

WheelBuilder[©] PE

by

da Lynchi

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DRAFT

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Forward

Like many things, da Lynchi WheelBuilder PE (Personal Edition) is the result of frustration. A hub started playing up not long after having a wheel rebuilt around it. A better hub would mean new spokes and another build and truing fee. So I started wondering if this wheel building stuff was actually as mysterious as I had been led to believe. Research very soon revealed enough material to indicate that it's not really a mystery at all - but it needs practice.

And then I got side tracked. The Spoke Length Calculators that I could find all appeared to do exactly what they are meant to do - that is to calculate spoke lengths. No surprises there. But none of them seemed to provide an easy means of archiving and searching the details of previous builds. So having written a few databases before I decided to write something to do just that.

The spoke length calculation has been verified against a number of other well known calculators to be found on-line. Of 10 calculators tested, the difference between the shortest and longest spoke answers was less than 0.7mm. WBPE's results were within 0.2mm of the mid point of this range.

WPB on its own will not make you a wheel building expert. That you can only aspire to by building wheels - lots of 'em, because experience cannot be taught. If you want to build an expensive light weight 18 spoke radial wheel for a 100Kg-plus rider then WBP will calculate the spoke lengths for you. It won't stop you using or supplying the wrong wheel no matter how well you build it.

Finally, these things are never really 'finished'. It seems like there's always something more that you think you should have added or as soon as you show it to somebody they ask for something that you've not yet included. Projects can easily be drawn into 'feature creep' territory with the only result being that the product never gets out the door. At some point you have to say that's it. Let's get version one out there, take a breather, and then start thinking about what's next. So while I work on WheelBuilder Pro, here's what I think is a good start at a free version and I hope you enjoy using it, WheelBuilder PE.

Feel free to nudge me if you think I've got something wrong, forgotten something or there's something you think I should include. wheelbuilders@me.com

My thanks to Mark, Chris and everyone else at Sigma Sports in Hampton Wick for their invaluable help in putting WBP through the mill and introducing me to reality and Arup for his invaluable advice.

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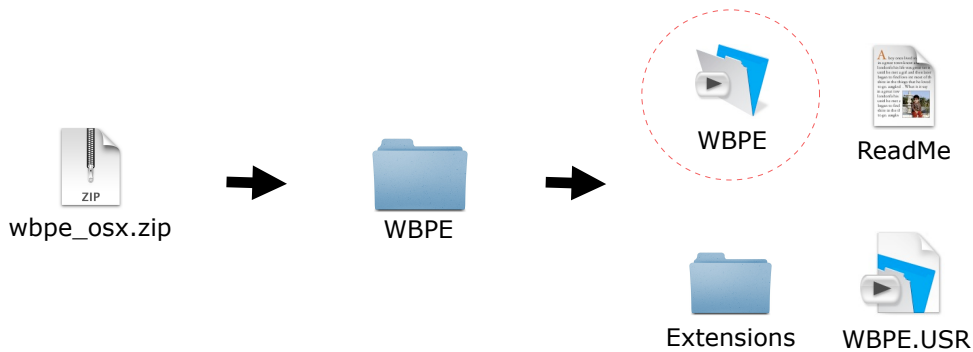
Ianardo da Lynchi: 12/2010.

GETTING STARTED

Installing WBPE

For both Mac and Windows, simply unzip the download and copy the WheelBuilder PE folder (WBPE) to wherever you prefer on your hard drive. The Applications / Programs folder would be a sensible place. You can make an alias / short cut of the WBPE *file* and put it on your Dock or on your desktop.

To launch, double-click the WBPE *folder icon* (not the WheelBuilder.USR file)



Note, that compressing the files above into a single zip file upsets the the icon layout such that when subsequently unzipped, the files within the WBPE folder appear sorted alphabetically. You can leave them that way if you wish, just be sure to understand that WBPE is the programme file and WBPE.USR is the data file.

