Consider the Honda Civic, a 5-place road car that is 177.3 in. long, 69.0 in. wide, 56.5 in. high, and weighs 2608 lb. (empty – might want to add a reasonable payload to this). The wheelbase is 104.3 in.; the front track width is 59.0 in.; the rear track width is 59.9 in. The spec engine for this car has a 4-cylinder inline arrangement, a displacement of 1798 cc, a compression ratio of 10.6, a bore to stroke ratio of 0.928, and is naturally aspirated. Its rated maximum torque is 128 ft·lb at 4300 rpm (mechanical efficiency 0.94). Its rated maximum power is 140 hp at 6500 rpm (mechanical efficiency 0.89). Transmission primary reduction is 1:1, and gear ratios are 3.143 in 1st (lowest gear) and 0.727 in 5th (highest gear), with a 4.29 final drive ratio. To cruise at 70 mph on a flat, smooth road requires 29 hp. Dimensionally, the tires may be considered to be 205/55R16. For performance calculations, consider the paint color to be Dyno Blue Pearl. In use, parts of the rear seat have become a little sticky.

So sticky, that the Suitable Transportation for Household Teenagers Department has given up the GV as a total loss, and the remains have been turned over to the Let’s Make a Track Car out of it Department. One of the modifications that LMTC is considering is a change from rear steer (i.e., steering the front wheels, but from a steering rack placed behind the front wheel (virtual) axle) to front steer (rack in front of the axle). This clears out some space in the engine bay that can be put to other uses (like accommodating a lowered engine with straighter driveshafts). The new steering rack will be manually-powered with a suitable ratio (the stock rack was power-assisted), and so no parts may be transferred from the old steering system to the new.

Outline a rack and pinion steering system for this GV that meets the following criteria:

1. 30º maximum outside steer angle.
2. “Reasonably” linear mean steering angle from lock to lock, as a function of rack displacement.
3. “Good” degree of Ackermann over the entire rack displacement range, from lock to lock.

By “outline”, what is meant is:

- Rack length
- Rack offset from axle
- Steering arm length
- Steering arm angle
- Plot of mean steering angle v. rack displacement
- Plot of Ackermann % v. rack displacement

Complete the assignment by discussing what had to be done, designwise, to ensure that the above design criteria are met.