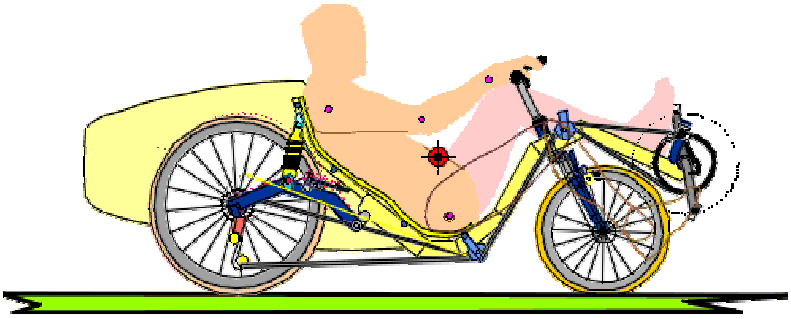
How to build your own recumbent bicycle.



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Introduction.

This manual aims to help you in making your own recumbent bicycle. If your are a first-timer it will be a project to remember. You will end up with a very fast extravagant bicycle. Although I have a separate chapter regarding the amount of work and skills required for this project, remember it requires commitment to finish.

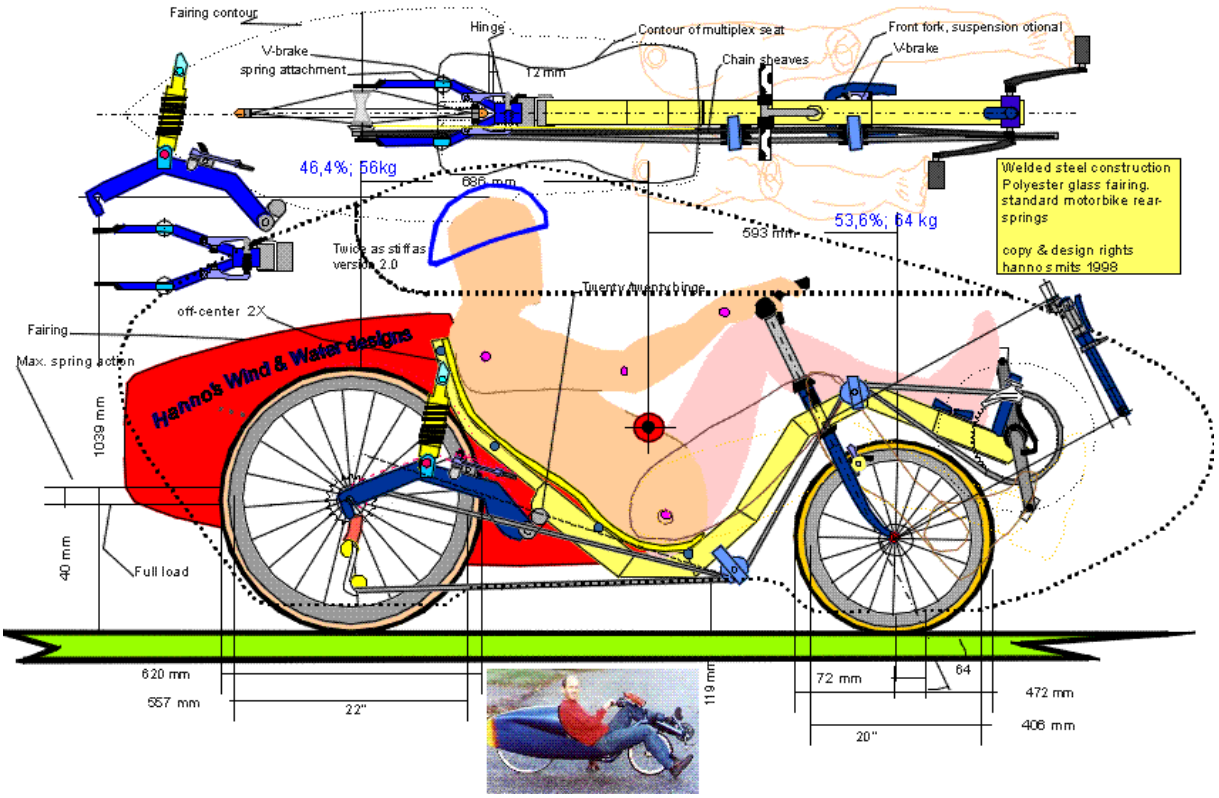
I have been offering the design for free on the internet for 2 years now. About 200 plans have been sent all over the world. From the response I know that only a few start the project I hope that this manual will help to get in more of the bicycles to be finished.

