WinCELL

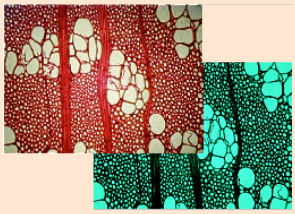
WinCELL is an image analysis system specifically designed for wood cells analysis. It can quantify the changes in wood structure over annual rings.

Anatomical wood cell analysis is an alternative to wood density analysis with x-rays (as done with WinDENDRO). Wood density, color, mechanical and chemical properties are in effect related to wood structure which in turns is related to climate. By measuring the radial cells (tracheids) size, distribution and their proportion to walls, wood quality can be assessed.
WinCELL measures wood cell morphology on thin wood slices cut with a microtome or, for larger cells like earlywood vessels of deciduous species, directly on wood surfaces*. Wood cells morphological data can be measured per annual ring in one or more images per ring with the aid of XLCell, a companion program for data post-processing and visualization.
Image analysers not made specifically for wood cells measurement are not usually able to produce data suited for dendrochronology studies. These systems lack some knowledge about annual tree rings formation and the structure of their cells (to compute the ring width for example) so they don't know how measurements are done in this field. WinCELL has this kind of know-how built-in. It knows, for example, that a wall between two adjacent cells must be split in two to compute the cells length and earlywood or ring width. Its versatile settings allow to analyse different wood species (vessels of deciduous and radial row of conifer tracheids). It supports different automatic and interactive analysis modes. The latter allows you to select rows of cells to analyse them in a way that mimics the traditional trachedoid** method. WinCELL handles incomplete cells, those truncated by image boundary, so that they have no effects on the average cell measurements.

*With proper image acquisition device and sample preparation.
**Tracheidograms are curves of radial cell size variations in function of position in an annual ring.

IMAGE ACQUISITION

Recent developments in high-quality affordable digital cameras have made anatomical wood cell analysis more accessible than ever.



SAMPLE PREPARATION

Wood cell analysis is usually done on thin wood slices cut with a microtome from core segments. Staining is sometime used to enhance lumen-wall contrasts. With proper preparation and optics, the larger vessels can be analysed directly from wood surfaces.

MICROSCOPE

To acquire images of microtomed samples, a microscope with a receptacle tube for a camera attachment and a C-mount adapter (sold by microscope manufacturers) is required.

CAMERA

WinCELL can analyse images acquired with digital or analog video cameras. The models sold by Regent Instruments are of scientific quality grade and have a standard C-mount thread which allows them to be installed on a microscope. We sell three models ranging from 1 to 6 Megapixels (millions of pixels). These cameras can also be placed directly above a piece of wood (with optional lenses). WinCELL can also acquire images from optical scanners when the sample surface is well prepared to analyse larger cells (vessels) from such images (please inquire about conditions before purchasing). Cameras sold by Regent can be interfaced to computers via a fast Firewire (IEEE-1394) or USB2.0 connection. WinCELL is TWAIN compatible, meaning it can acquire images from many camera or scanner models.

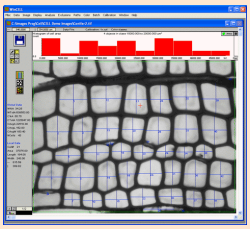


IMAGE ACQUISITION FROM WinCELL

Simply click an icon in WinCELL's window and it starts displaying images live (or semi-live depending on the camera model) on the computer screen while you adjust the microscope or the sample position. You can also set the image parameters (size, color, filtering) while the image is displayed. To digitize and analyze the image, simply click a button in the camera interface window.

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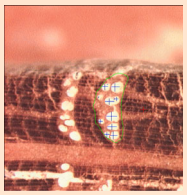
WinCELL Measurements

Cells morphology can be done by different methods; automatically, semi-automatically or manually (interactively).

Region of analysis

The first step for analysing a sample is to choose the region to analyse. All versions can only analyse the whole image while the Pro version can also analyse regions of any shape.

WinCELL Pro can analyse regions of any shape. In the example to the right, an analysed region (outlined in green) has been created to analyse only the earlywood vessels belonging to a particular annual ring. Such regions are created easily simply by outlining them in the image. Commands are provided to rapidly and easily create rectangular and circular analysed regions.



