Homebuilt
Child
Recumbent
Bike

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1 Introduction.

The following is a description of how to build a child recumbent bike yourself with the following tools at your disposal:

- A welding machine
- A drilling stand
- Some kind of grinding machine (to make life easier !)
- Ordinary toolbox with screwdriver, file, adjustable spanner.

The design is known as an "Odense cykel" due to the guy who made the original design Mogens Skov.

It may sound weird that this documentation is done in English, but I have an idea about publishing this at the Internet.

1.1 Abbreviations.

Abbreviation	Description
HPV	Human Powered Vehicle
Liggecykel	Recumbent bike

1.2 History.

Date	Ver	Description
2001-09-14	1	Initial version
2002-03-25	2	Updated some chapters
2002-05-28	3	Added "3.6.2 Pitfalls when mounting the steer" Added "3.8 Brakes". Updated "3.5.1 Mounting of the seat".
2002-11-16	4	Minor changes.

1.3 References.

Reference	Description
1	Calculations20020924.xls Excel file with frame calculations.
2	RecumbentBikeParts20020606.doc Description of improvements to the Odense recumbent bike.
3	http://www.wisil.recumbents.com/wisil/idler/idler.htm Ref to chain wheels made out of Roller Blade Wheels.
4	http://www.ihpva.org/people/tstrike/building/index.htm A lot of good information about building a recumbent bike yourself.

2 Design and calculations.

2.1 Bike assumptions.

Before I started I made the following assumptions:

- Front wheel 16”
- Rear wheel 20”
- The seat and the pedals had to be adjustable.

The seat and the pedals had to be adjustable since the bike was for my kids. As my kids, at that time, were at the age of 9 and 11 they were expected to grow. In order for the bike to fit them while growing, the bike had to be adjustable.

The first bike I made based on the same design was made for me only. So if you are not at least 180 cm high, you would have problems riding the bike.

The original design was based on a 20” front wheel and a 27” rear wheel. I imagined that a 16”/20” solution for a kid’s bike would be fine then.

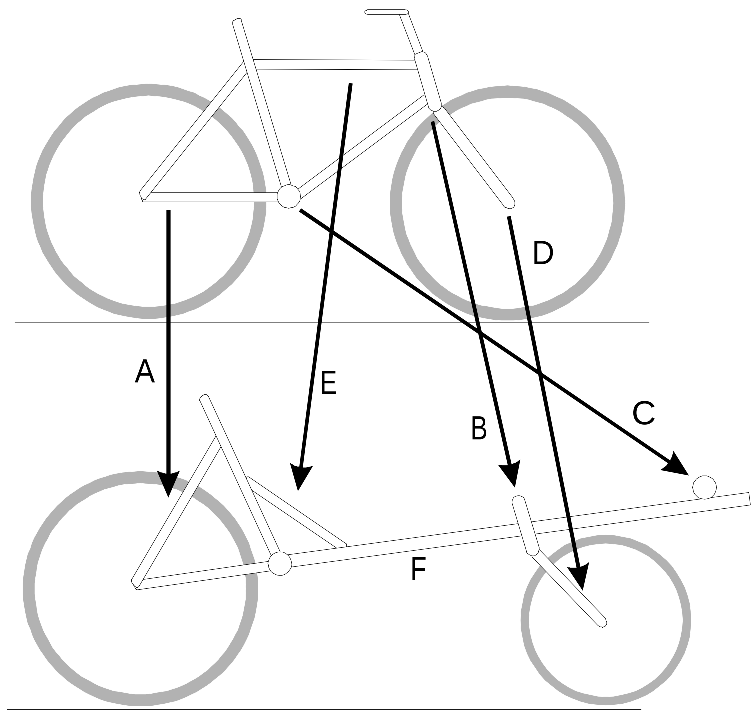
2.2 Tooling assumptions.

The frame had to be made of iron. No exotic materials, since my welding experience is not extensive. The only welding equipment I could get was a CO^2 welder. So all welding had to be done by the CO^2 welder. This is not optimal, but you can get far by that.

The father of the “Odense cykel” suggests that you braze the frame together. This was out of the question, since I do not have any experience whatsoever with brazing. It of course gives you betterlooking connections but, again, I didn’t have the required skills.

The design also had to be based on readymade parts from common bikes. This is one of the original ideas of the “Odense cykel” design. Take your old 27” racer bike and make a recumbent bike. The following diagram shows which parts are included in the final recumbent bike.

Figure 1:
An indication of where the different parts come to form the recumbent bike.



Since we are having two sizes of wheels we also need to have two different bikes initially.

Item A and E are taken from the 20” bike. There are no requirements to item E. All that is needed is a small piece of tube, which can be taken from anywhere.

Item B, C and D are taken from the 16” bike.

Item F is new and it is a 40 x 40 mm square tube.

Figure 2:
This is how the recumbent is expected to look when finished.

2.3 Calculations.

From the original “Odense cykel” design I had the following design guide lines:

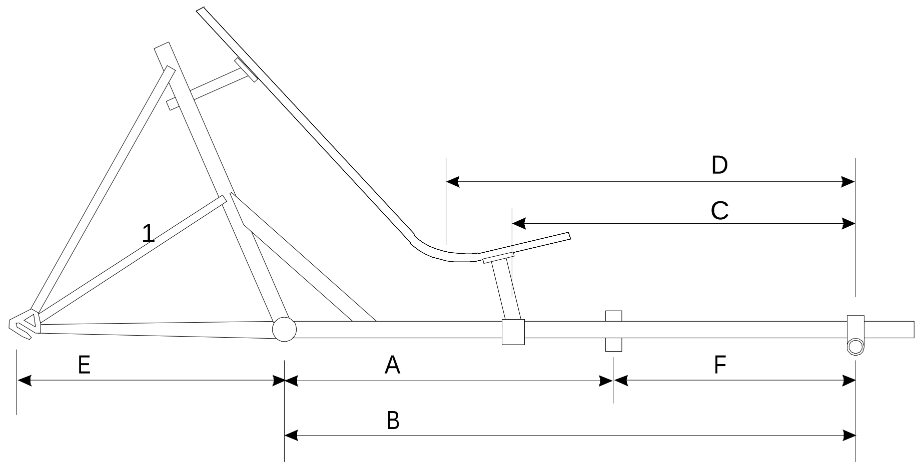


Figure 3
Schematic drawing of the child-recumbent bike. Tube marked (1) are for an adult recumbent bike.