Please let me know what you think of the manual so that I can make revisions . I would very much like to make a special section of my website with project of you fellow recumbent builders. Send me pictures of your project please.

Remember: You will learn nothing if you do not make mistakes, you will become a sour person if you do not enjoy and if you do not play you have lost life's essence:

Try, play and learn.

Red Yellow and Blue; recumbent for daily use; hanno smits; scale 1:10; rider 1,90m; 4 1998 Ver 8



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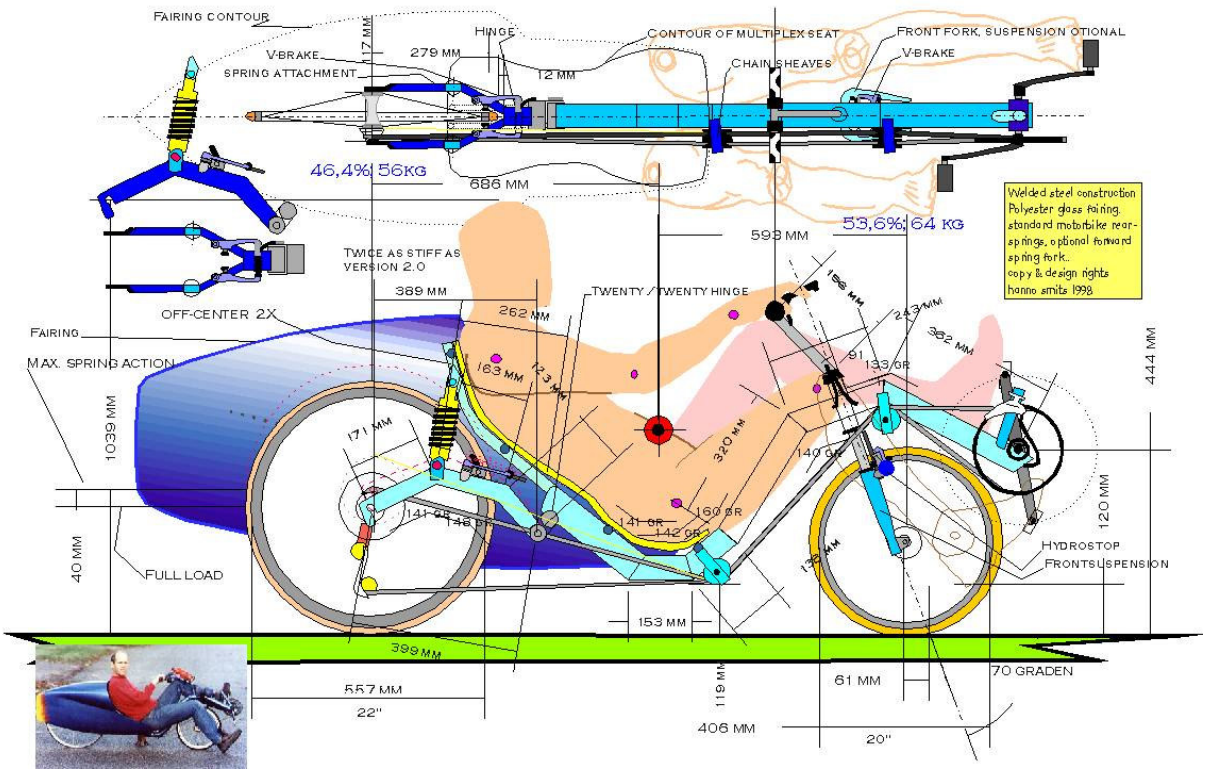


1. Your abilities.

You will need some skills, time, money and stamina to finish this project. Below you find a little table with most of the essential ingredients. Remember that I cannot define everything precisely. For example what the bicycle will cost you in raw materials will highly depend on the prices in your country, the type of components you use, and the time you invest in getting bargains.

What ..	**Requirements**
Skills	Metal working including welding (or have it done), woodworking, bicycle mechanics, spray painting, with fairing glass-reinforced plastics.
Time	Nett approximately 40 hours, combined with a working family life app. 6 weeks.
Money	App. US$ 400,-
Personality	Enjoy working with your hands, like to learn, like to learn new skills, Have the creativity to adapt the bicycle to personal requirements.

