PROJECT - Midget Go Kart

By G Wellwood ©2004

PROJECT
Midget Go Kart

Pocket Rocket for Pocket Change

Purpose...

In this activity you will build a Midget Go-Kart. This project is intended for Senior Metalwork classes where students have established basic critical thinking, problem solving, design and fabrication skills. The intent behind this project is to provide an inexpensive, simple, durable, portable, conversational toy to have fun with and impress friends and family, whilst learning far more about design, fabrication and engineering.

This project evolved from a marvelous set of Motorized Barstool plans by Dale Hynes, into the Motorized Lawnchair featured on www.gwellwood.com, into what you see here.

While there are drawings within this booklet, this project booklet is intended to be a guide only - not a "set of plans." The frame outlined in this booklet is stronger and easier to build than the frame design shown in the photographs - this design is by no means set in stone; you can build it differently. It is expected that some aspects of this project will change depending on the components selected, as well as the student's desired outcome. The cost can range from $50 - $200, depending on steering, tire selection and resourcefulness.

Please contact me regarding any errors you find - this is the first printing! g_wellwood@yahoo.com

Preparation....

For this project you will need the following:

- ❑ Pen and paper
- ❑ Tape measure and ruler
- ❑ Angle-finder
- ❑ Dividers
- ❑ Scriber
- ❑ Vernier caliper or Micrometer
- ❑ Demonstrated safe use of MIG Welder
- ❑ Demonstrated safe use of Machine Lathe
- ❑ Demonstrated safe use of Drill press
- ❑ Hacksaw
- ❑ Hammer and Centre Punch
- ❑ 4 - 7/16 x 2 UNC bolts
- ❑ 2 - 1/2 x 3 UNC bolts, Nyloc nuts
- ❑ 2 - 1/2 x 4 UNC bolts, Nyloc nuts
- ❑ 4 - 5/16 x 1 1/2 UNC bolts, Nyloc nuts
- ❑ 4 - 5/16 Spherical rod ends
- ❑ 9 - 1/4 x 1 UNC bolts
- ❑ 4 - 1/2" ball bearing inserts
- ❑ Aluminum or steel for front hubs
- ❑ 4 - Boat trailer wobble rollers
- ❑ 2 - 3/4" bearing blocks
- ❑ 3/4" x 3' angle iron
- ❑ 3/4" x ~15' 0.063 square tubing
- ❑ 1/4" x ~2' round, or ready rod
- ❑ 3/4" x ~2' round
- ❑ 3/8" x ~2' round
- ❑ 2" x 2" x 4" 0.120" square tubing
- ❑ 2 - 1/2" grade 8 washers
- ❑ Toyota starter motor
- ❑ Ford-style starter solenoid
- ❑ Steering wheel
- ❑ Push-button, high current
- ❑ 5" square 16ga aluminum
- ❑ 1 sq ft 22ga galvanized steel
- ❑ 1/8 x 1 x 24" flat steel
- ❑ 3/4 x 1" round aluminum
- ❑ Battery cables, to length
- ❑ 18ga (or better) Wire, to length
- ❑ Fuse holder, in-line
- ❑ Whatever else I forgot

THE DESIGN PROCESS

Project Planning

Procedure...

Designing any project begins as a process. When you design something, you go through these steps in your head naturally. A much more skilled and disciplined designer would express these thoughts on paper to enable them to work through the ideas in greater detail.

I cannot stress the importance of The Design Process enough!

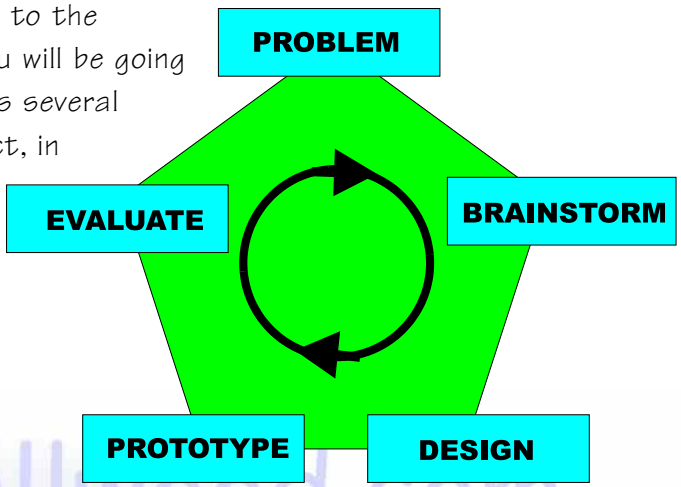
If you rush ahead to start working, but scrimp on design, your project will be unsatisfactory!

The design stage is probably one of the most critical stages of this project. As I mentioned, this is NOT a set of plans - you will have to custom build your kart according to what YOU want and have.

Note that the more effort you put into the design stage, the greater your success will be. Understand that your product will always turn out less than your design.