Child recumbent bike.		Kid-1	Kid-2	Difference
Measured				
	Length of the legs	790	660	130
(E)		395	395	0
Calculated				
(A)	Botom Bracket/Stear mount	514	429	85
(B)	Square tupe total	1067	891	176
(C)	Botom Bracket/seat	797	667	130
(D)	Mounting of tube for seat.	711	594	117
(F)		553	462	91
	All dimensions in mm			

Table 1

Formulas:

(A): 0.65 x <length of the legs>

(B): 1.35 x <length of the legs>

The calculations can be found in an Excel spreadsheet [Ref1]

Given my kid’s size, I calculated the rest of the sizes of the bike.

As you will see in the next chapters I did not mount tube number (1) in Figure 2. Tube number (1) is if you are building the recumbent bike for an adult, then you need this tube in order to make the frame stiffer.

Please note that if you want to be able to calculate the trail of the bike you have to take the size of the front fork and the wheels into consideration.

3 Construction.

3.1 Materials.

The following materials is needed in order to make the frame itself:

- A 20" bike
- A 16" bike
- 120 cm of 40 x 40 x 2 mm square tube.
- 40 cm of 35 x 35 x 2 mm square tube or 2 pizes of 5 x 40 x 75 mm metal. (for the pedal holder)

3.2 Main frame of recumbent bike

First item A of Figure 2 has to be separated from the rest of the bike.

As shown in Figure 4 you have to remove all the remainder of the tube connecting item A to the front wheel.

Figure 4:
Top of the rear end of the 20" bike. Remember to get rid of all the unwanted tubes.

Next the 40 x 40mm square tube has to be cut into the right size.

You find the right size by using the formulas related to Table 1. Since this recumbent bike is expected to be used for kid's of different sizes, you use the biggest kid's size.

After the square tube is cut in the right size, you have to fit the head tube for the steer.

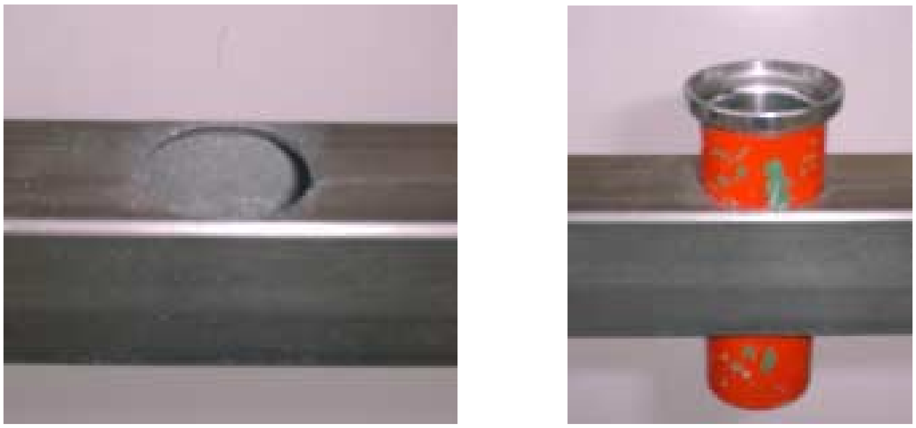
This tube is taken from either the 20" bike or the 16" bike. In the picture below, the one I used is shown.

Figure 5:
The head tube before and after cleaning up.

Now that the head tube is clean you can use it to make the hole for it in the square tube.

The size of the hole has to be very accurate in order to make the welding look nice.

Figure 6:
The hole for the head tube, and the head tube mounted in the square tube.



Before you weld the head tube to the square tube you have to adjust the length of the head tube. This can be seen in chapter 3.6.1.

What needs to be done before the square tube can be welded to the back of the 20" bike is an adjustment of the square tube.

Again this has to be done very precisely in order to have a nice welding.

The welding of the square tube together with the 20” bike has to be very accurately since this welding gives the overall performance of the bike.

In the figures below you can see what happens if the welding is not done accurate enough.

Figure 7:
The recumbent bike seen from behind. Note that the front and rear wheels have to be aligned.

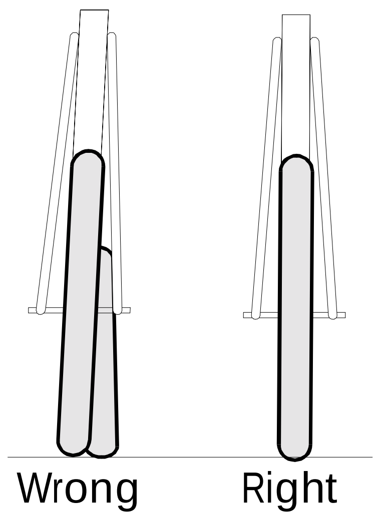
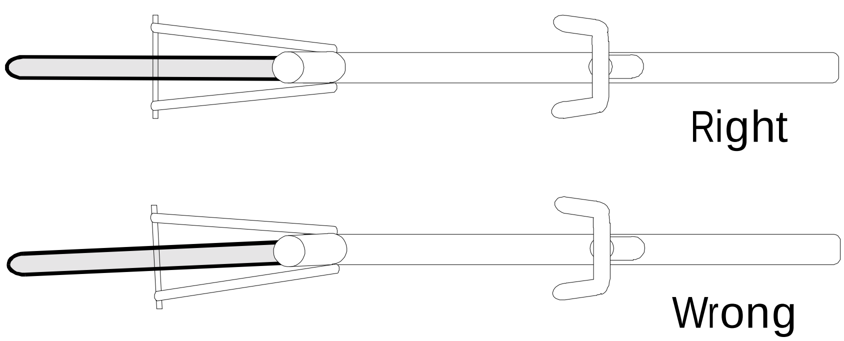


Figure 8:
The recumbent bike seen from above. Note that the front and rear wheels have to be aligned.



To fix the two objects during the welding process I made a jig.

Figure 9: The back of the 20" bike and the square tube mounted in the jig before welding.

I know it will take a lot of time to make a proper jig, but it is worth it. Once made it is a lot easier to get a nice result. Finally check, check and then check again that everything is in order before you weld. It is not nice to cut it all apart after the welding and start over again.

When a description of a better jig are ready it can be seen in Ref[2].