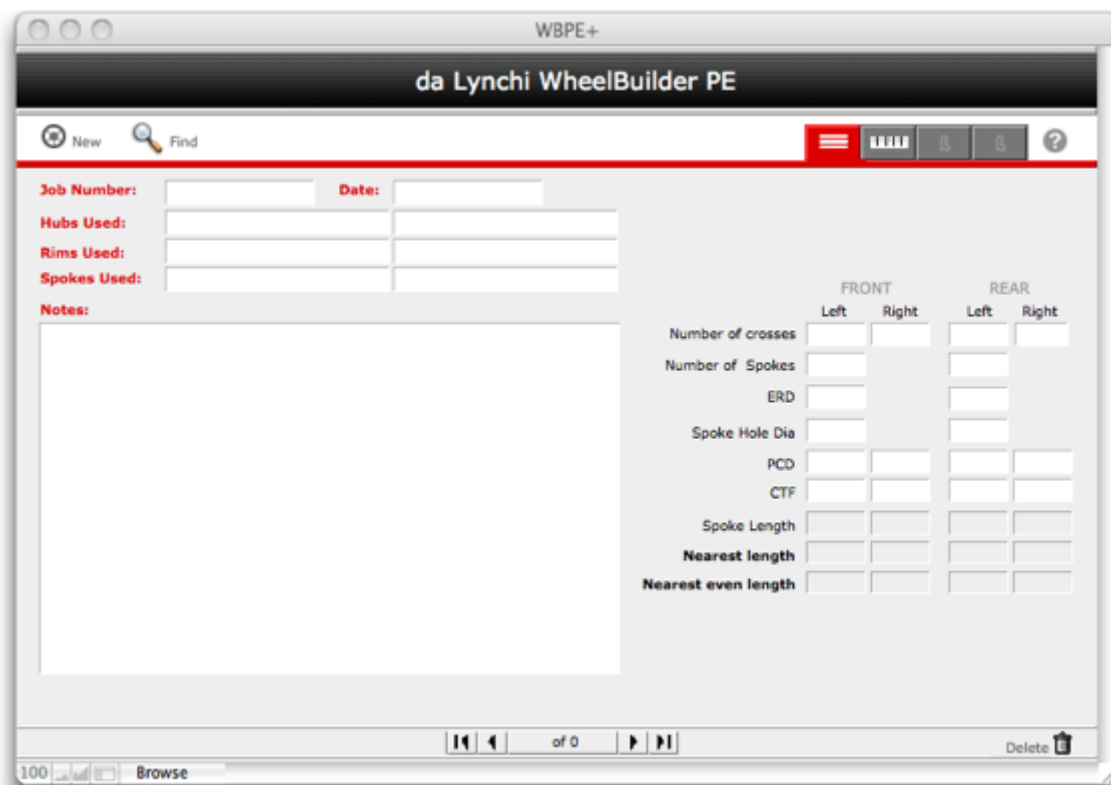
Minimum requirements

Mac OS X.2 or above, 50Mb free disk space, 512mb Ram.

Windows XP or above, 50Mb free disk space, 512mb Ram.

QUICK START

If you don't like reading manuals, just go straight ahead and create a new record.



- Click on the "New" button top left to create a new record.
- Fill in any details you want to record about the components you are going to use.
- Go to the Spoke Length Calculator on the right hand side of the window.
- Enter the number of crosses and the spoke count for either or both wheels.
- Enter the rim and hub measurements

Your spoke lengths are then calculated.

That's all there is to it really. You can use the notes field to record whatever you like about the wheel build went; how easy was it to source the components you used for example, or how the spoke lengths ended up in the finished wheel.

If you want to see an example, select "Create an Example" from the help menu.

If you have the components but don't know how to measure them, select "Measuring Components" from the help menu. (There's also a video available for download)

If you want to discover what "Post-build Numerical Analysis is all about, select that from the help menu too.

SPOKE LENGTH CALCULATOR (SLC)

NOTE: All spoke calculations are based upon 12mm nipples.

Front/Rear

These fields tell the Spoke Length Calculator (SLC) which wheels are being built. Either or both checkboxes must be enabled to activate the SLC.

Number of Crosses

These fields define the "lacing pattern" or number of times each spoke crosses another. You may only enter a single digit between zero and 4. Although not common on front wheels, different lacing patterns are possible on either side of either wheel. A rear wheel for example may have 2 or three crosses on the drive or right side and fewer crosses on the left side or even none at all known as "radial".

The number of Spokes

You may only enter a whole number between 18 and 40. If you leave this field empty it will be filled in for you if you choose a hub or a rim from the Parts List. A valid number must be present for the spoke length calculation to proceed.

