

WHEEL BUILDING

# Overview

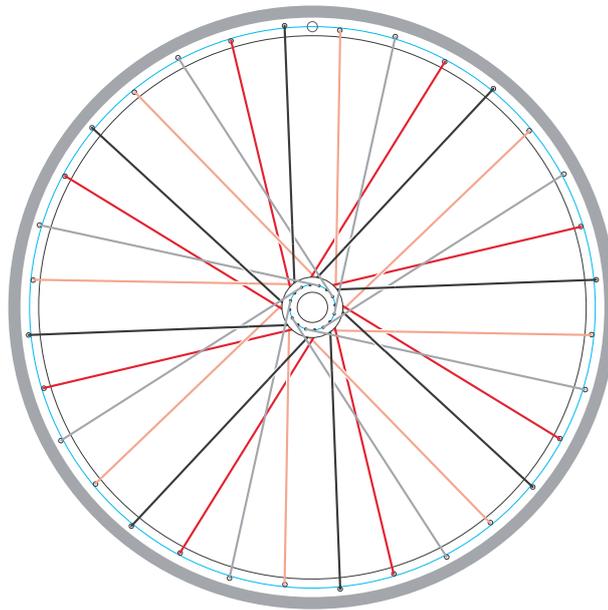
A brief summary of the  
wheelbuilding process, covering

STAGE ONE: COMPONENT SPECIFICATION

STAGE TWO: SPOKE LACING

STAGE THREE: WHEEL TENSIONING

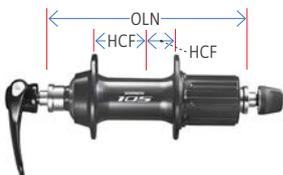
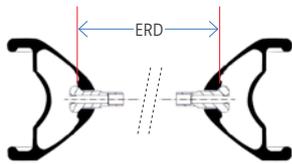
plus a selected list of useful  
websites and further reading



**ROSS SPEIRS**

*Cycle wheel builder*

Some factors to consider when selecting components: 559mm (26") wheels tend to be stronger than 622mm (700C) wheels; 36-spoke wheels are stronger (and slightly heavier) than 32-spoke wheels; cross-3 spoking is stronger than cross-1 spoking.



On a front rim-brake wheel, using a hub with equal-sized flanges, the HCF distance (and therefore the spoke length) will be identical on both sides of the wheel

## COMPONENT SELECTION

Select appropriate rims, hubs and spokes for the wheel required. Take into account the type and weight of the bike; what kind of riding it will be used for (e.g. shopping, road racing, touring with panniers, etc); and the weight and build of the rider(s).

## COMPONENT MEASUREMENT

For each wheel, measure (in millimetres):