3.3 Pedal mounting method 1.

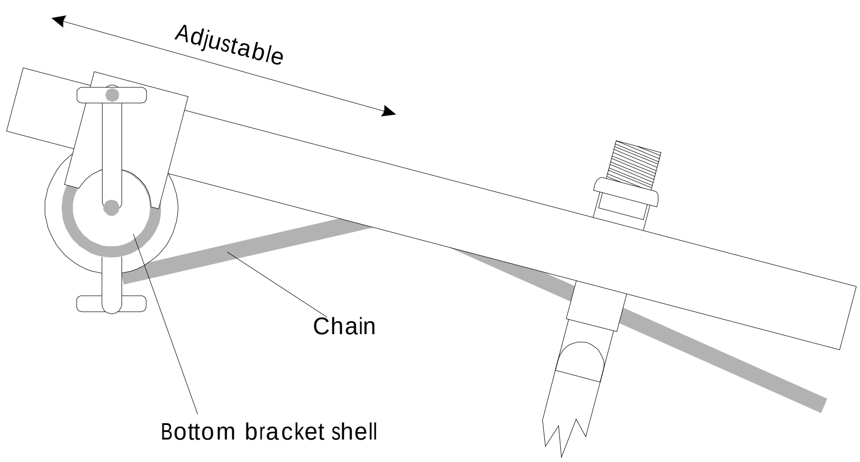
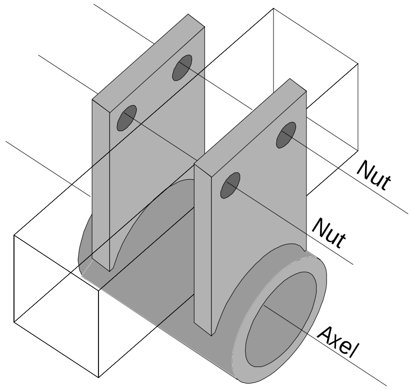


Figure 10: Mounting of the pedals in a separate bottom bracket shell.

In order to be able to adjust the pedals they have to be in a separate bottom bracket shell. This shell has to be attached to the square tube so the pedals don't come loose.

Figure 11
An adjustable bottom bracket shell (BBS)



The above schematics and pictures indicate one way of making an adjustable bottom bracket shell. The actual measurements can be found in Appendix A2. Bottom Bracket Shell (*pedal method 1*)..

The following pictures give an indication of how the adjustable bottom bracket shell is assembled.

Figure 12
How to make the adjustable BBS

As you can see the BBS is made out of the old BBS from the 16” bike, where all of the old tube has been removed. Instead of doing so you can get hold of a piece of tube with the right dimensions and make the necessary thread in each end.

You then take two pieces of metal measuring 5mm x 40mm x 75mm. The 40mm is the width of the BBS. In one end you adjust the two pieces so they fit the BBS. Before you weld it all together you make the four holes.

In order to have it fit the adjustable BBS I placed it on the square tube while welding it. Remember to take into account that your bike is going to be painted. Which means that you need a little space in-between the adjustable BBS and the square tube.

3.4 Pedals mounting method 2

Since the initial construction of this bike, additional methods of mounting the bottom bracket shell have been investigated.

A much better method can be seen in the figure below. It does not give the same amount of adjustability, but it works much better.

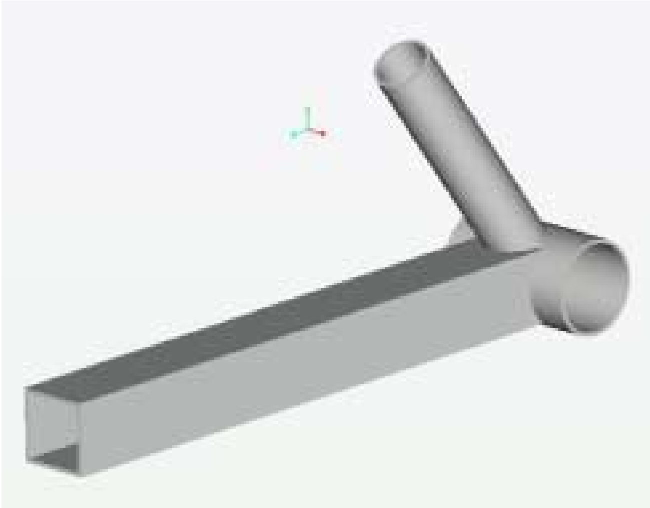


Figure 13: Alternative bottom bracket mounting. The 35x35 mm square tube slides in the bigger 40x40 mm square tube.

This bottom bracket shell consists of a sligtly smaller square tube with the bottom bracket mounted on it. The actual dimensions can be seen in Appendix A3. Bottom Bracket Shell (pedal *method 2).*

In order to secure the bottom bracket shell the end of the 40 x 40 mm square tube has to be modified as shown below.

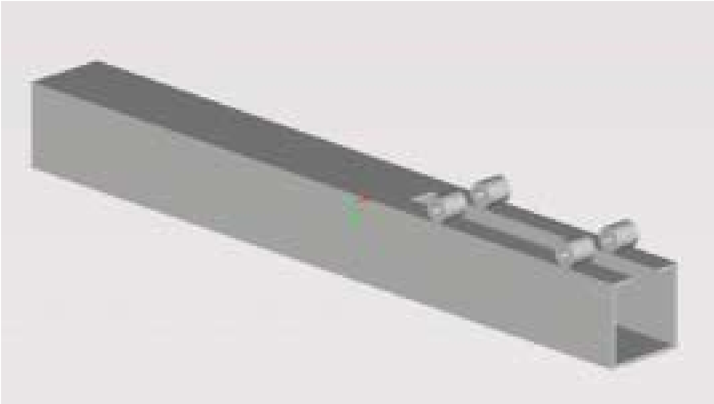


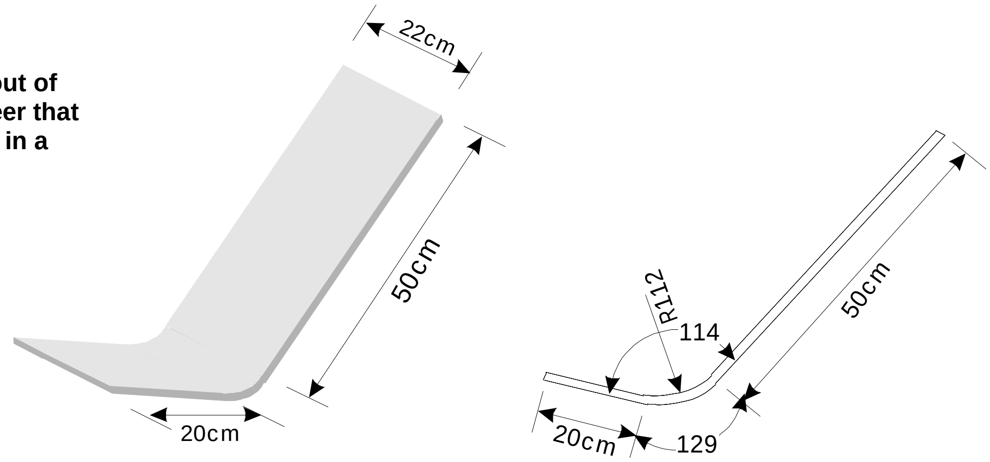
Figure 14: The 40x40 mm square tube has to be modified in order to secure the positioning of the 35x35 mm square tube. Figure seen from below.