ERD Provided

Effective Rim Diameter is a critical measurement where even minor variations can greatly affect the calculated spoke length. A figure for ERD Provided comes from the manufacturer's specifications and can only be entered by choosing a rim from the parts list. This field is write protected so you cannot enter anything manually or overwrite the automatic figure.

ERD

The Effective Rim Diameter expected by this spoke length calculator is the length between spoke ends when they sit just flush with the bottom of the slot in the nipple head. The figure provided by the manufacturer of your rim may or may not correspond with this. Sometimes they may specify NSD or Nipple Seat Diameter which is not the same thing. Always check as ERD has the most effect on the final result.

Spoke hole diameter

This is the diameter of the holes through which the spokes must pass in the hub flanges. If you are working with an unknown hub you should expect a number of approx 2.6mm. (Measure the diameter of a spoke that fits it nicely).

PCD

Pitch Circle Diameter is the diameter of an imaginary circle that passes through the centre of the spoke holes in the hub flanges. It is typically the same on both sides of a hub although the calculator allows for differences.

CTF

Centre to Flange is the distance from the centre of the hub to either flange. For a front hub the lengths are usually identical. For a rear hub they will be offset to take account of the drive sprockets.

Spoke Length

This field, which will only be displayed if all the parameters the calculation is based upon are present, shows the arithmetic length to two decimal places.

Nearest length

This field shows the arithmetic length rounded up or down to the nearest millimetre. You can use this value to source your spokes.

Nearest even length

This field shows the nearest even length spoke to the arithmetic length as sometimes even lengths are all that are available.

THE FOLLOW UP:

Build Tolerances:

This is your responsibility but if you are new to wheel building, you should try to achieve 0.2mm laterally, 0.5mm radially and 0.5mm either side for dishing (1mm total).

Job Number

Job Ticket using the Notes field and the fields about spoke lengths.

HUB, RIM, SPOKES

If you are only ever going to create a few records it doesn't really matter what you enter in these fields but if you want to search a large number of records, be consistent about what you enter. Try to adopt a consistent naming convention about your components otherwise you might have difficulty finding records.

Notes

The Notes field is simply a text area where you can write whatever you like, difficulties with placing nipples into a particular deep section rim for example, or how your preferred choice of hub turned out to be difficult to source in time available.

The recommended spoke lengths may prove difficult to source in the time you have available to complete the build. Make a note if you decide to adjust the recommended lengths by a small amount, usually no more than -1mm, if those lengths are more readily available.

There is no need to 'save' the Job Ticket, it is saved automatically. You can click the "New" button to return to the SLC and create a new build you wish to.



RADIAL, LATERAL AND SPOKE TENSION TABLES

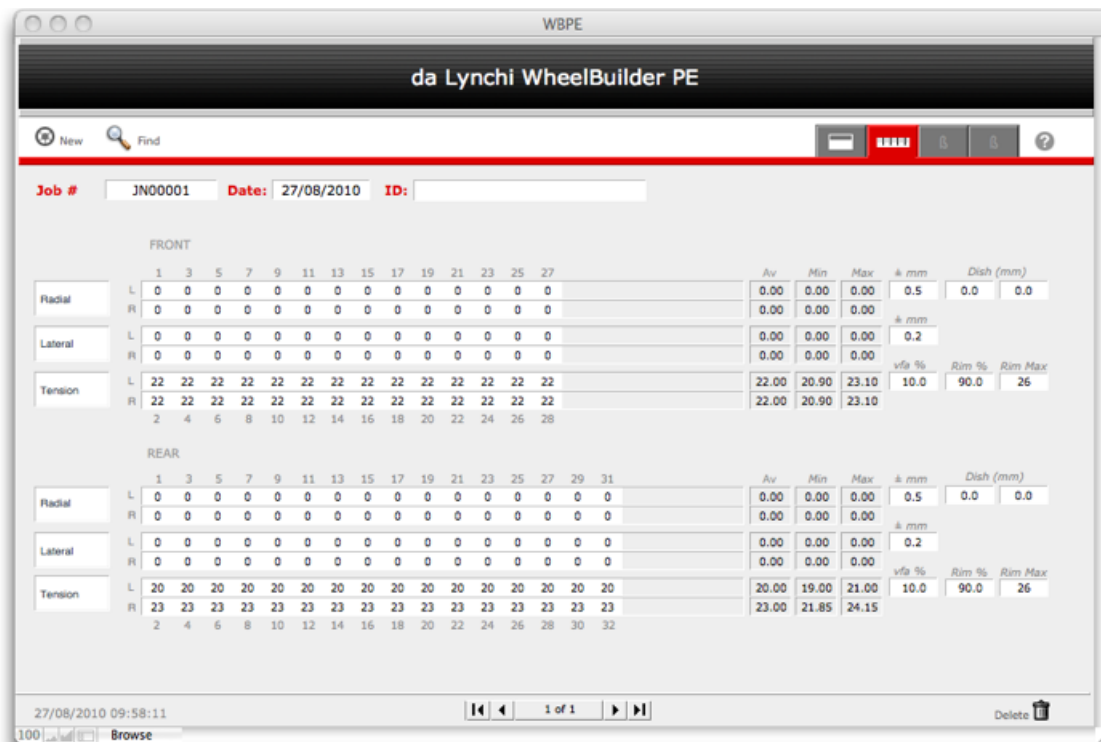
These tables are provided for wheel builders who use deflection and tension gauges and want a numerical record of their finished wheels. Recording these measurements is by no means essential for well built wheels and so the tables are placed out of normal view behind the main data entry window. They are brought into view with the ruler button.