Awesome design	=	Good product
Good design	=	Average product
Average design	=	Poor product
Poor design	=	Unleashed wretchedness

There are five parts to the design process. You will be going through these steps several times on this project, in several different areas of the project.



Your First Assignment!

1. PROBLEM

Write a detailed, well written paragraph outlining exactly what it is you want to build.

This is where you need to be very clear and detailed. Merely stating "I want to build a Midget Kart" is not going to cut it. How big will it be? What's will power it? What about wheels? Bearings? Steering? Chain or belt? Where will the components be located/mounted?

TIPS

Design TIPS:

- ✔ Try to keep the weight as low as possible and as close to the centre as possible. This improves handling and safety.
- ✔ Design the sides of the frame to hold you in - it will corner harder than you can hang on.
- ✔ Keep the Kart as small as possible - it's easier to transport and store.

This paragraph will be handed in for marks. Be sure to check it over for spelling, grammatical and logical errors.

2. BRAINSTORMING

Your Second Assignment!

Now you need to look at the critical parts of the Kart, and begin to plan how it is going to come together. Draw detailed sketches of the following:

- Electrical wiring
- Frame layout
- Steering linkage
- Starter mounting
- Rear axle mounting
- Battery mounting
- Front hubs
- Rear hubs

These drawings need to be very detailed and clear. If you are not sure what it might look like, do some research. Here are some TIPS to help you in your designs:

TIPS

If you need to explain your drawing, you need to re-draw it. This is not a Salvador Dali exhibit.

✔ Your steering depends on what you use for parts. Spherical rod ends are the best, but are expensive. Eye bolts and rubber grommets work, just not as accurately.

✔ Different wheels are mounted different ways. Some come with bearings already installed - ideal for the front, however, these wheels cannot be driven by the motor.

✔ Some starter motors turn different directions than others - make sure you know what you are working with!

TIPS

Do some research on how Karts are made. Learn to search The Internet more efficiently. Here are some TIPS:

✔ Use a plus symbol in front of the words you WANT, and a minus sign in front of the words you don't

✔ Use quotes to find phrases, or specific wordings

Hand in your 8 high quality detailed sketches for marks.

FABRICATION

Go Big or Go Home

Here is where it comes together. As you start building your Kart, you may run across details that require further study - you will discover things you may have overlooked in the design stage. No problem. Just be sure to figure them out now.

DO NOT be tempted to "rush" through
to make things magically fit,
--They won't--

Sit down, relax, clear your mind, and approach your problem methodically. Sketch. Research. Discuss. You can do it!

TIPS

Since your shop does not have enough equipment for everybody to be doing the same thing, here's a TIP:

Try to multitask. If you planned on doing some welding, and the welders are full, find something else to work on, like machining your hubs, rebuilding the starter, cutting out frame materials. You will not get the project done in time if you don't use your time efficiently.

Here are the instructions to get started on a Kart, Remember, **YOUR** design may be different than this one.

In the real world, time is money. Use your time wisely!

Employers want people who will make them the most money during their shift. Make your employer money, and they will do every-thing they can to keep you with them!

NOTE:

- The Kart is designed to fit YOU (plans are not "to the letter")
- The Kart is made to fit YOUR parts (make sure you have them!)
- The Kart requires critical thinking skills, design skills, planning, and a systematic approach