The actual measurements of the modified 40 x 40 mm square tube can be seen in Appendix A3. Bottom Bracket Shell (pedal *method 2).*

3.5 Seat

The seat that I used for my bike can be seen in the figure below. There are a lot of other seats which can be used instead. The present design is easy to work with, and it is easy to shape to your needs.

Figure 15:
The seat is made out of two pieces of veneer that are glued together in a jig.



The seat is quite easy to make, if you have room for two pieces of veneer bathing for 4-5 hours. I made this bike during the summer period, so I used my kid's swimming pool.

Figure 16:
One of the two pieces of veneer being softened.

When the wood is wet it's no problem bending it. So again I made a jig in order to bend the two pieces of wood into the right shape.

Another seat and jig can be seen in Ref[2].

Take the necessary time for the two pieces of veneer to get all wet. When I say wet I mean really wet. If they are not all wet, they can get damaged when you try to bend them.

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Figure 17:
The seat jig with the two veneers mounted.

They are placed on top of each other with glue in between.

Remember to use outdoor glue which is waterresistant.

Figure 18:
The jig seen from the side. Take your time to get the curve right.

It is not an easy task to get it all together. So keep assistance within range, when you get short of "hands". It is also a good idea to have thought it all through, so you have ALL the necessary tools at your disposal.

The wood has to be under pressure until it is completely dry. If you take it off too early, the seat will lose its shape.

Remember to remove the glue that in excess before it dries up, since it is difficult to remove, once it has hardened.

When it is completely dry, you can work on it and give it a nice finish.

Figure 19:
The final seat with bolts mounted and lacquer.

Before you continue you need to find out how you want to mount the seat to the bike. This can be seen in the next chapter.

In order to get the right comfort I have added several layers of the soft material you sleep on when you go hiking. It is not expensive and it is easy to work with. Either you can glue it on or you can use carpet tape to fix it to the seat.

As a nice finish you can put some fabrique on to keep water out of the soft material. I use the material which my kid's winter overall is made out of. I think it's called Beaver nylon.

3.5.1 Mounting of the seat.

There are probaby a lot of ways to mount the seat. I use the original design by Mogens Skov.

It consists of two mountings that can be seen below. Mechanical drawings can be found in Appendix A1. Seat mounting.

In order to have both the mounting positioned at the right places, you shold first mount the bottom seat mounting. When this is in place align the seat and find the right place for the top seat mounting.

Please note that the mountings have to be mounted before you add anything to the seat besides lacquer.

In order to mount the top mounting at the bike, you have to make a small slit in the frame.

Figure 20:
Top seat mount.

There should be no problems in mounting the bottom seat mount. The only thing to remember is to have the seat mount fully aligned with the square tube.

Figure 21:
Bottom seat mount.

Please note that in case you reduce the height of the bottom seat mount, check to see if the chain is not touching the seat. In case the chain does so, you can have the chain run in a small plactic pipe underneath the seat.

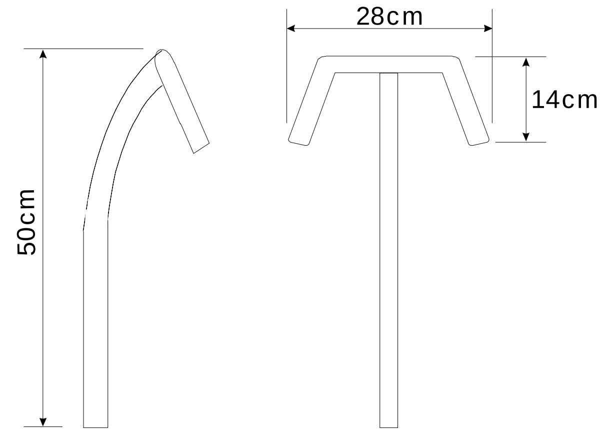
3.6 Steer

This bike is using what is called “Over Seat Steering” (OSS). I have not concidered making an “Under Seat Steering” (USS). But there should be a lot of places at the Internet which can guide you through making one.

The steer is made out of a 22 mm tube that is bent to the right shape, and welded together.

The figure below is how I made my steer. It can have any shape and size, find out what is best for you.

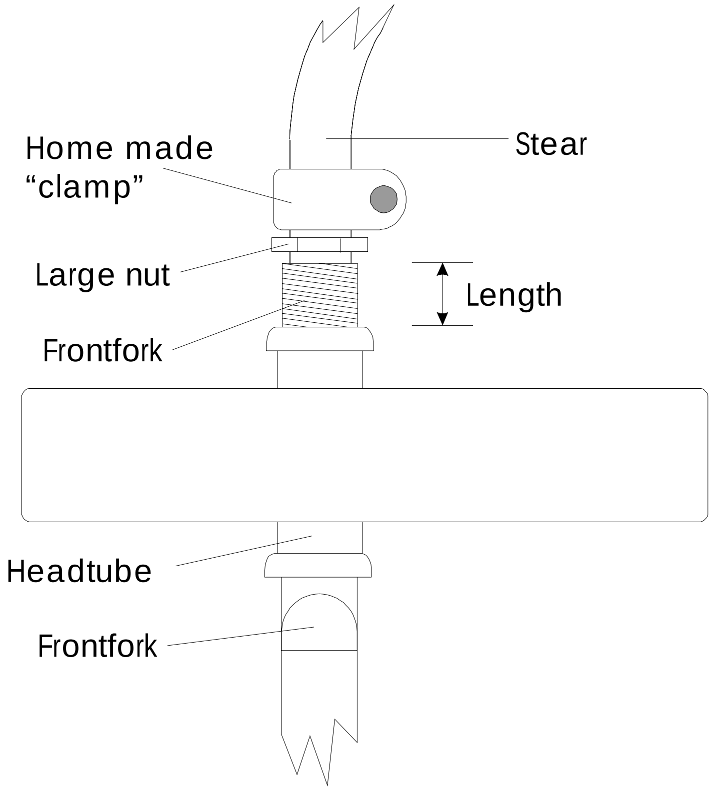
Figure 22: Steer made out of 22mm tube and bent into shape.



What needs to be considered here is the way the steer is connected to the front fork. This can be somewhat difficult. In the following I will describe how I did it.

3.6.1 Mounting of the steer

Figure 23: Schematics of the assembly of the front fork and the steer.