The upper bank of tables is for the front wheel, the lower bank for the rear wheel. The upper row in each pair of rows is for the spokes on the left side the wheel, the lower row for the spokes on the right side of the wheel. Spokes are numbered with 1 as the spoke nearest to the valve hole in a clockwise direction viewed from the right side of the wheel. All the odd numbered spokes are on the upper row of each pair of rows and all the even numbered spokes on the lower. Always progress around the wheel starting from the valve hole and alternating between upper and lower cells.

Table 'cells' are greyed out for spoke numbers greater than number of spokes for each wheel. Do not use these cells. eg, for a 32 spoke wheel, spoke positions 33 to 40 will be greyed out indicating that you have 16 spokes on either side of the wheel.

Units

The Radial and Lateral tables are in millimetres plus and minus. For spoke tension you may enter the numbers from the deflection scale of your favourite spoke tension meter or a unit of force such as Kgf. Since the maximum spoke tension for most rims will be less than around 150kgf, the cells can comfortably accommodate three digits. Working in Newtons however will likely result in needing four digits, as 1Kgf is approx. 10 Newtons (9.0665). If your rim is specced in Newtons it is preferable to divide it by 10 and work in Kgf.



Range

How your measurements are displayed depends upon the tolerances you set for trueness and spoke tension. Cells that are outside your set tolerance will be shaded bright yellow. For trueness, set your tolerance in plus or minus millimetres remembering that $\pm 0.5\text{mm}$ is a total deviation of 1mm.

Even spoke tension throughout all spokes on each side is a characteristic of a well built wheel. It is common practice to tension all the spokes for each side of a wheel to be within a percentage range of the average tension of all the spokes on that side. Plus or minus 20% of the average is often quoted and this figure is automatically entered into the "via%" field for you. Change it to whatever you like if you want to but remember that the range is from minus that percentage to plus that percentage. 20% therefore is from minus 20% to plus 20% from the average which is a range of 40%. Spoke tensions outside the specified range will display with a bright yellow background.

Maximum Rim Tension

Tension spokes too far and the rim will deform way before any damage to the spoke occurs. Either its 'roundness' will suffer as flat spots develop or spoke tension can crack the rim at the spoke hole. Rim manufacturers therefore specify a maximum spoke tension and this can be entered into the "Rim Max" field. If the rim is specced in Newtons, divide the number by 10 and work in Kgf or extrapolate Newtons to the deflection reading on your Spoke Tension Meter. Do not mix units!

The Rim% field allows you to specify how close to this limit you wish to tension. eg, specifying '90' means no spoke should be tensioned beyond 90% of the maximum for that rim. Spoke tensions at or beyond this limit will display with bright red digits.

Because of the above, it is possible to see cells that are coloured with both a yellow background and red digits. This would indicate uneven spoke tension AND spokes that are too close to the maximum tension for the rim.

The objective is therefore to properly true and tension a wheel to your own specifications with no yellow or red cells in any of the tables.