2. Materials you need.

This will be a list of all materials you will need. I will use the Standard International Units, so everyone can use them (sorry for some of you still using the size of your foot and thumb but ...). You will see that you will basically decide yourself what the bicycle will look like as far as equipment is concerned, you can decide how much money you want to spend. I know from experience that anything to do with the drive train is money well spent as it will increase average speed even more.

Frame materials choice.

What	Dimensions L=length, T=thickness, D=diameter, etc.	Number
Mainframe tubing:	D 57mm T 1.5 mm, L app. 1500 mm	1

What	Dimensions L=length, T=thickness, D=diameter, etc.	Number
Seat support tubing back	D=28mm, T=1mm, L =500mm	2
Seat support tubing bottom	D 15mm, T=1mm, L=100mm	4
Rear fork tubing	Oval 38x20 mm, L:360 mm	2
Supports, suspension	Strips L=42mm, T=5mm, W=21mm	8
Chain support bottom	Strip L=90mm, W= 19mm, T=3mm	1
Front shifter support	Check you shifter!!; D=28mm, T=1mm, L=90mm	1
Pedal axle tubing	Check your axle!!; D=39mm, T=2mm, L=67.5mm	1
Rear suspension axle	Contact Flevobike for twenty-twenty hinge or built your own. D=39mm, T=2mm L=67.5 mm, twice with flanges connecting them and nylon gliders.	1
Rear wheel support	T=6MM, contact flevobike, use from old bicycle, or make yourself, should fit on oval tubing.	2 Left and right differ!!
Seat support bolts	M6, L=40mm	6
Suspension bolts	M10, L=50mm	4
Chain support rollers	Contact flevobike, or built your own, roller bearings, flanged rollers D=40/60mm	4
Chain, support roller bolts	M8.8 L=120mm, 97mm unthreaded, use stronger that standard bolts!!	2
Seat	Make your own using 3 layers of bending plywood	1
Seat cover	Use outdoor camping mattress, or find your own alternative	1
Front fork	Buy a standard fork for a 406 front wheel, otherwise construct one yourself	1
Frontfork bearings.	Suit yourself, I like the moutainbike quality ahead sets best.	1
Handlebar	Suit yourself. I like very narrow handle bar,	1

What	Dimensions L=length, T=thickness, D=diameter, etc.	Number
	sawed of moutainbike variety.	
Front wheel, tire	28x406 Continental, with rim, spokes and hub to your liking.	1
Rear wheel , tire	25x559 Continental, with rim, spokes, hub, chaincogs to your liking.	1
Rear-gear shifter	Up to you, do not forget shifter, cable, sheeting and accessories.	1
Front shifter.	Up to you, do not forget, shifters, cable, sheeting and accessories.	1
Front brake	Up to you, use the most powerful version you can still afford. Do not forget cabling, etc.	1
Rear brake	Some people do not use a rear brake on a recumbent. I like the extra safety, it's up to you.	1
Chain	Use a chain suited for your cranks and cogs	2
Pedal axle	Your choice, I like the new type which you press in	1
Cranks	Use a length of the pedal suited to you. Think about the quality of the chainwheel I advise two chainwheels with the larger having a minimum of 52 teeth. Some guys use 60, so...	
Accessories	Speed sensor, rear-view mirror, which I do not use as nobody ever overtakes me ;-)) , Bidon attachments, polyester fairing.	-

3. General run-through of the building process

I think that there a four main phases in the project, which all require a different attitude to the project.:

1. Getting the materials.
2. Making the frame and fitting the equipment.

3. Spray painting the bicycle.
4. Fitting out of the bicycle.

You can of course let phase 1, drag along and get your materials during the project. I always prefer to have all major components available when I am making the frame. You will almost certainly want to adapt the design to your personal needs, and then you need to see if it all fits.

Getting the materials.

Almost everything you need for the recumbent bicycle is readily available. There are some special items: suspension hinge, rear-wheel supports and chain support rolls, you will have to find a solution for these. The easiest way is to mail-order them from Flevobike Dronten The Netherlands or Flevobike@wxs.nl.
Finding the materials falls into two categories:
1. Finding the steel tubing etc.
2. Finding the bicycle parts.

Steel components.

Any good hardware store should be either able to help you with all the steel components, or be able to tell you where you can get them. As you are probably able to weld you will know your way around. Do not make your life more complicated by using special steel, or special sized tubing. The tubing I suggest works fine and although the bicycle could probably be made a bit lighter this works while still keeping the welding pretty simple.
If you cannot weld or do not have the equipment ask the local blacksmith, car-plateworker if he can do you welding.
I have built recumbent also from old bicycles, by simply cutting and welding parts of several bicycles together. Do not hesitate to use components of old bicycles for your recumbent cycle.