I mentioned earlier that the steer has to be made out of a 22mm tube. What’s essential is that the steer fits inside the front fork as shown in the figure above. Since the inside of my front fork was 22mm and the outside of the steer was 22mm I had to grind 3/10 to 4/10 of a mm off the radius to have them fit together.

The length of the head tube has to be so short that the “home-made-clamp” and the “large nut” are no longer than the distance “length” in the figure above. This adjustment of the head tube has to be done before it is welded to the large square tube !.

In order to be able to hold the front fork and the steer together with the “home-made-clamp” a small slit has to be made at the top of the front fork. See pictures below.

Finally the “home-made-clamp” is taken from a stem and shaped to the size shown in the pictures below.

As with ordinary bikes you have to put new steer fittings into the head tube before you can assemble the front fork and the steer for the first time.

Figure 24:
The steer and front fork assembly with the "home-made-clamp"

Since this is a vital part of the recumbent bike, you have to be accurate with your work here. There is no fun in suddenly having a loose steer !.

3.6.2 Pitfalls when mounting the steer

Please note that when adjusting the headtube (see fig 23) you have to assure that the thread of the front fork is long enough. If the front fork's thread is too short, the steer fittings together with the large nut will not be able to hold the front fork in position. Thereby you will get a front fork which will be loose and you will not be able to steer correctly.

On the other hand the length indicated by "Length" in fig 23 also has to be long enough in order for the handmade "clamp" to get a good grip of the front fork.

So before shortening the head tube in order to get a good grip of the front fork, check that it all fits. As mentioned earlier "the best thing is to do that before the head tube is welded to the frame", but it can be adjusted afterwards.

3.7 Chain

Due to the long distance between the pedals and the rear wheel, you need 3 ordinary chains put together to form one long chain.

In order to get the chain clear of the front wheel you need to make some kind of guide.

From other designs I have seen that roller blade wheels can do the job.

In order to have it work you need to grind a place for the chain.

Again from the internet I saw that an old drill stand and a sharp knife can do the job se Ref[3].

Figure 25:
Roller blade wheels before and after grinding.

The result of it can be seen in Figure 26. The wheel itself is mounted in the mainframe with a small fitting. If you are certain about the position you can weld a small piece of metal to act as fitting.

Figure 26:
Chain guidance made out a roller blade wheel.

If you have access to the rigth tools a more professional chain wheel can be made as shown in the picture below.

Figure 27:
Professional chain wheel made out of nylon.

The dimensions can be seen in Appendix A4. “Professional” chain wheel..

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3.8 Brakes.

For brakes I use the V-brake type. In case V Brake Pivots are already mounted no problem. In case V Brake Pivots are not mounted at the frame, you have to do it yourself.

Since the two V Brake Pivots have to be mounted in parallel to each other a small tool has to be made. This tool can be seen in the figure below.

Figure 28: One way of mounting rear V Brake Pivots by a small tool.

You have to find out how to place the V Brake Pivots in proportion to the wheel by looking at a bike with V Brake Pivots already mounted.

In case you need to mount V Brake Pivots at the front fork you use the same method.

3.9 Paint.

This chapter could have been placed somewhat earlier, but I expect that some test assembly and disassembly will always take place, so I don’t expect it as being a problem. It is obvious that the bike has to be completely finished before you paint. That is, no more welding needs to be done.

I did the painting myself and it became “acceptable”. I used a bottle of spray for both the actual blue panit and also for the anti-rust paint. It gives a nice and smooth surface, but it is very fragile. So if you want something that lasts, you need to go to a pro. I do not know how expensive that is, since I haven’t done so yet.

If you paint yourself remember to add many thin layers instead of a few thick ones. The thick ones are more difficult to control.

The blue paint was something, which I found in a car shop.

4 Cost.

This is merely a chapter which should make you consider what you are actually going to do when you start building your bike.

My experience is that the expenses get larger than expected in the first place. So before you start make “a budget”. The following should at least be in the budget:

- 2 bike frames.
- seat material.
- square tubes.
- material for the seat mounting.
- a 20” wheel and a 16” wheel (that is with a hub, tube and tire).
- 2 set of brakes with handles and cables.
- Typically 2 sets of gear shifters with handles and cables.
- Pedals with chain rings.
- Steer and steer fittings.
- Frame paint.

If you know how to do business you can make a recumbent bike like the one described here for less than a 1000,- Danish kroner.

5 Short working checklist

This chapter includes a short checklist which can be used when you have gathered an overview of what needs to be done and you start working.

No	Task	Done/Date
1	Separate the rear end of the 20” bicycle from the rest of the bike	
2	Cut the 40mm x 40mm square tube in the right length (length “b” in Table 1) and make a hole for head tube and adjust to the rear end of the bike.	
3	Weld the rear end of the bike together with the square tube.	
4	Adjust and weld the square tube “E” from Figure 1 to the rear end of the bike and the square tube.	
5	Weld the head tube to the square tube.	
6	Choose which of the “pedal methods” to use. **Method 1)**: Clean the bottom bracket shell to be used. Cut the two pieces of metal in size and adjust them. Weld it all together. **Method 2**): Clean the bottom bracket shell to be used. Cut the 35x35 mm square tube in size. Adjust the square tube to fit the bottom bracket shell. Weld it together. Follow the adjustments of the 40x40 mm square tube as described in the text	
7	Make the seat as described in the text.	
8	Make the top and bottom seat mounting.	
9	Mount the bottom seat mounting in the right position.	
10	By placing the seat with the bottom seat mounting in the right position mount the top seat mounting.	
11	Finish the seat with something soft to cover the wood.	
12	Make the steer as described in the text.	
13	Make the homemade clamp to fasten the steer to the front fork.	
	At this point you can either paint the entire bike before the final assembly or you can make a test-assembly (recommended)	
14	Place the steer fittings in the head tube and mount the steer.	
15	Mount the seat to the bike.	
16	Mount breaks, gear derailleur and the like.	
17	Mount the (homemade) chain wheels.	
18	Mount the chain.	
19	Go for the first ride.	
20	Make necessary adjustments.	
21	Paint the bike (if not already done)	

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6 Appendix A1. Seat mounting.

This appendix describes how the seat mounting has been made.

6.1 App A1. Top seat mounting

Figure 29:
3D drawing of the top seat mounting.