VIEWS

All Wheelbuilder PE windows are designed to be viewed on screens with a resolution of 1024 x 768 or better although 1280 x 800 or better is recommended. Windows/PC views will look approx 20% bigger than the same view on a Macintosh computer due to their differing display architectures. You can also adjust your default display size in the 'View' menu item.



Data Entry: The Single Record button switches the view to the Data Entry view. The Data Entry view is the default view. As it's name implies, it's where you do most of the interaction with the programme, inputting data and calculating spoke lengths.



List View: The List View button switches the view to the List view. If you ever build a small number of wheels then list view isn't much of a benefit over the Data Entry view. But as the number of records in your databases increases, navigating through them becomes tedious in Data Entry view and so it is easier viewing multiple records together.

You can still edit the fields that are shown in List View but there are necessarily fewer fields displayed. However, you can also sort the records listed by clicking on and of the column headers. When you find a record of interest in the list, click into one of its fields and then click the red Data Entry View button to see that record's details.

New: Creates a new blank record

Find: Enters Find mode. You will be presented with what looks like a new blank record but in fact it's a window waiting for you to enter whatever you want to search for. Enter your search terms into the field or fields where you expect to find a match and hit return..

The body of records (if any) returned from a Find operation is known as the "Found Set" and is an important concept in database operations.

If no match is found, press the cancel button to return to the data entry view or re specify your search terms.

Delete: Deletes the current record. For safety, there is no facility to delete multiple or all records at the same time. If this is what you want to achieve, create an empty clone of your database instead using the "Save a Copy As ..." item in the File menu. If you want a selection of records in your new clone, make the selection in the original file using a suitable Find command, export them to a file and then import that file into your new clone.

Navigator: The tape/DVD-like icons in the Record Navigation bar are hopefully self evident, providing First, Last, Previous and Next functions. However, the record number indicator in the middle is also a button which, if clicked, presents a dialogue for you to enter a record number.

MENU ITEMS

Notice that many menu items have quick-key combinations assigned to them. These are key combinations that are often quicker to use than mousing up to a menu. The key combination of and the letter "p" (Ctrl + P on Windows) for example, starts the print dialogue.

FILE MENU

Page Set up

Selects which printer, page dimensions, scaling and paper orientation.

Print

The most important thing to remember about printing from a database is whether you want to print all the records you currently have selected (The Found Set), or just the single record that you are looking at. This is chosen during the Print dialogue so make sure to notice it or you might mistakenly print many records when you only wanted one.

Furthermore, in the limited environment of this database, the only printout that makes much sense is to print a list of previous wheel builds. Printing from the Data Entry view may not be of any great benefit if the Notes field contains more text than you would see on a printout. However, a version of the Data Entry window is provided in order to accommodate the post-build measurement tables should you wish to use it. If you are in the Data Entry screen when you choose the Print option, you will print this version of the Data Entry screen. If you are in List view, you will print the List view report. Neither of these printouts are customisable.

Import Records ...

Imports the contents of a file. You will be presented with a dialogue to locate the file to import. Once imported, the records in the import file become the Found Set. See Appendix A for the field order

Export Records ...

Exports the contents of each field in each record of the Found Set. You will be presented with a dialogue to decide on a file name, location and format. Export as an Excel file to export with field names. See Appendix A for the field order.

Save a Copy As ...

There are three options to backing up your current data file to a different location. The data file is the one named WBPE.USR. You can save a copy, a compacted (smaller) copy or create a new empty data file (Clone).

Back up your database frequently.

EDIT MENU

Which items in the Edit menu are active at any one time depends upon what is highlighted / selected at that time.

Undo

The Undo menu changes according to whether there is actually anything to undo. If you have edited some text for example, the Undo menu will say "Undo Typing". If you have made a format change, the Undo menu will say "Undo Formatting". Undo is once-only opportunity to reverse your last action and that last action only. Once you make another change, you can no longer reverse any previous alterations.

Cut

Deletes whatever is the active selection whilst leaving a copy of it on the Clipboard.

Copy

Copies whatever is the active selection to the Clipboard.

Paste

Pastes the contents of the Clipboard to the current location.

Clear

Deletes whatever is the active selection without leaving a copy of it on the Clipboard.

Select All

Selects everything within the active field (the field in which is the cursor).

Find/Replace

As in a word processing application, you can find and replace data across multiple fields (including related fields) in a record or across a found set of records.

