. Notice that the inside wheels of the car are following a smaller diameter circle than the outside wheels.

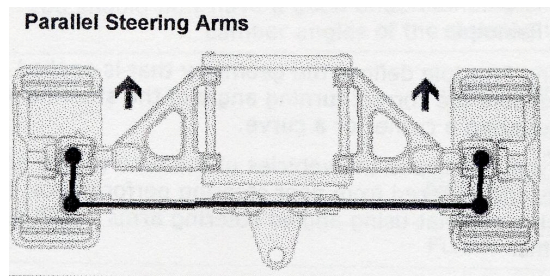
If both the wheels were turned by the same amount, the inside wheel would scrub (effectively sliding sideways) and lessen the effectiveness of the steering. This tyre scrubbing, which also creates unwanted heat and wear in the tyre, can be eliminated by turning the inside wheel at a greater angle than the outside one.



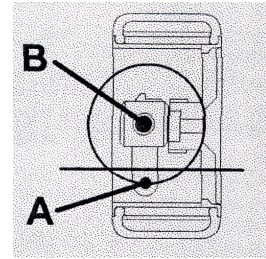
Steering Arm Angles

Creating mis-alignment of the wheels is, as mentioned in the introduction, achieved by a combination of the angle and the length of the steering arms. Below we have a few diagrams that give examples using parallel and angled steering arms to demonstrate why there is a need for using the Ackerman Steering Principle.

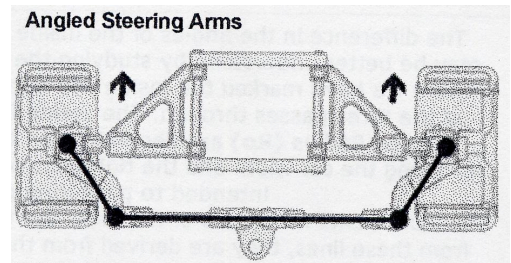
The steering arms in the diagram to the left are straight and parallel to the sides of the vehicle, which would create a situation where equal movement of the steering servo would produce equal angular movement of the wheels.



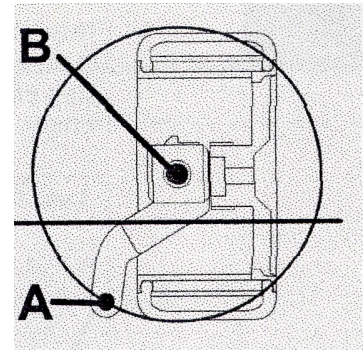
Why this equal angular movement occurs can be seen by studying the animated image of a wheel to the right, where a red circle has been drawn to show how the sideways movement of the steering arms is converted in a circular one. As the steering arm pivot point **(A)** is vertically aligned with the king pin pivot point **(B)** when the wheel is pointing straight ahead, the same amount of movement to the **Left** or to the **Right** moves the steering arm pivot point the same vertical distance forward of it's starting point.



The steering arms in the image to the left are angled inwards to create a means for the wheel angles to change at a different rate. This is the basis of the Ackerman Steering Principle and creates this unequal angular movement of the wheels.



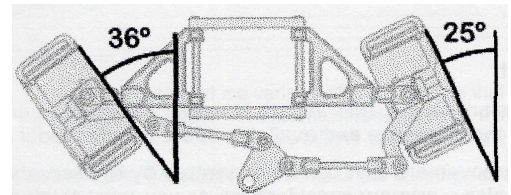
Why this unequal angular movement occurs is shown in the image to the right and happens because of the relative position of the steering arm pivot point **(A)** around the circumference of the circle that has been drawn in to show how the steering arm pivot point moves around the king pin pivot point **(B)**.



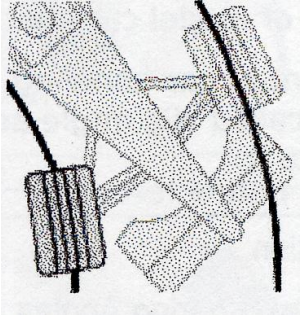
As the steering arms are angled, the pivot point **(A)** is not vertically aligned and is, in a straight ahead position, part way round the circle. Because of this, a **Right** movement of the steering arm will cause the pivot point to move a greater distance in the forward direction than a **Left** movement of the steering arm.

An important point worth noting is that this unequal angular movement is exponential, that is, the more you turn the wheel the greater the angular difference between the wheels - otherwise both the wheels would never point forward when the car is not turning.

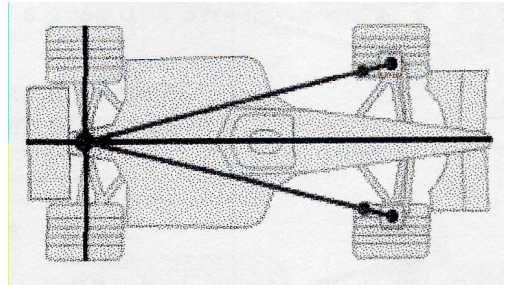
The deliberately emphasised example above would result in a wheel angle difference somewhere in the region of the figures given in the image to the left, whereas the parallel steering arm example would have resulted in the same wheel angles being generated on each side.



True Ackerman steering geometry is shown in the image to the right. This is defined by angling the steering arms so that a line drawn between both the king pin and steering arm pivot points intersects with the centre line of the rear axle.



As this gives true Ackerman steering geometry, there is no Toe Angle change on the inside wheel (the wheel is aligned with the circumference of the circle), which can be seen in the image above left.



Parts List (Go-Kart)

Purchased

- Engine (optional)
- Centrifugal clutch (to match engine crank shaft)
- Gears w/ keyed mount (one to match engine crank and one for axle)
- Chain (must match gear teeth size)
- Keyed Axle
- Pillow block bearings (to fit axle)
- Steering wheel (possibly manufactured)
- Seat
- Rotor and calliper brake system
- Cables (brake and throttle linkage)
- Wheels and tires
- Tie rod ends (4)

Student Built

- Frame
- Steering column and linkage
- Spindles and hubs

Design Considerations (Go-Kart)

The frame of the Go kart should be large enough and rigid enough to support a full grown adult and a small engine. This often requires using engineering principles to construct our vehicles on such a way to maximise strength while reducing weight. The engine mount must be moveable on the go kart to allow for proper chain tensioning.

Parts List (Mini Bike)

Purchased

- Engine (optional)

- Centrifugal clutch (to match engine crank shaft)
- Wheels and tires
- Brake and throttle linkage
- Braking system (rotor and calliper or locking hub)
- Gears w/ keyed mount (one to match engine crank and one for rear wheel)
- Chain (must match gear teeth size)

Student Built

- Frame
- Forks
- Steering neck (possibly recycled from bicycle)
- Handle bars and risers
- Foot pegs
- Front and rear fenders

Design Considerations (Mini Bike)

The frame of the mini bike should be large enough to make room for a small engine and be strong enough to support a full grown adult. The final resting position of the bike will depend on the wheel size and thus it is a good idea to have the wheel size before designing the frame. The rear wheel mount on the mini bike must be adjustable to allow for chain tensioning.

Other Design Considerations