Lumen and wall area

Lumen area is measured automatically and is a true measure of the area (based on the number of pixels contained within), not an estimation from its diameter. Lumen can be separated into cells and vessels groups based on their area. Those larger than a value you specify are classified as vessels and those smaller are classified as cells and both groups are analysed separately (you get global and individual data for both of them). You can also change the classification of a cell or vessel simply by pressing a keyboard key and clicking the object to reclassify.

Wall area is computed automatically by counting the area of pixels classified as belonging to walls in the analysed region.

Lumen and wall area are available as total values for the analysed region (in measurement units and in percentage of the analysed region area). Lumen area is also available on a per cell or vessel basis in the individual analysis data.

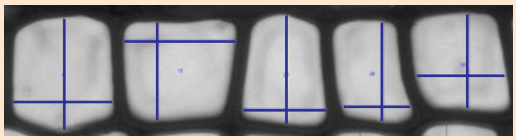
Lumen Area in function of color

In addition to cell and wall areas, the Pro version can also measure the lumen and wall area in function of their color, globally for the analysed region or individually (per cell).

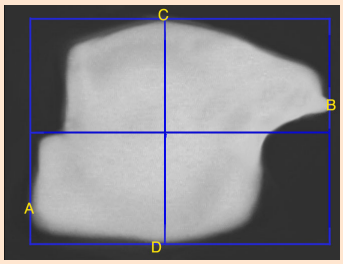
Tracheid length and width

Tracheid length and width (or radial and longitudinal diameters) can be computed by 4 different methods:

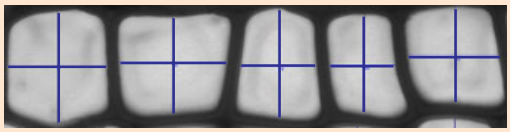
Maximum (Horizontal & Vertical)



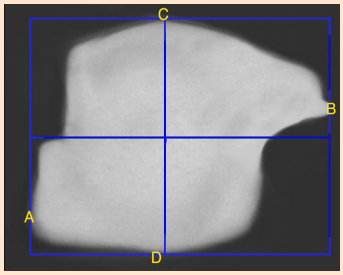
With the **Maximum (Horizontal & Vertical)** method, length is measured as the horizontal distance between the two farthest cell boundary points of same vertical position. For example, in the image on the right, the length measured is the distance between point **A** and point **B**, which are on the same vertical position. The width is the vertical distance between point **C** and point **D**, which are on the same horizontal position



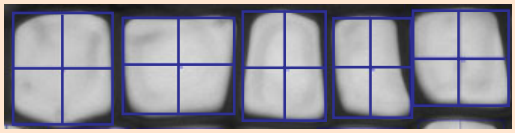
Center (Horizontal & Vertical)



With the **Centre (Horizontal & Vertical)** method, length and width are measured as the horizontal and vertical size of the cell in its centre of gravity position. Length is the horizontal distance between **A** and **B** at the same vertical position and width is the vertical distance between **C** and **D** at the same horizontal position.

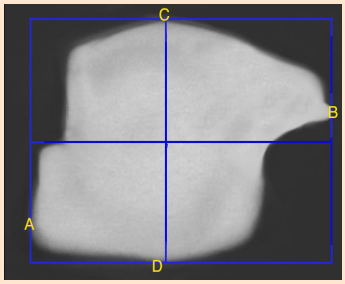


Bounding Box (Horizontal & Vertical)

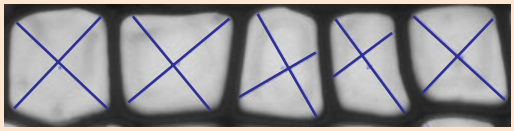


With the **Bounding box (Horizontal & Vertical)** method, length and width are measured as the horizontal and vertical size of the bounding rectangle that encompasses the cell. The bounding box on the right is delimited by points **A**, **B**, **C** and **D**.

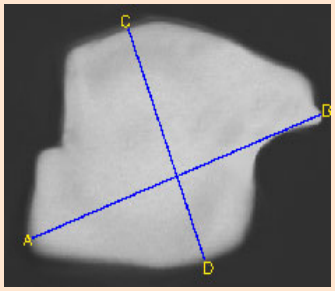
Unlike the Maximum and the Centre methods, **A** and **B** doesn't have to be at the same vertical position and **C** and **D** doesn't have to be at the same horizontal position.