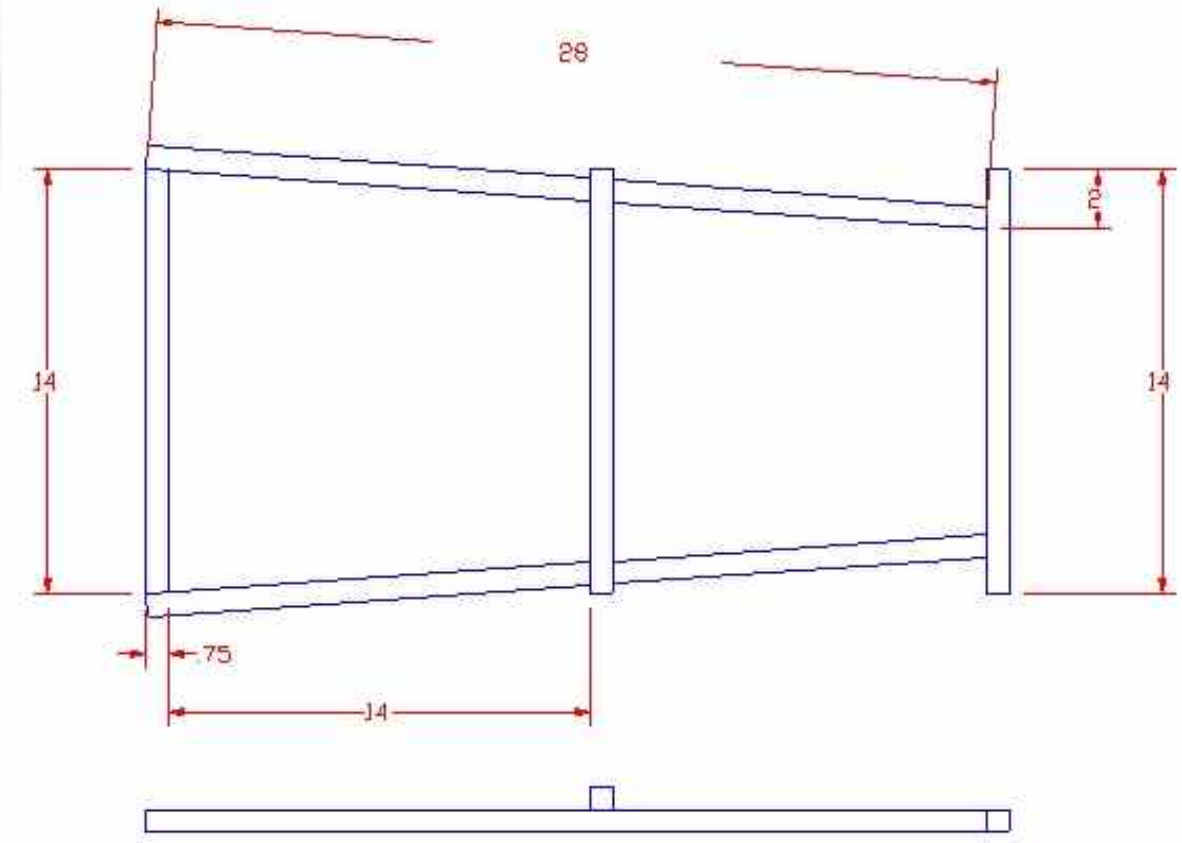
FRAME ASSEMBLY

1. Measure your hips
   a. This determines the frame size
   b. For the purpose of this document, we will use a hip width of 14" (my hips)

2. Cut 3 pieces of 3/4" 16ga square tubing to the width of your hips (14")
   a. These are the front axle, and front and rear of the seat area

3. Cut 2 pieces of 3/4" 16ga square tubing to twice the width of your hips (28")
   a. These will become the left and right sides of the frame

4. Tack weld these five tubes together as shown below:



a. The frame must be SQUARE. For an object to be square, it will measure the same diagonally. Measure from the LF to RR and RF to LR - the dimensions should be the same

TIPS

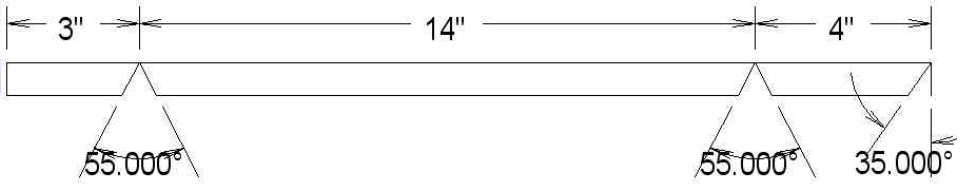
TIP: When welding, always tack everything together first. It's much easier to change components when they are only tacked together!

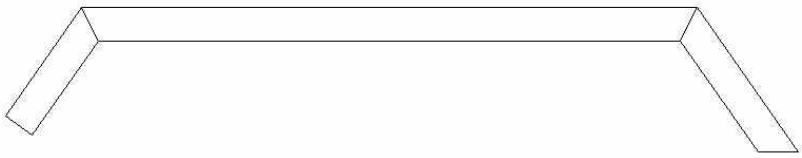
Remember: Your dimensions may vary depending on your parts!

5. Cut two 5" length of 3/4" tube, with one end at 35°. This is the mount for the rear axle bearing blocks. The axle should be behind the driver, as this improves the weight distribution. 3/4" solid round is recommended for the axle, the centre of which should be even with the frame rails

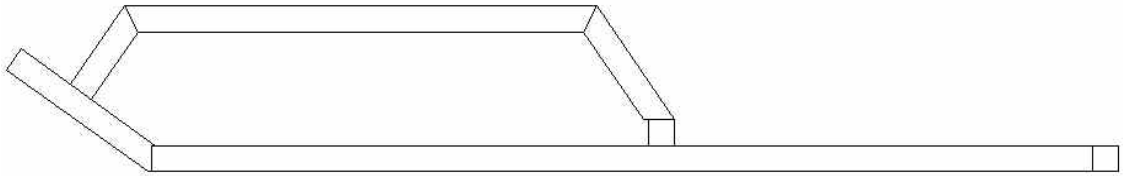
6. Tack weld as shown below:

7. Cut two pieces of 3/4" tube to 1.5 times your width (1.5x14=21") for the side rails as shown below. The V-cuts are cut with a hacksaw to ease bending (if you are using different lengths, calculate the **proportions**