Spelling

Check the spelling of text in a selected word or passage in a field, the visible fields in the current record only or the visible fields in all records in the current found set.

Export Field Contents

Exports the contents of a single field in the active record to a new file.

FORMAT MENU

The format menu behaves just as is other programmes and as you would expect provided that you have some text selected. The one difference however is that your changes will affect only the selected text in only the current record.

Font

-

Size

-

Style

-

Align Text

-

Line Spacing

-

Text Colour

-

You can also access Font, Size, Style and Text Colour with a right-click into a field (ctrl-click).

RECORDS MENU

- New Record** Create a new blank record. The 'New' Button does the same thing.
- Duplicate Record** Makes an exact copy of the current record.
- Delete Record** Deletes the current record
- Go To Record** The record number specified becomes the current record.
- Show All Records** If a sub set of all records is the Found Set, this command ensures that all records in the database becomes the Found Set.
- Unsort** Restores the records in the current Found Set to their creation order (the order in which they were entered in the file).
- Replace Field Contents** Replaces the contents of the same field the entire found set with the contents of the field the insertion marker is in. So use it with caution!
- Note:** You can sort records in ascending or descending order of any field by right clicking into it (ctrl-click).

VIEW MENU

When first installed WBPE will display at medium size. You can change this to your preferred size and it will be remembered when you next relaunch it.

- Small** Windows are adjusted to 430 x 680 pixels
- Medium** Windows are adjusted to 514 x 735 pixels
- Large** Windows are adjusted to 612 x 914 pixels

HELP MENU

"In-app" sections of this manual are available including

"Using WheelBuilder PE"

"Measuring Components"

"Post-build Numerical Analysis"

In addition you have the option to create an example record with dummy data. To enter example data for the Post-build Numerical Analysis, select that Help option and click the word "Example" on the top right of the page.

Upgrades / Updates

Select "About" in the Help menu and then click "Check for Updates". This will open a web browser window at the WBPE downloads page.

Choose "import" in the file menu of the new database and select the old database to import records from.

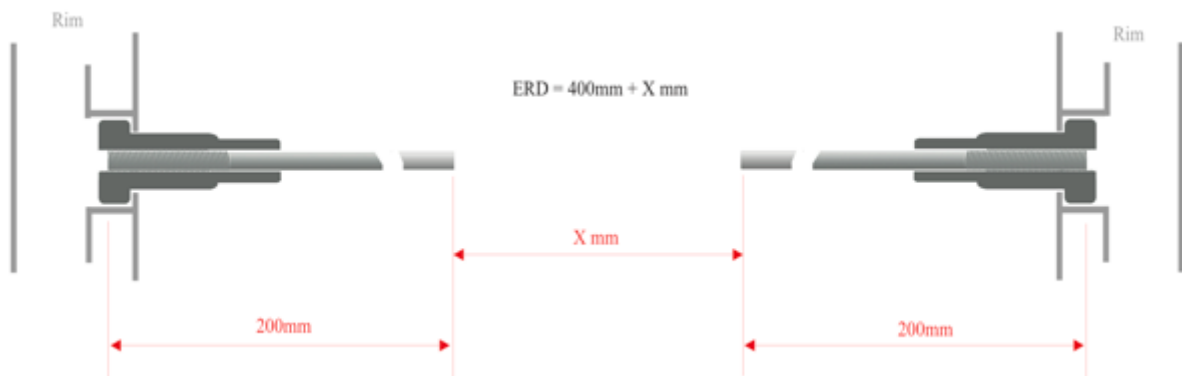
MEASUREMENTS

THE RIM

Measuring something as simple as the diameter of a wheel rim can be a surprising complicated affair in practice. The outer edges? The inner surface? From the top of the nipple? And how do you actually get your ruler into the right place? Roger Musson, (<http://www.wheelpro.co.uk>) in his book 'The Professional Guide to Wheel Building' solves this problem in the simplest of ways.

He recommends bonding a couple of 200mm lengths of spokes to nipples such that the threaded end of the spokes sit just flush with the bottom of the slot in the nipple head. (This is precisely where you want your spoke ends to finish up once the wheel has been properly trued and tensioned)

You then thread each 200mm spoke through opposite spoke holes in the rim and measure the length of the gap between them. The Effective Rim Diameter is then 400mm plus the gap length. Do this several times and average the results.