Figure 1 The complete rear-wheel support is from an old bicycle, as is the frontfork, the handlebar and various components

Steel is cheap so this is not where you will be spending much money.

Bicycle parts.

This is where you will be spending the real money. To start with you will have to decide on which side of the spectrum you are, the builders who wants a great, fast en durable exercise bicycle, or the craftsman who wants to try his hand on this type of machine.
If you want to make a lot of kilometres on this bicycle, buy expensive top of the line parts, particularly the quality of the hubs and the brakes will pay-off.
When you are unfamiliar with bicycle components and quality etc. Go to a large bicycling shop and get professional advice.

4. Making the frame and fitting the equipment.

Making the frame.

To start with you need to transfer the design to full-scale on a working underground. I always use a piece of cheap pressed wood. As the main frame is flat you do not need special blocks to hold the frame. You can at the start simply clamp it to the wood support plate.
Once you have the design of the frame transferred you will need to put the wheels you have bought and the front-fork on the design. It is not impossible that you cannot obtain exactly the same wheel size as I have used. You will have to adapt the full-size drawing accordingly.
This is also the phase where you adapt the design to you body-length, Particularly your leg-length will have to correspond with the full scale drawing.

The rear suspension bridge

Whereas, the main frame is flat and can be made on any flat surface, the rear suspension-fork or bridge is of complicated 3-dimensional shape.

The reason for this is that we have to combine several functions in this part of the frame. It the support for the springs as well as the axis, it holds the rear-wheel in place, the brakes are attached to this and it will have to stay clear of the rest of the frame and the chain.

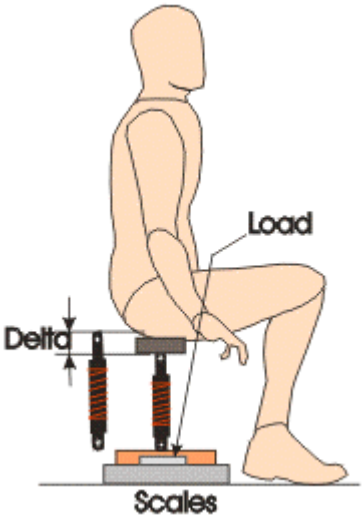
The photographs show what it looks like three dimensionally.

I made this construction by cutting the pieces approximately, measurements based on the side view. I then made a construction of wooden supports, before point-welding the pieces together.

Then I put the rear-support in the bicycle and made adjustments where necessary. Alignment of the whole bicycle is very important and can be done in this stage without having to take too much of the bicycle apart.

The fitting of the suspension is also when I attach the spring-supports and the brake-supports. These have to be exact while otherwise the load on either brakes or suspension will be uneven for left and right.

Adjustment of springs.

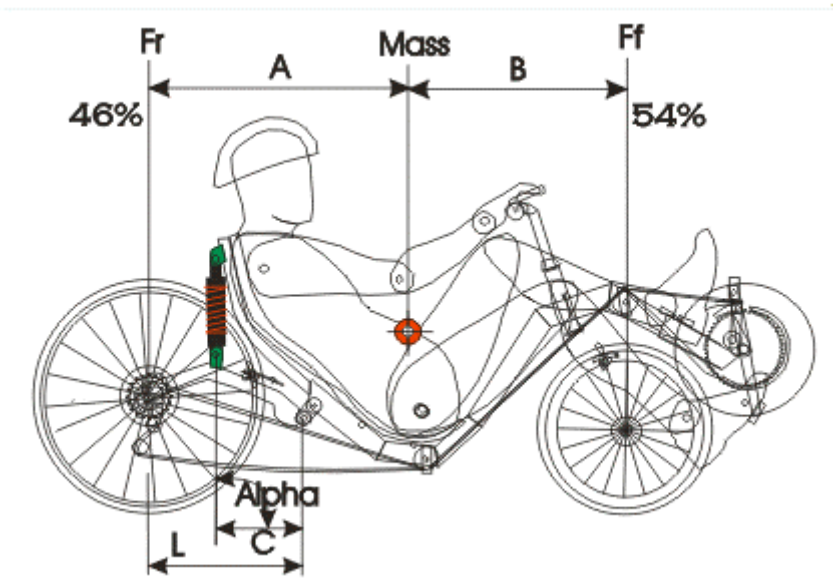


The springs are an important part of the rear-suspension, be sure to use dampened springs. Dampened spring will prevent oscillation of the rear suspension which can be pretty dangerous at the speeds you will be going. I once experienced this when I was going downhill in access of 60 kph and the floating

sensation of the rear is terrible. So use well dampened springs.