8. Tack weld to the frame as shown:



9. A back brace should be made to fit comfortably. It is welded between the upper part of the side rails.

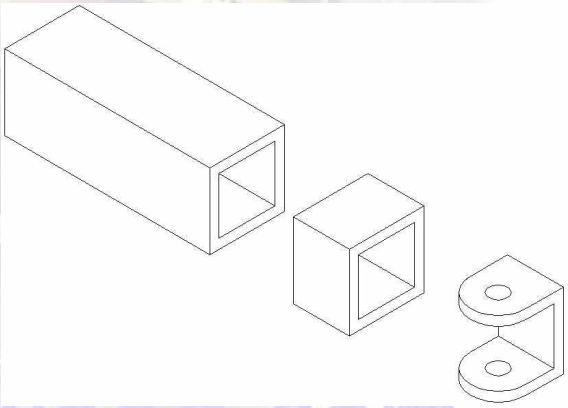
STEERING

Remember to always use a pilot hole for drill sizes over 1/4"

10. Cut two pieces of 2" x 2" 0.120 wall square tubing to 1.5" for the steering spindle mounts

11. Mark the centre on one side adjacent to the welded seam of the tubing, centre punch and drill through both sides 1/2".

12. Cut off the side with the welded seam and round the corners as shown:



13. Grind the ends of the front axle to fit the spindle mounts on the end. The angles are not overly critical, but **MUST** be the same left to right or the car will always want to pull to one side.

   a. Ideally, you want about 5-10° Steering Axis Inclination (steering axis tilting towards the frame at the top).
      i. This helps to centre the steering wheel after turning
      ii. Less SAI makes the steering very vague
      iii. The farther the wheel is away from the axis, the steering becomes very sensitive to bumps

b. You also want about 2-5° Caster (the steering axis tilted rearward at the top)
   i. This helps to improve steering stability
   ii. Less castor makes the steering very light, but twitchy
   iii. More caster makes the steering very heavy but stable at speed

Alternatively, 1/2x3 and 1/2x4 UNC bolts can be used.

This method provides experience in using thread Dies

14. Cut 4 pieces of 1/2" x 4" CR round (check your wheel size to make sure this will fit)

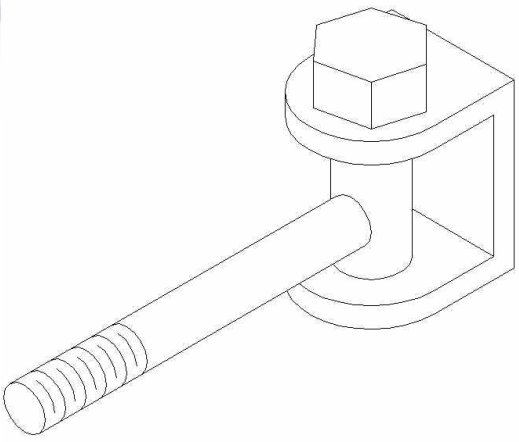
15. Cut UNC threads on both ends of two
   a. These will become your kingpins

16. Cut UNC threads on one end of the remaining two
   a. These will become your stub axles

17. Cut two pieces 3/4" x 1.75" round, centre drilled 1/2" on the lathe
   a. These will become the spindles

18. Assemble the kingpins and the spindles with a standard nut and a Nyloc® nut. Weld the standard nut to the kingpin.

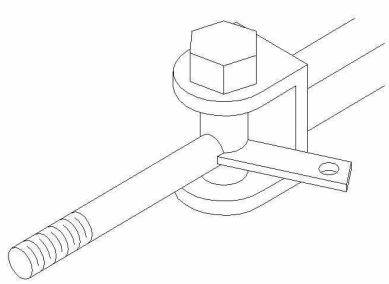
19. Grind the unthreaded end of the stub axle to fit closely to the spindle, and tack weld so that it is perfectly horizontal
   a. Any angle here is camber (the tilting in of the wheel at the top) and is unnecessary on a vehicle with no suspension
   b. You should now have something that looks like this:

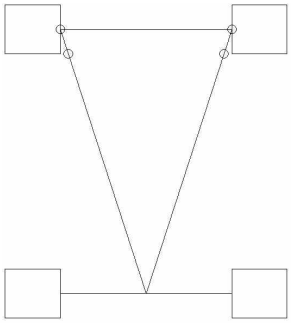


20. Cut two pieces 1x1/8" flat to 2" length.
   a. These are the steering arms.

21. Drill a 5/16" hole centred at one end.

22. Weld the un-drilled end of the steering arm to the spindle, such that an imaginary line drawn from the kingpin, through the 5/16" hole, will intersect the centre of the back axle as shown:





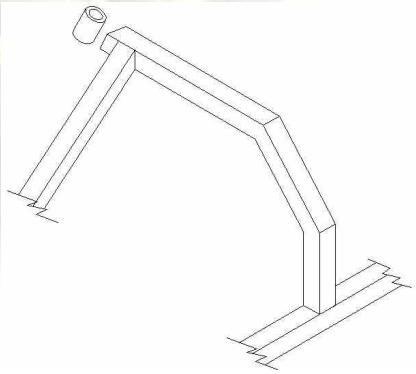
   a. This is called "Ackerman"
   b. The nature of the Kart steering will actually increase Ackerman, resulting in very responsive steering

23. Cut some 1/2" solid round to a length suitable for a steering shaft.

24. Centre drill a 1/2" hole through a 2" piece of 3/4" round.
   a. These will become the sleeves for the column

25. Insert the shaft through the two sleeves to make sure they are on the same axis, tack welding the bottom sleeve to the centre of the front axle. Pick an angle that is comfortable.