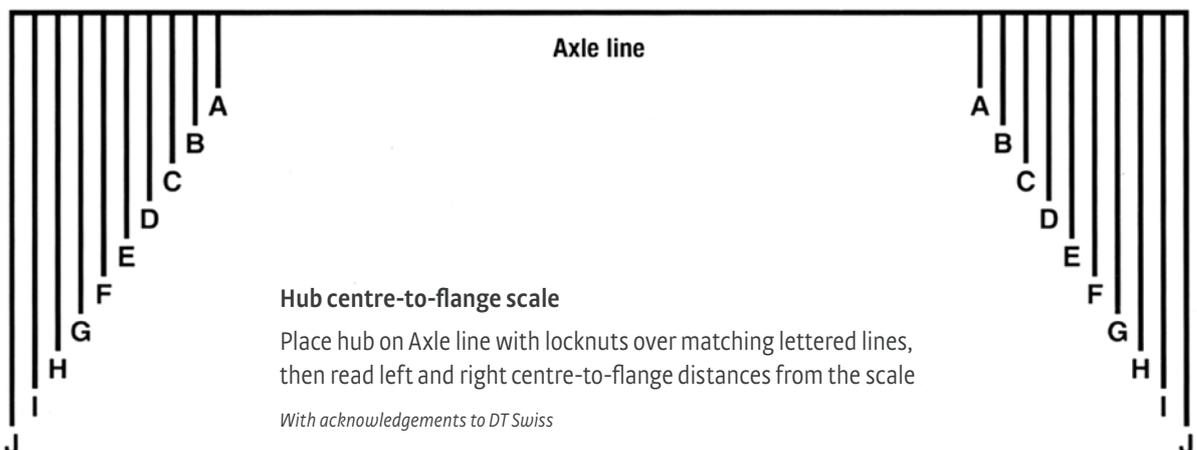
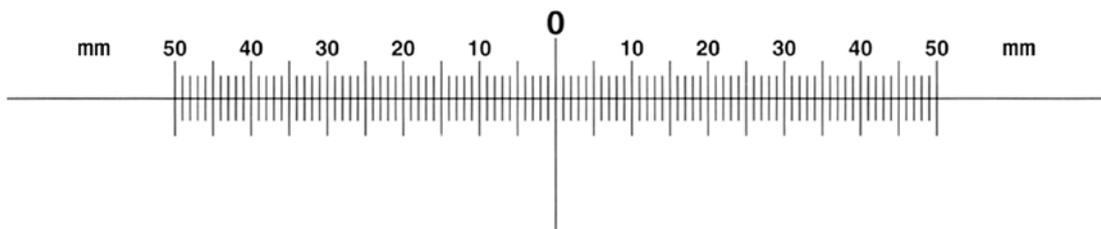
- ERD The effective rim diameter – the diameter of the rim measured across the point where the spoke nipples are seated *inside* the rim.
- HFD The hub flange diameters, measured across the centres of opposite *holes* in the flange. (Note that on certain types of hubs, the left and right flanges are different in size.)
- HCF The hub centre-to-flange distances. The centre of the hub is midway between the outsides of the locknuts, or the OLN (over lock-nuts) dimension. Using the scale below, measure from the hub centre (O) to the centre of each flange. The two distances will be different on some hubs: for instance, on rear derailleur hubs the distance from centre to right (drive-side) flange will always be less than the distance from centre to left flange.

## SPOKE LENGTH CALCULATION

Decide on the type of spoke lacing you will use (for instance, tangential cross-3 lacing). Now input that information, and the above measurements, into an online spoke calculator such as <https://www.wheelpro.co.uk/spokecalc/>

Some calculators also ask for spoke diameters. Commonly used J-bend spokes are either double-butted (slightly thicker at each end) or plain gauge (consistent diameter). Double-butted spokes will typically be 1.8mm in diameter along most of the spoke length; plain gauge spokes will typically be 2.0mm in diameter along the whole spoke.

On rear wheels and disc-brake wheels, spoke length on the drive or disk side will be different from that on the non-drive or non-disk side.



### Hub centre-to-flange scale

Place hub on Axle line with locknuts over matching lettered lines, then read left and right centre-to-flange distances from the scale

With acknowledgements to DT Swiss

## STAGE TWO: SPOKE LACING

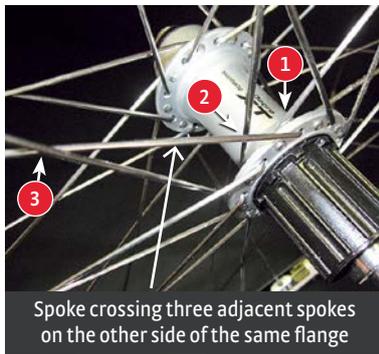
### CHOOSING THE LACING PATTERN

The two principal methods of spoking a wheel are radial and tangential.

With radial spoking, spokes leave the hub and enter the rim at right angles, and do not cross any other spokes. Radial spoking is weaker than tangential spoking, but slightly more aerodynamic. It is discouraged by some hub manufacturers, such as Shimano.

On a tangentially spoked wheel, the spokes leave the hub and enter the rim at an angle of less than 90°, depending on the crossing pattern. Each spoke will pass across a fixed number of adjacent spokes coming from the *other side* of the same hub flange, and will be laced over or under the final crossed spoke. A common crossing pattern is cross-3, in which each spoke passes across two spokes before being laced under or over the third spoke (see left). Other frequently used patterns are cross-2 and cross-1. Laced crossings on a tangentially spoked wheel add strength and stability to the wheel.

More complex patterns, such as cross-4 (used on tandems and wheelchairs), are only possible where the wheel hubs have very wide flanges.