Depending on what you can buy. (I prefer longer ones as they), you will have to determine where to fit the springs and how to fit them.

So how do you determine where to fit the springs. You start-off by measuring the springconstant, This is the characteristic of the spring, how much it gives under load. As springs can differ very much this measurement is and the consequences for the positioning of the springs is important so take your time to review the method I propose and measure carefully.
I always load the spring by sitting on it, this results in an approximately the same constant loading as in the bicycle. Some springs may have a spring-constant written on them, but most will not so you will have to determine the constant yourself.



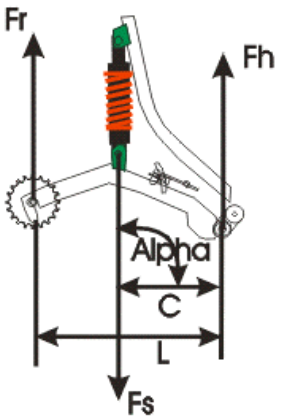
The figure shows what I do, remember to keep the spring vertical. Measure the difference in length between the spring when you are sitting on it and when it is unloaded. Also have a careful look at the scales and write down the load. Repeat this measurement several times and use the averages. The spring constant is the shortening of the spring divided by the load, ie Delta/load. **Spring-constant = Delta/load**
So now we know how stiff the spring is we can determine where on the rear wheel bridge it should be placed. Looking at the figure we will determine **C**. C is the distance between the hinge point of the rear-fork and the attachment of the spring.
To able to this you will have to measure several other dimensions of your bicycle, ie A, B, tot determine the load on the front-wheel and the rear-

INTERMEZZO **Units.**

You might have noticed that I do not use any units in the calculation, reason for that is that they are not important when you only use the same units in the whole calculation, and not using units makes the example universal. So once you start using inches and Lbs, or kg and cm or N an mm stick to it al through the calculations and it will be right.

wheel. A+B being the wheelbase of your bicycle. If you did not change anything from my design this will result in a rear-wheel load of 46% of your bodyweight.
You can also use an alternative method in which you put the rear-wheel on an scale, the front wheel on a woodblock of the same height (the bicycle will have to remain horizontal!) and measure the rear wheel load. Of course you will have to fixed the rear wheel fork, somehow.

Once you know the rear-wheel loading, you need to think about the amount of travel you want in your rear axel.
I always try to make it rather stiff. Remember you can do almost anything here, so if you want a travel of 15 cm, 7" that is no problem, but it is of no use either.
I prefer a travel of the rear axel of approximately 3 to 5 cm (1 to 2") between unloaded and loaded. From experience I know that this will increase between two and threefold when cycling, which is quite a large suspension travel.



Travel rear-axel = X (you can select this I suggest 3 cm)

C = X/Fr * Load/delta * L / 2 (The factor two is while we are using 2 springs!!)

All this seems complicated but is absolutely essential so do this meticulously.

Example: Mass rider 90 kg, L= 41.5 cm, X=3 cm
Determined spring-constant delta=3.2 cm for load = 50 kg
Rear-axel load =46% ==> 41.4 kg =Fr
C = X/Fr * Load/delta * L / 2
C = 3/41.4 * 50/3.2 * 41.5 / 2 = 23.5

The steering geometry

Do not hesitate to change a few things but be particularly careful with the steering configuration ie, angle and curve. I always ride the bicycle in a rough form to determine if the steering suits me and if not I simply cut it open again and change it.

The seat.

Fitting the equipment.

As I said before I always testdrive the rough frame, this means that all essential equipment should be available at this stage. It also allows you to weed out any problems with the geometry where the chain runs along the frame, the rearwheel is in contact with the seat etc. You can easily change these things in this stage as nothing is painted or finished.

Test driving.

Learn how to drive

Sanding and clearing welds.

5. Spray painting the bicycle.

6. Fitting out of the bicycle.

7. Final comments

ENJOY the bicycle, you now own a bicycle built by yourself, which will allow you to cycle very fast. Being this low to the ground adds a lot to the sensation of speed. If you are more interested in long trips this bicycle will save you a lot of energy.

BE PROUD, ENJOY. LEARN AND PLAY.