26. Design and build a top mount for the steering column. The shape of this depends on the size and location of your battery and starter motor. Here is an example that comes up from the middle frame tube, wraps over the starter motor, and is braced on both sides (one shown) to the side frame tubes. This style is the same as was used in the Kart on the first page of this booklet.

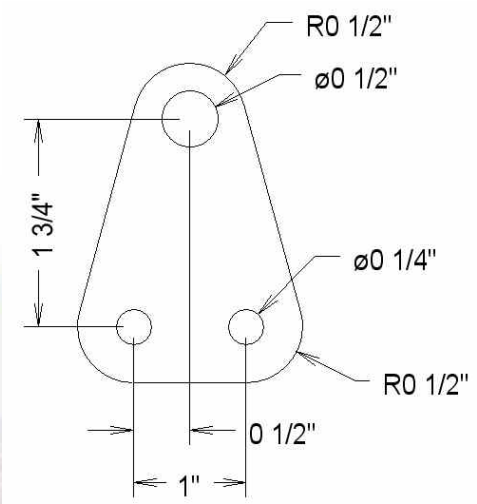


27. Design and fabricate a steering wheel. The mounting should be very solid - make sure the mounting point of the wheel is at least 1/2" thick where the steering column is inserted, or

the wheel will break off.

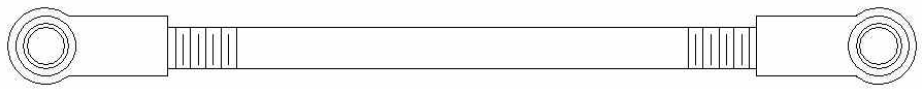
a. You may use an existing wheel
b. A chain link steering wheel, although very 1970's, is **very** easy to make.

28. Make a steering arm out of 1/8x2" flat steel.
    a. This is welded to the bottom of the steering column
    b. You may need to "tweak" this arm to clear frame tubes and improve alignment to steering arms

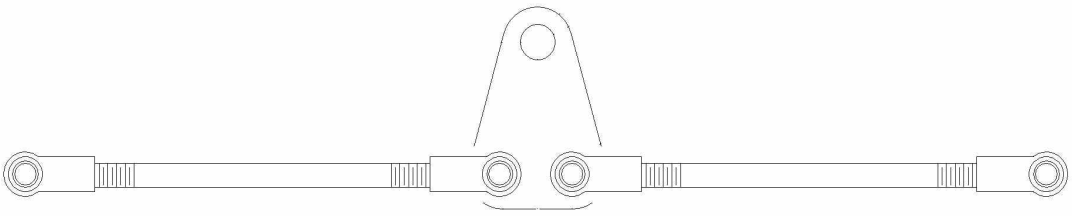


29. Assemble the steering column, column mounts, and steering wheel. Check the fit and tack weld together

30. Steering links can be made from 5/16" female spherical rod ends, joined together with two 5/16" UNF bolts welded together head-to-head. Alternatively, you can use eye bolts with 5/16" rubber grommets inserted into the eyes. Use flat washers larger than the ID of the eye bolt with the fastener to ensure they don't come apart at inopportune moments.



31. Attach the left and right steering links to the steering column arm and steering spindle arms



32. Check that the steering moves fully and smoothly. You may need to clearance the spindle mounts to have sufficient movement at the wheel.