It is good practice to do this every time you build a wheel! Even if you have the rim manufacturer's ERD figure to hand, measure it yourself to be sure that what they are referring to as ERD is what you actually measure. If there's a difference, use your own measurement. (Sometimes manufacturers specify the Nipple Seat Diameter (NSD) whereas the calculations here expect the ERD to mean the distance to the spoke ends as described above.) This might only mean a difference of a millimetre or two but this is the most critical measurement of all. Small differences in ERD can lead to significant differences in spoke length. So measure it as described and believe your own figures!

THE HUB

Pitch Circle Diameter (PCD)

The PCD is the diameter of the circle that passes through the centre of the spoke holes. It may be different for left and right flanges. It is usually between 38mm and 67mm and is a critical measurement so make several measurements and average the results.

Spoke Hole Diameter (SHD or ϕ)

SHD is the diameter of each spoke hole, usually 2.6mm

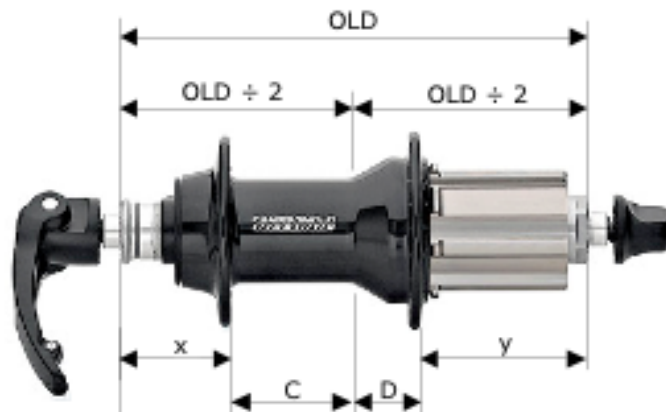


Over Lock Dimension (OLD)

OLD is the distance between the outside flats of the lock nuts and corresponds to the frame gaps front and rear. Note that the axle itself protrudes some way beyond the OLD so as to engage with the drop outs. Half the OLD equates to the centre line of the hub.

Centre to Left Flange and Centre to Right Flange

Clf and Clr are the two other important measurements. They are not measured directly as it's impossible to judge the centre line of the hub by eye.



Instead the dimensions x and y are measured and subtracted from half the OLD to provide C and D respectively. The measurements can be made by removing the Quick Release if attached and dropping each side of the hub into a hole in a flat surface just big enough for the axle width. The distance from the flat surface to the flange can then be taken with a ruler. Holding the flat face of the over lock nut against a good straight edge of a desk or table can also be useful.

Note that spoke lengths need to be calculated for EACH flange on each hub, front and rear. Front non-disc hubs will probably have equal length spokes on both left and right flanges. Rear hubs that carry the drive mechanism such as a cassette will have different length spokes on the left flange (the "non-drive" side) to the length of spokes on the right side (the "drive" side).

NIPPLES

Note, all WheelBuilder PE spoke length calculations are based upon the use of 12mm nipples. If you use different lengths you will need to compensate for this by adjusting the spoke lengths recommended by WBPE.

A simple method to determine a compensation to apply for a longer nipple is to screw both a 12mm and the longer nipple each all the way on to separate spokes. The difference in the length of the threaded end of the spoke protruding from the head of the nipple is the amount that you need to SUBTRACT from the spoke lengths given by WBPE.

Longer DT Swiss nipples may need special consideration.

APPENDIX A - RECORD EXPORT / IMPORT FIELD ORDER

When records are exported, the relevant WBPE database fields are exported to a plain text file in the following order. Likewise when importing data into WBPE, you must arrange that fields are placed in this order.