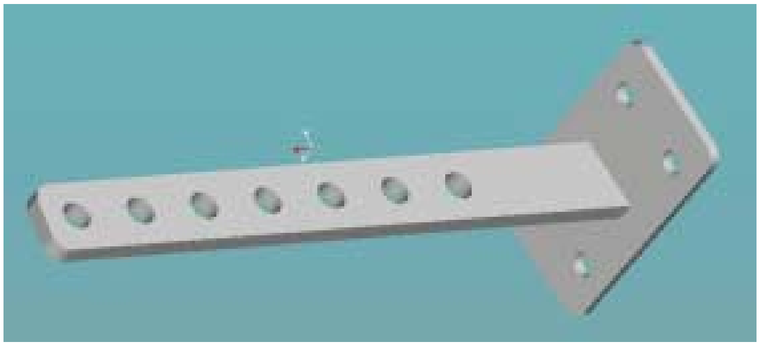


Figure 30:
Top seat mount seen from behind. All measurements in mm.

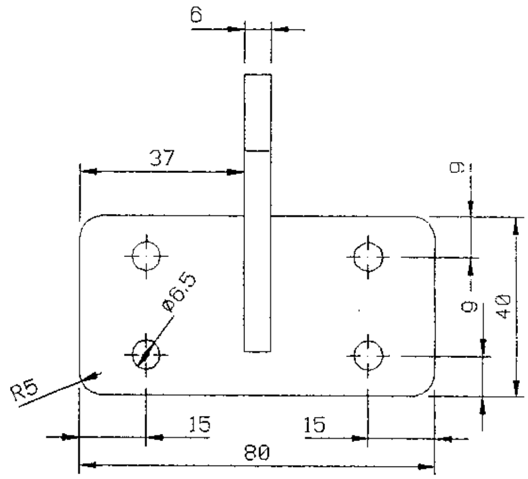
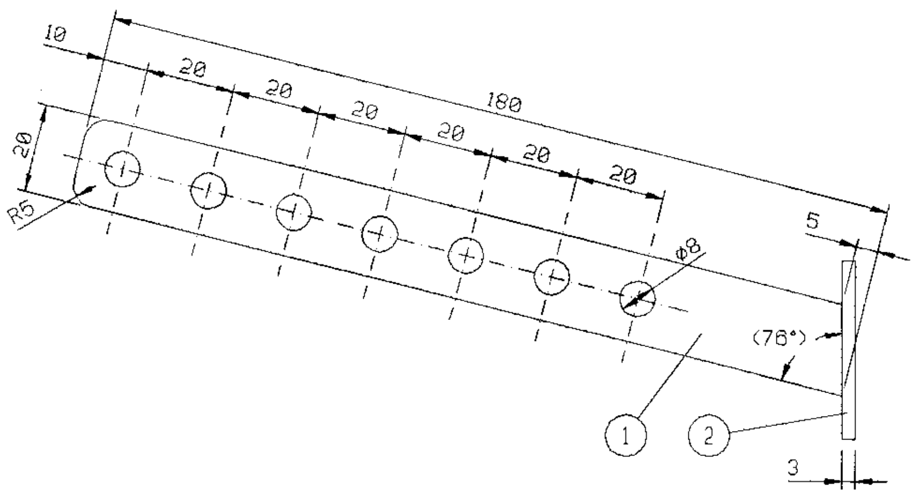


Figure 31:
Top seat mount side view. All measurements in mm.
(1) 40x3x80 mm
(2) 20x6x180



6.2 App A1. Bottom seat mounting.

Figure 32:
3D drawing of the bottom seat mounting.

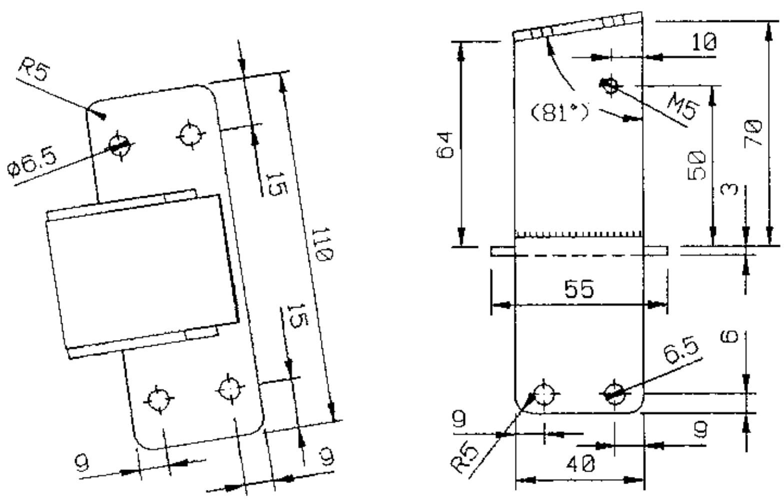


Figure 33:
Bottom seat mount seen from below and the side view. All measurements in mm.

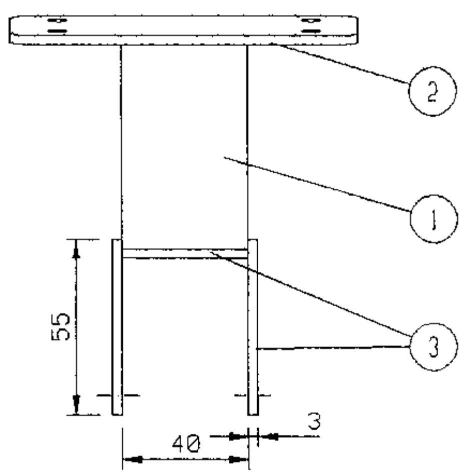


Figure 34:
Bottom seat mount seen from behind. All measurements in mm.
(1) 40x3x55 mm
(2) 40x3x110 mm
(3) Square tube 40x40x2x70

7 Appendix A2. Bottom Bracket Shell (*pedal method 1*).

This appendix describes one way of making the adjustable bottom bracket shell.

Figure 35:

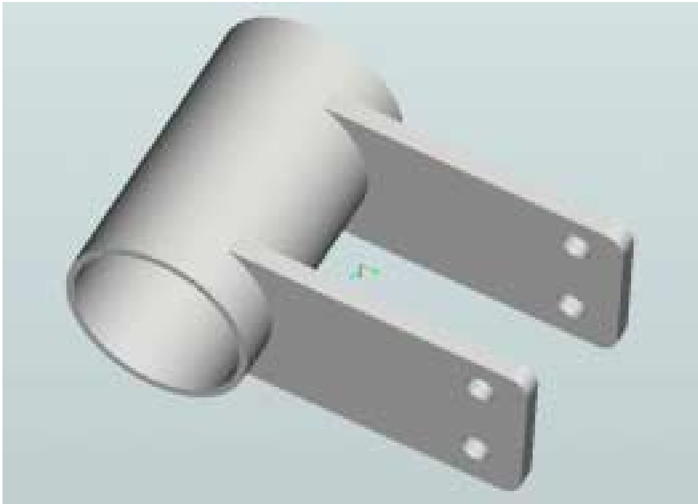
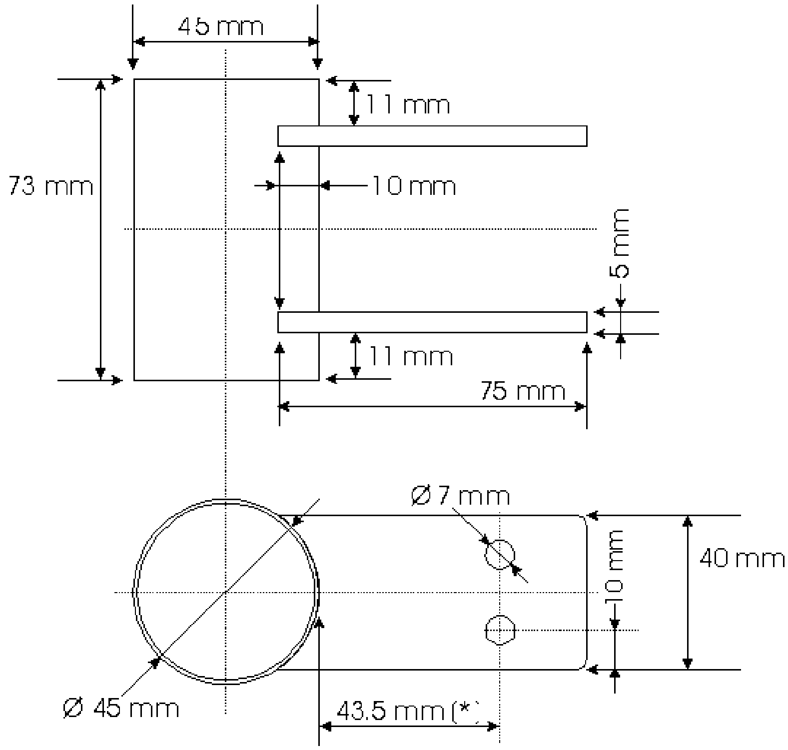


Figure 36:



(*) Note: that if you change the size of the 7 mm bolt you have to change the size 43.5 mm (= 40 mm +(7mm/2)) accordingly.

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8 Appendix A3. Bottom Bracket Shell (*pedal method 2*).

This is another adjustable bottom bracket shell.

Figure 37:
Another adjustable bottom bracket shell.

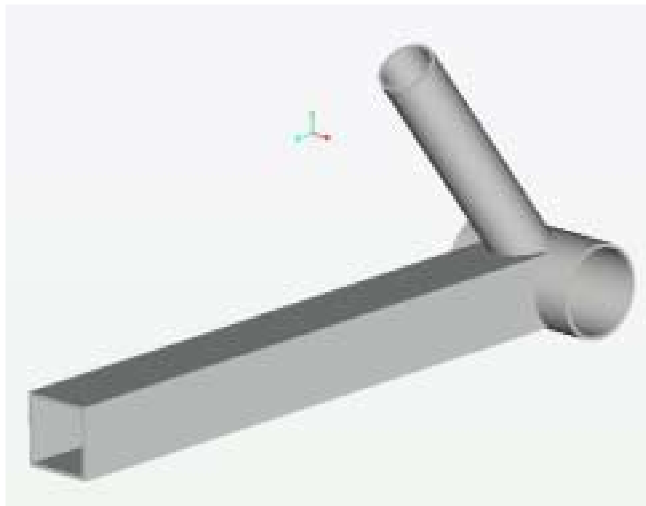


Figure 38:
The dimensions for another adjustable bottom bracket shell.

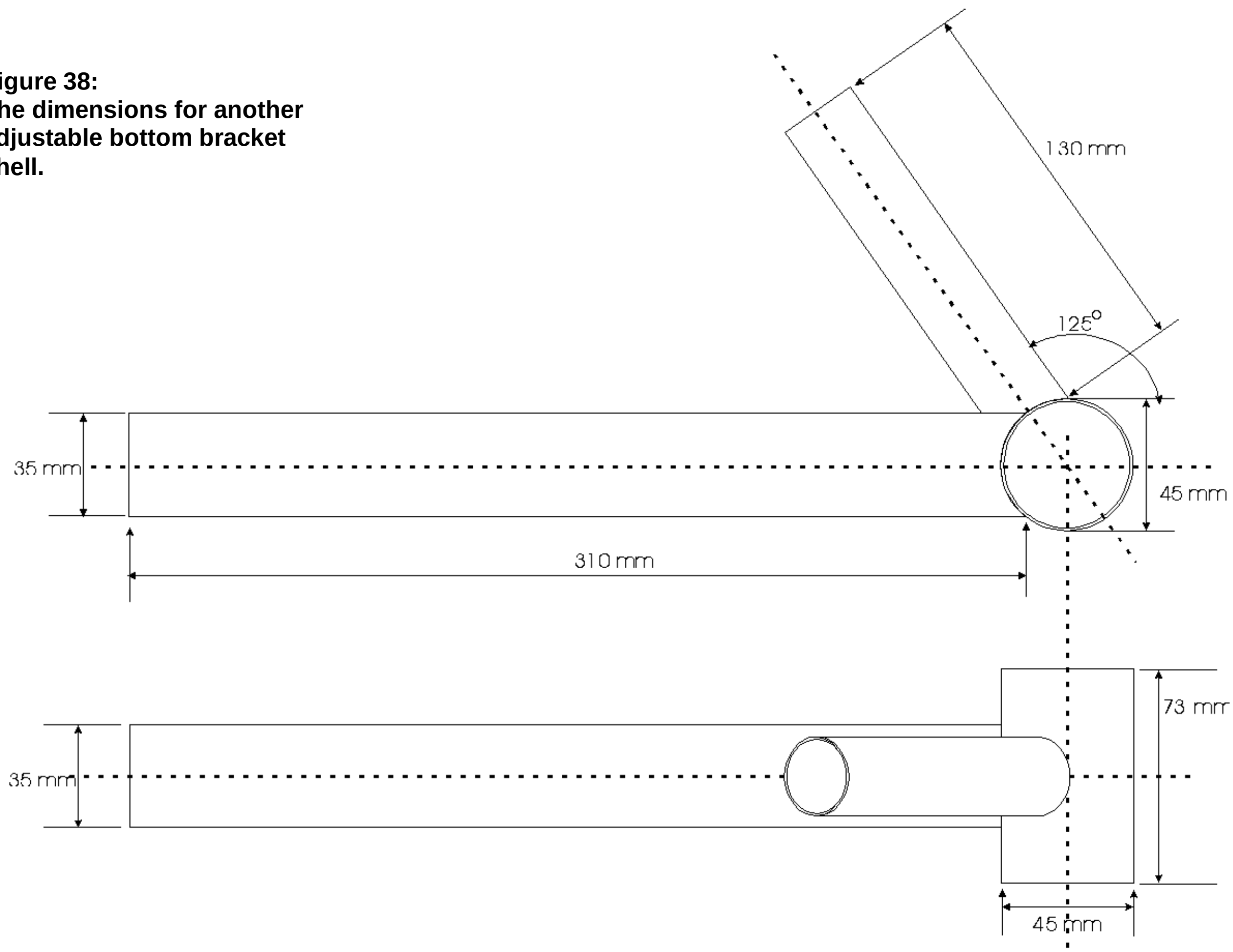


Figure 40:
3D of the modified 40 x 40 mm square tube. Figure seen from below.