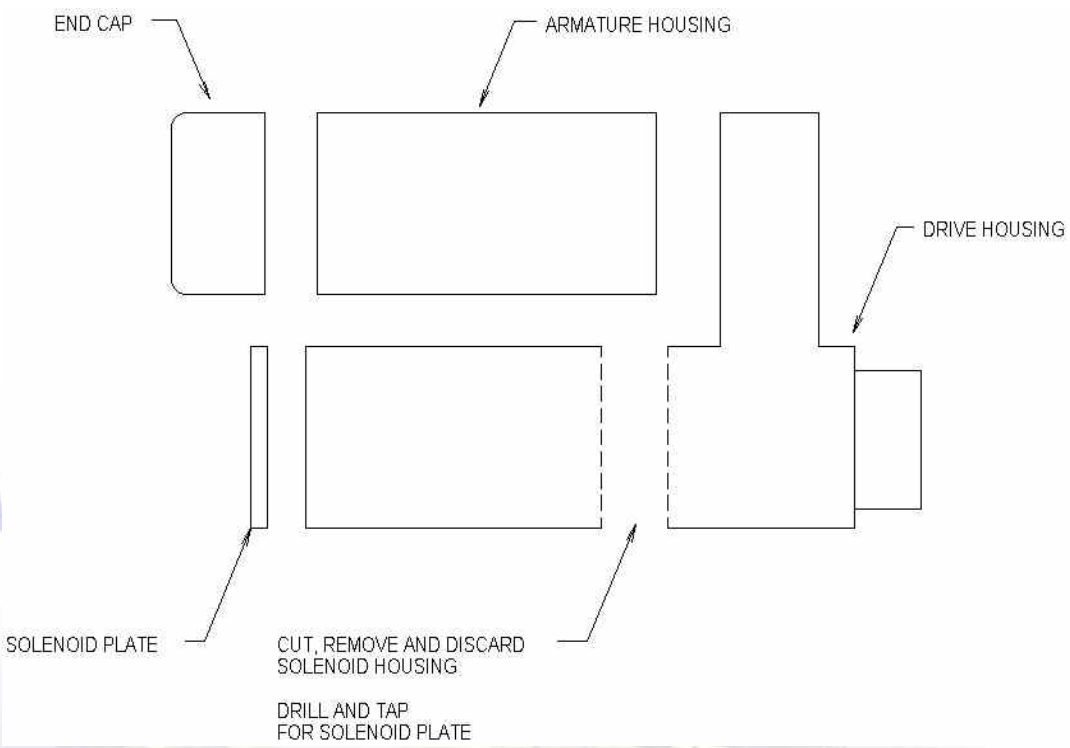
33. Use a 1/2" nut, drilled through with a 1/2" bit as a spacer on the spindle for the wheels. When ideal wheel location is determined, weld the nut to the spindle on the inboard side.
    a. Keep the wheels as inboard as you can get away with

34. Mount the wheels and make sure they steer correctly. You should be able to see some Ackerman (toe-out-on-turns), and angles should be the same on both sides.

STARTER MOTOR MODIFICATIONS

35. Completely disassemble and clean the starter motor.

36. Cut, remove and discard the solenoid housing
    a. Do not cut through the drive rear bearing support!
    b. Cut as straight as possible
37. Drill and tap the drive housing to re-attach the Solenoid plate to the now shortened solenoid housing



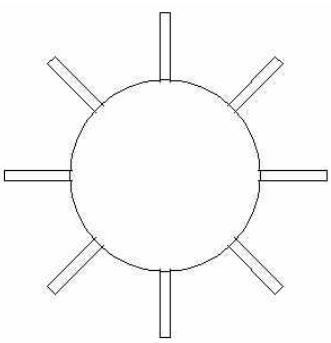
38. Disassemble the entire starter drive assembly. Remove all springs, clips and gears. Push the starter drive through the gear as far as it will go, and weld it solid to the inner race.
    a. Do not get any weld or spatter in the bearing itself

39. Drill as many holes as you can in the front and rear sections of the starter motor winding (armature) housing
    a. The key here is to get as much airflow as possible through the motor
    b. Do not drill through "reinforcements" in the castings
    c. Do not drill into the gear area

40. Cut about eight 1x1/8 strips to use as cooling fins.
    a. Make them as long as the armature housing
    b. Ones near the solenoid plate must be shorter

41. Tack weld the cooling fins around the armature housing.

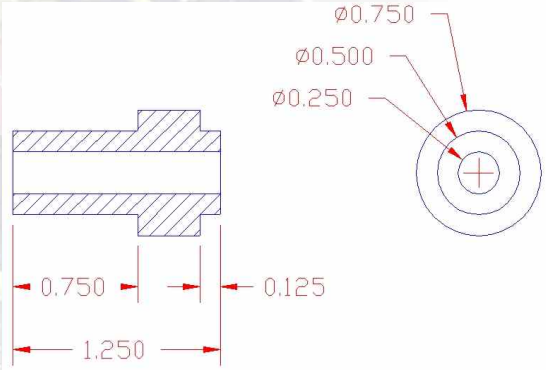
a. Weld about 1/2" at a time, moving around the motor a lot to keep the temperature down.
b. Feel the motor with your bare hand - if it starts to get warm, let it cool. DO NOT get impatient.
c. Don't forget about the location of the end cap screws