Spoke crossing three adjacent spokes on the other side of the same flange



### OILING THE SPOKE THREADS

Before lacing the wheel, dip the threaded end of the spokes in boiled linseed oil. Wipe off any excess oil, then arrange the spokes into two groups, one for the left (non-drive) side of the wheel, and one for the right (drive side).

The linseed oil will help reduce friction during the final tightening, when the spokes are nearing final tension. Once the oil dries it will inhibit spokes unwinding when the wheel is under the changing stresses of a ride.

### LUBRICATING THE NIPPLES

Each spoke will be passed through a hole in the hub flange and threaded to a spoke nipple pushed through the inside of the rim. Before attaching the spoke, lightly coat the shoulders of each nipple with a little cycle oil before placing it in the rim: this will help reduce friction during final tightening. (Two cotton bud ends, dipped in oil and fixed upright, will make this process easy.)

### LACING SEQUENCE \*

#### Start on the correct holes

It is vital to attach the first 2-3 spokes to the correct holes in the rim, because these spokes will determine the position of the valve hole and the hub label. The valve hole (circled red, left) should be located between two straight spokes (*not* two crossing spokes) to allow easier pump access. The hub label (circled yellow) should appear directly below the valve hole, reading left to right when the bike is facing forward.

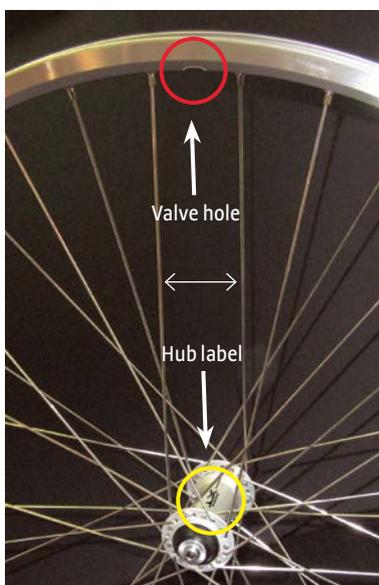
#### Inside spokes first

Begin by attaching all the the spokes coming from the *inside* of the hub flanges to the rim. Do the inside drive-side spokes first, then the inside non-drive spokes.

#### Outside spokes last

Once all the inside spokes are attached, start on the spokes that come from the *outside* of the hub flanges. Lace them through the inside spokes according to the chosen lacing style. Do the outside drive-side spokes first, then the outside non-drive side spokes.

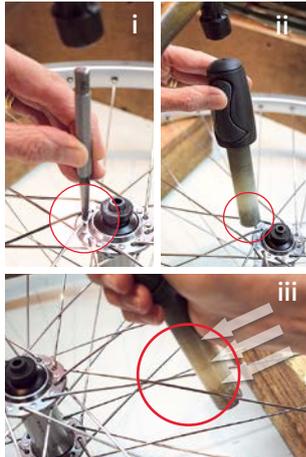
\**Spoke lacing is described in greater detail in a separate document.*



*This checklist is only a guide. Every wheelbuilder will develop personal preferences; e.g. at what point to start checking lateral and radial truth, how often to check dishing, etc.*

*When taking up the slack, give the nipples 1-2 turns to begin with.*

*On the rear wheel drive side, add an additional half or full turn.*



*For lateral adjustment, use tone to help identify the spokes to adjust.*

*Radial truing should be achieved primarily by tightening spokes, thus building up towards final tension.*

*It takes a larger adjustment to affect radial deformation than it does to affect lateral deformation.*

★ *Check rim and hub manufacturers' recommendations before deciding on the final spoke tension.*

*Typically, front wheel spoke tension would be around 100Kgf/1000N. Rear wheel spoke tension would be around 60Kgf/600N on the non-drive side, and up to 115Kgf/1150N on the drive side.*

*As the tension increases, avoid over-tightening by using smaller, fractional turns of the wrench.*

*On rear wheels use different increments for tightening each side of the wheel; for instance half a turn on the drive side spokes followed by a quarter turn on the non-drive spokes.*

*At high tensions spokes may be prone to twist as well as turn. Compensate for spoke twist by over-adjusting then backing off.*

### 1 Equalise the spoke threads

Use a nipple driver to equalise the starting amount of thread used on each spoke.