Job Number
Date
Number of spokes in the front wheel
Number of spokes in the rear wheel
Lacing pattern of the left side of the front wheel
Lacing pattern of the right side of the front wheel
Lacing pattern of the left side of the rear wheel
Lacing pattern of the right side of the rear wheel
ERD measured on the front rim
ERD measured on the rear rim
OLD Over Locknut Dimension, front
OLD Over Locknut Dimension, rear
Spoke hole diameter on the front hub flanges
Spoke hole diameter on the rear hub flanges
Front hub centre to left flange offset
Front hub centre to right flange offset
Rear hub centre to left flange offset
Rear hub centre to right flange offset
Front hub left Pitch Circle Diameter
Front hub right Pitch Circle Diameter
Rear hub left Pitch Circle Diameter
Rear hub right Pitch Circle Diameter
Front left spoke length exact
Front right spoke length exact
Rear left spoke length exact
Rear right spoke length exact
Front left spoke length nearest whole number
Front right spoke length nearest whole number
Rear left spoke length nearest whole number
Rear right spoke length nearest whole number
Front left spoke length nearest even number
Front right spoke length nearest even number
Rear left spoke length nearest even number
Rear right spoke length nearest even number
Build notes
Front hub used
Rear hub used
Front rim used
Rear rim used
Front spokes used
Rear spokes used
STFL Spoke Tensions Front Left
STFR Spoke Tensions Front Right
STRL Spoke Tensions Rear Left
STRR Spoke Tensions Rear Right
Time stamp

APPENDIX B - RECOVERING DAMAGED FILES

Power failures, hardware problems, or other factors can damage a database file. It is always good practice to make back up copies of your important data. You can do this by copying just the file WBE.USR, or the whole WBPE folder, to a safe backup location. If suspect that your database has become damaged, you will need to run the recovery process on it. (You can think of the WBPE file, the one with the folder icon, as the 'programme' or application and the WBPE.USR file as the 'Data' file). Data corruption would occur in the .USR file not the programme file)

To recover a damaged file:

On Windows machines press Ctrl+Shift while double-clicking the application icon. Keep the keys held down until you see the Open Damaged File window.

On Mac OS X machines press ⌘-Option while double-clicking the application icon. Keep the keys held down until you see the Open Damaged File window.

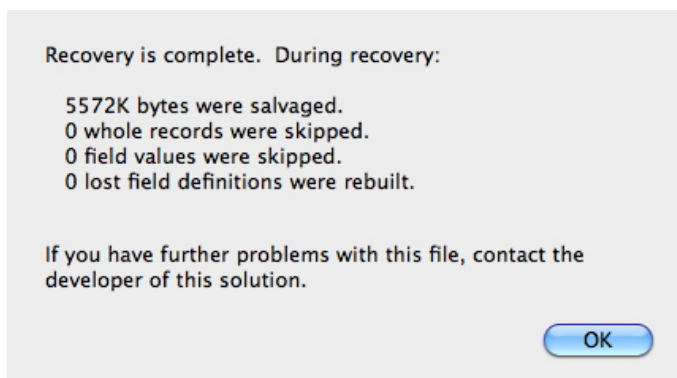
Select the suspect data file and click open

The recovery process ... creates a new database file

renames the suspect file by adding Old to the end of the filename (WPE Old.USR)

gives the repaired file the original name (WPE.USR)

Tells you what it did ...



If you experience unusual behavior in the recovered database you should revert to a backup copy that was made before the file became corrupt, or

1. Recover the damaged solution file using the method described above.
2. Open the recovered file.
3. Choose File menu > Save a Copy As.
4. In the dialog box, choose compacted copy (smaller) from the Save a (Windows) or Type (Mac OS X) drop-down list, name the file, and click Save. Give the compacted file the same filename as the original file.
5. Make a clone of the original database and import the data from the recovered file into it.

SPECIAL THANKS

<http://www.wheelpro.co.uk>: Roger Musson is a professional wheel builder. His eBook, 'The Professional Guide to Wheel Building', 5th Edition is packed with practical advice and is a bargain at just £9 /\$14. It's a simple download from his web site and is must read for anyone interested in wheel building. Do nothing further until you have bought it and read it several times!

<http://www.sigmasport.co.uk>: Thanks to the workshop guys at Sigma Sport in Hampton Wick for bringing some reality into my flights of fancy!

ACKNOWLEDGEMENTS

Any internet search associated with wheel building / truing will present a number of choices for spoke length calculation. The following are perhaps the most popular ...

<http://www.dtswiss.com>:

<http://www.sapim.com>:

<http://www.sheldonbrown.com>: No one can even mention bicycles without visiting this famous fount of knowledge. He has links to a number of spoke length calculators too.

<http://en.wikipedia.org/wiki/Wheelbuilding>: The famous on-line encyclopaedia has a section on wheel building including an explanation of the geometry involved in the spoke length calculation.

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