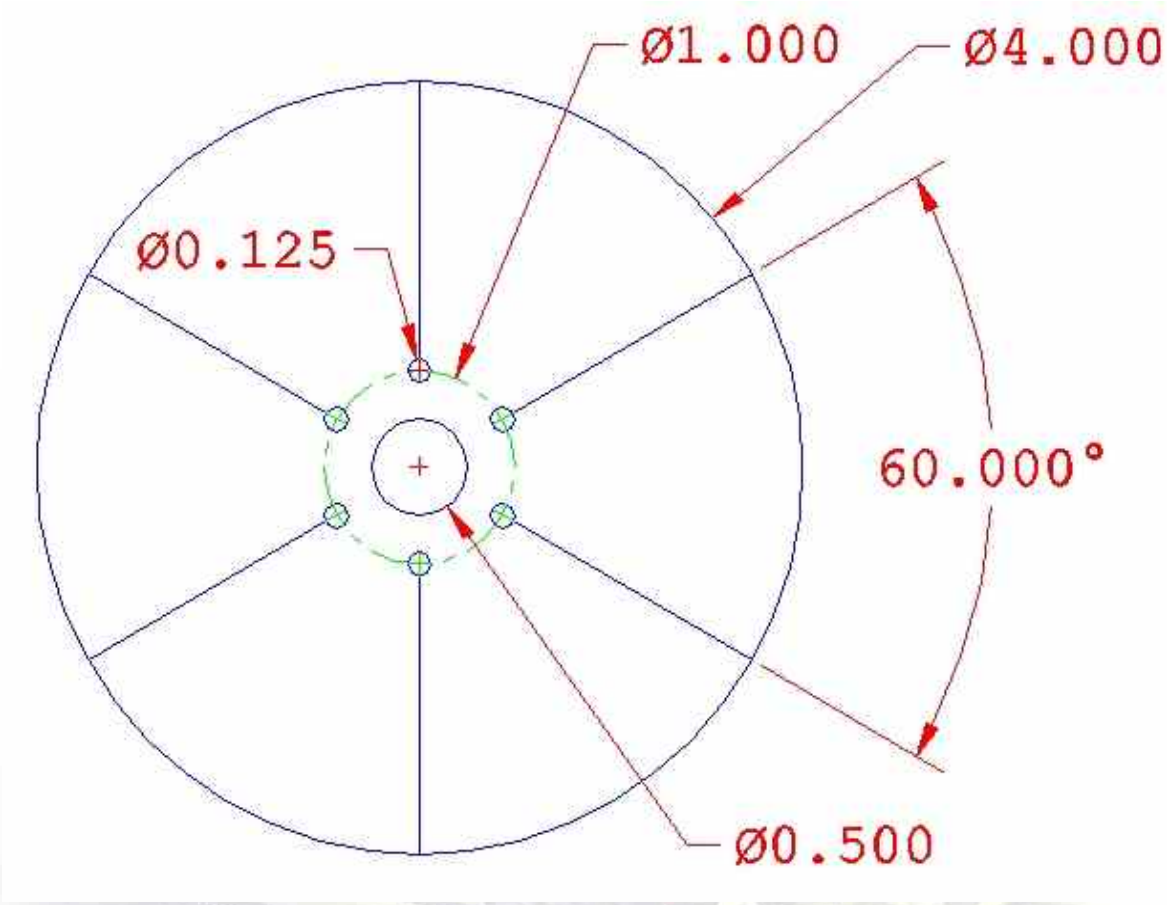
42. Chuck the armature into the lathe and use fine emery paper or crocus cloth to clean the contacts.

43. Centre drill the rear of the armature on a lathe for a 1/4-20 tap, then carefully tap.

44. Machine a hub for the fan out of aluminum. The step for the fan should be slightly thicker than the fan blade, so the metal can be "mushroomed" over to hold the fan.



45. Make a fan out of 16ga aluminum - be sure to drill the holes at the inside end of the fan blades before you cut!
a. The fan should be almost as large in diameter as the cooling fins.
b. The fan must be perfectly balanced or it may come apart at speed. You must shroud the fan for safety.



46. Mount the fan onto the hub, mushroom the end of the hub to secure the fan to the hub. Re-drill the hole if needed.

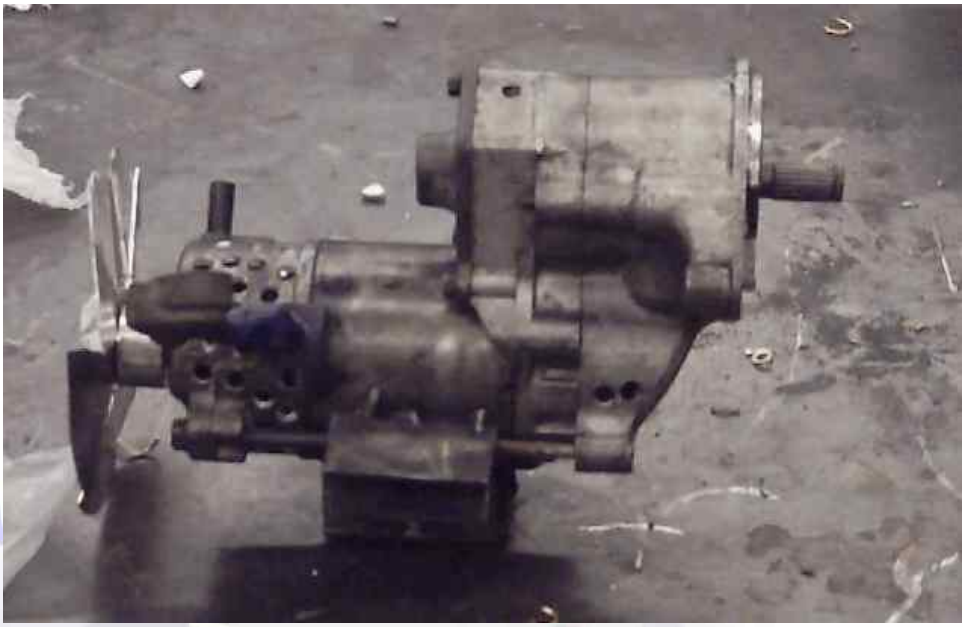
47. Drill a 1/2" hole in the centre of the armature end cap for the fan hub to allow the hub to me fastened to the armature

a. Make sure there is no contact with the hub

The starter motor can produce enough torque to break weak chains!