### 2 Take up the slack

Working round the wheel, start tightening the spokes until they become firm and straight. *Throughout the build, work on each side of the wheel separately.*

On rear wheels, aim initially to pull the rim well over to the right (drive side), so the spokes will be almost vertical to the hub.

### 3 Straighten the spoke lines

Once the spokes are firm, straighten out the spoke lines as follows:

- i use a spoke punch to seat the spoke heads on the outside of the hub flanges.
- ii using a grooved plastic rod to protect the spokes, lightly hammer the J-bend of each *outside* spoke to flatten the curve (hammer just beyond the edge of the flange).
- iii press each spoke crossing inward towards the hub with a screwdriver shaft or similar.

### 4 Start tensioning the wheel

Continue tightening the spokes until they make a tone when plucked.

### 5 Adjust for lateral truth

Look for major deformations first. Move the rim where necessary by adjusting *both* sides of the wheel at the point of deformation (tighten and loosen).

Drive-side spokes on rear wheels have *less* effect on lateral truth than non-drive spokes.

### 6 Adjust for radial truth

Look for high spots. Feather out the tightening towards the edges of high spot regions.

Drive-side spokes on rear wheels have *more* effect on radial truth than non-drive spokes.

### 7 Equalise spoke tension

Spokes on the same side of the wheel should sound the same when plucked.

Where a spoke needs to be tightened or loosened, apply an opposite compensating adjustment on neighbouring spokes *on the same side of the wheel*.

### 8 Correct the wheel dish

Take out most of the dish error.

On rear wheels, use left side spokes as the primary means of correcting dish.

*From now on, check lateral truth, radial truth and dishing regularly, gradually bringing all three to within  $\leq 0.5\text{mm}$  for lateral truth, and  $\leq 1.0\text{mm}$  for radial truth and dishing.*

### 9 Increase spoke tension

Work round the wheel, gradually building up to the final spoke tension ★.

### 10 Stress-relieve the spokes

Squeeze pairs of parallel spokes together at midpoint between rim and hub (drive and non-drive sides simultaneously). Work round all the spokes on the wheel. If you hear a noise as spokes untwist or move, work round the wheel again until no noise is produced. Check and adjust lateral truth, radial truth and dishing.

### 11 Bring the spokes to final tension

Repeat steps 9 and 10 until the spokes reach the required tension.

Spoke tension on the left side of rear wheels will be determined by the dish of the wheel.

### 12 Finish off

Clean the rim and hub with de-greaser, and fit rim tape.

## SELECTED REFERENCES

There are countless websites and books offering information and advice on wheelbuilding. Here are a few of the better ones.

## USEFUL WEBSITES

**Wheelpro**

<https://www.wheelpro.co.uk/>

Roger Musson's website, including a spoke length calculator and a link to his excellent ebook *Professional Guide to Wheelbuilding*.

**Park Tool**

<https://www.parktool.com/>

Primarily a catalogue for the well-known US manufacturer of bike tools, this site also has a wealth of practical information and advice on all aspects of cycle repair and maintenance, including wheelbuilding.

**Sheldon Brown**

<https://www.sheldonbrown.com/wheelbuild.html>

Another US site, with sound practical advice on wheelbuilding.

**Wheel Fanatyk**

<https://www.wheelfanatyk.com/about/>

Geeky US site, with information on specialised wheelbuilding tools.

**Spoke length calculators**

<https://www.wheelpro.co.uk/spokecalc/>

<https://spokes-calculator.dtswiss.com/en/>

<http://www.sapim.be/spoke-calculator>

## FURTHER READING

**Professional Guide to Wheelbuilding**

Roger Musson

*Pdf download 130pp A4*

Probably the best available book on wheelbuilding. Downloadable from the Wheelpro website (above) for £9.00.

**The Art of Wheelbuilding**

Gerd Schraner

*Buonpane Publications 108pp 242 x 212 mm*

A practical guide from a master builder.

**The Bicycle Wheel**

Jobst Brandt

*Avocet, California 150pp 230 x 170 mm*

A fascinating and erudite treatise on bicycle wheels, strong on engineering theory.