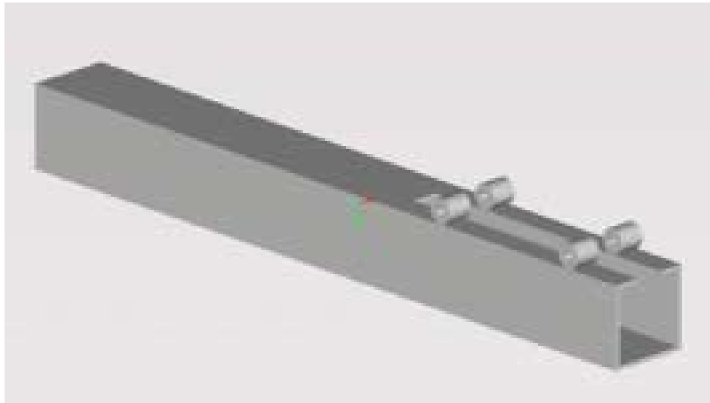
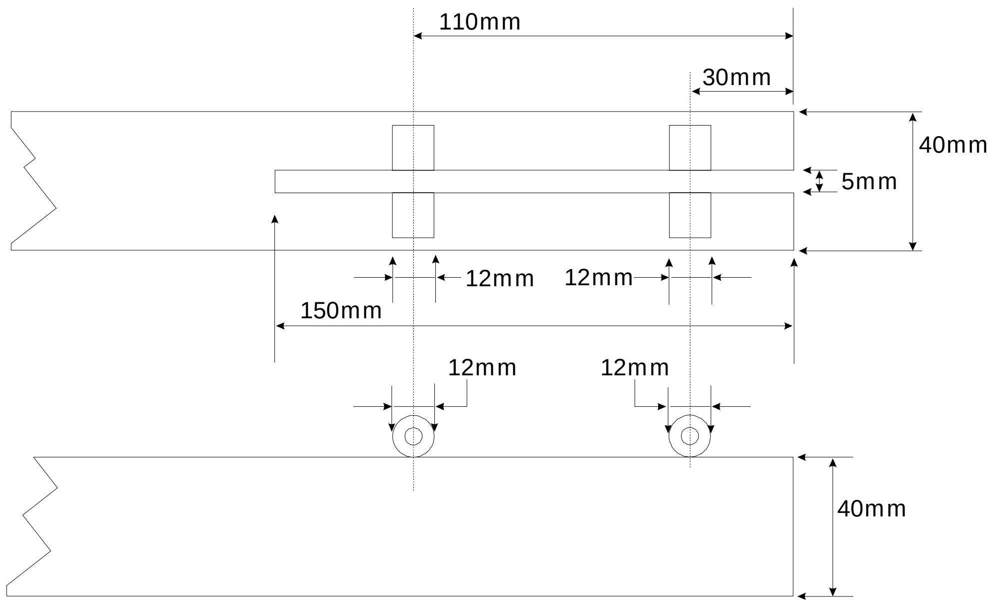


Figure 41:
The dimensions for the modified 40 x 40 mm square tube.



The two parts can be tightened together with a separate screw or a clamp.

Instead of the 2 small tubes, 2 small nuts can be welded in place. A 6 mm bolt should be sufficient to hold the two square tubes together.

The slit can be made either by a grinder or a compass saw.

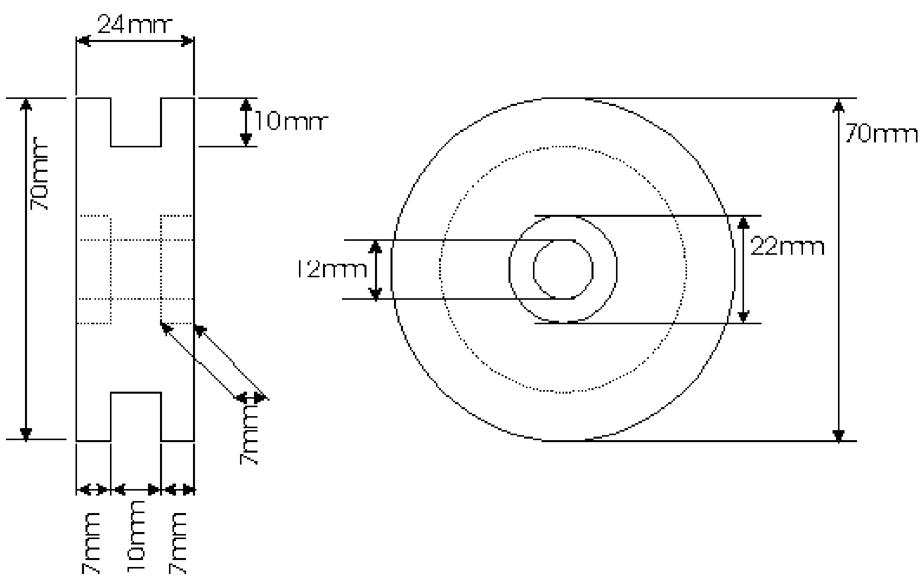
Note: that the 2 small tubes have to be placed under the square tube.

9 Appendix A4. “Professional” chain wheel.

This appendix shows how to make a chain wheel right from the beginning if you have access to a lathe.

Figure 42:
Professional chain wheel made out of nylon.

Figure 43:
Dimensions of a Professional chain wheel.



The overall size of the chain wheel can be reduced to 60 or 50 mm. The 7 mm thickness also can be reduced.

As ball bearings you should use the ones from the roller blade wheels. Go for at least ABEC 3.

10 Appendix A5. Bikeparts.

I have found the following picture somewhere at the Internet.

If you know who has designed the picture let me know.