MINIMUM chain size: #35

Bicycle chain is made out of butter... DON'T USE IT!



48. Assemble the motor, using some grease on the gears
    a. Use new brushes if required

49. Cut a piece of scrap sheet metal to use as a fan shroud. The shroud must extend the entire length of the cooling fins, as well as the cooling fan. Hem both edges, trim to fit around the solenoid plate, and secure with a 5" hose clamp.

Chain drives must be in perfect alignment. The sprockets must share the same plane. Any misalignment and the Kart will throw chains

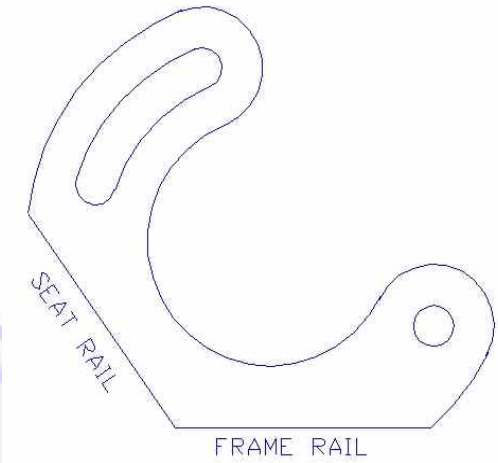
50. Weld the drive sprocket and hub to the starter drive spline (usually 1/2" and will fit a 1/2" sprocket hub easily). Sprocket choice (gearing) will depend on your tire size and what your goals are.
    a. Shorter gears (higher numerically) will improve acceleration at the expense of top speed
    b. Taller gears (lower numerically) will improve top speed at the expense of acceleration
    c. 3:1 final ratio is a good start for a beginner - mine accelerates harder than any street car I've ever driven, and top speed is reasonably safe (30km/h)

51. Determine where and how the motor will mount to the frame. Design and fabricate mounts and mount the starter - Be sure the chain will make it to the axle!

a. If anything will fail on the Kart, it will be the starter mounts. Make them very strong! Think about what kind of force it will be subjected to. Find out how to reinforce the mounts and distribute the loads for greater strength.

b. Make the starter mount adjustable for chain tension

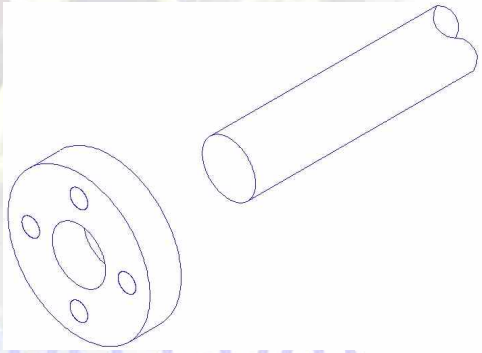
c. Here is one idea, made from 3/16" plate steel:



52. Design and machine rear hub flanges to fit your rear wheels and mount them to your axle, along with the bearing blocks and the drive sprocket.

a. Once the hub flanges are welded, the bearing blocks cannot be removed, so check, check and re-check before final welding

b. Make absolutely sure that everything is perfectly aligned and straight - "clown cars" are not cool



53. Mount the rear axle and bearing blocks to the frame, install the chain and make sure everything turns. Starters have an over-running clutch to prevent the car engine from over-speeding the starter should the starter drive become stuck. The starter should turn then the axle is turned in reverse, but not forward. The axle should be relatively free spinning.

54. Design and fabricate a solid, secure mount for the battery.
    a. If the starter is mounted under your right knee (most common), mount the battery under your left knee.
    b. Finish all bracketry so as not to injure the rider
    c. Make sure the battery posts are at least an inch away from any frame tubes.
    d. A non-metallic cover for the battery would be ideal, as it would prevent battery acid from eating the back of your pants!

55. Wire the Kart. You will need a Ford-style solenoid, since we cut off the Toyota solenoid (don't worry, it wouldn't have worked well anyway since we modified the starter drive).
    a. A fuse should be used to protect against fires should things go wrong
    b. Use adequate gauge wiring and a high-quality push button switch
    c. I recommend a key switch to prevent people from taking off with the finished Kart

56. Bolt plywood on for a seat

57. Try it out, but wear a helmet!