Any direction



With the **Any direction** method, length is the distance between the two points on the cell boundary that are the farthest apart (**A** and **B**). The automatic width is measured perpendicular to the automatic length at the position where the width measurement is the largest (**C** and **D**). This method is very general in the sense that it can analyse any object and the returned length will always be in the objects main axis direction. Walls are not calculated in this method.



Tracheids length and width are available as average values for the analysed region and individually per cell and vessel.

Cell position

Cells centre position can be measured in the image and relative to the annual ring beginning. The latter allows to compute statistics about cell structural parameters distribution in function of position on annual rings.

Number of tracheids (cells and vessels)

Cells and vessels in the analysed region or on traced paths (see below) are automatically counted.

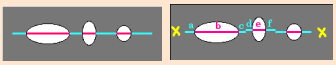
Automatic vs Interactive Measurement Method

The above mentioned morphological measurements can be computed automatically on all cells present in the analysed region or on selected cells via interactive measurements. In automatic mode, all you have to do is click the image or trace the outline of the region to analyse and cells included in that region will be analysed. In interactive mode, you simply draw a line across the cells to measure. The latter is typically used to analyse radial cell rows (rows of cells which position relative to a ring boundary are known).

The interactive measurement mode has four settings

In completely manual mode, no image analysis is done. This mode is provided to measure any object manually simply by clicking at its ends. It can be used to measure a cell length or as illustrated to the right, fibres length. Straight objects can be measured with two mouse clicks at their ends while curved objects can be measured with additional mouse clicks at inflection points along their curvature. Another manual mode is provided to measure an object length and width in pair (which can later be used to estimate its area). The latter can be used to measure cells which don't have enough contrast for the automatic analysis.

Two semi-automatic measurement modes allow to measure cells length and their two adjacent walls thickness (on opposite sides of the lumen). With one method this is done in the traced direction while with the other this is done in the radial direction.

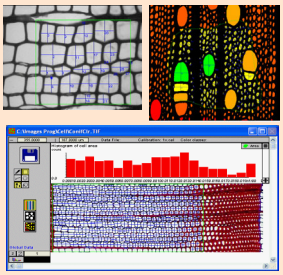


These two semi-automatic measurement modes also produce the length of radial cell rows (between annual ring boundaries to get ring width).

WinCELL Features

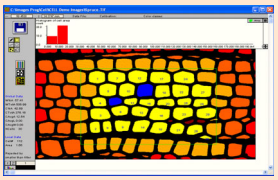
Pro version: Regions of any shape can be analysed. Rectangular and circular regions are pre-defined or you can use the lasso tool to create a region of any irregular shape. Once a region is created it can be resized and the analysis is updated automatically.

Regions can be used to analyse different part of an image separately (like the earlywood of the image to the right).

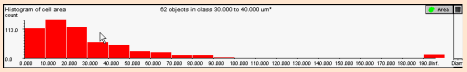


WinCELL uses the concept of analyzed region in order to reject incomplete cells. Cells touching the image boundary or located outside the analyzed region are not considered when computing average cell measurements (area, length and width).

The color used to draw a cell indicates its classification (truncated by image boundary, partially or completely outside or inside the analysed region, rejected by operator, debris, cell type between cell or vessel).



Measurements data are available interactively during the analysis and in text files that can be read by many software programs. These files are easily opened and visualized in spreadsheet style programs like Microsoft Excel. You can also click a cell to display its morphological measurement data. The cells distribution histogram, visible during the analysis or after in XLCell, also presents a global view of the cell structure parameters.



The cells distribution histogram displays the number of cells in function of area, length or width and for the Pro version the area in function of color.

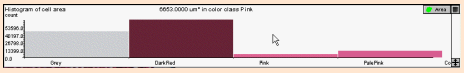
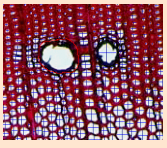


Image edition allows to compensate for defects or poor contrast (for example in latewood cells where the lumen is often darker).

Images can be edited with any color. It is easy to select a color present in the image and edit with it. A pen (to draw lines) and a lasso tool (to fill outlined regions) are provided for edition.

Pro version: Defects or regions you do not wish to be analysed can be excluded by outlining them with Exclusion Regions or by editing the image. Exclusion Regions can have any shape.



WinCELL can analyse grey levels or color images (our cameras produce both kinds). The Pro version can do more analyses on color images. It can display and analyse one of the three color channels of a color image, use the color content to better classify the pixels into lumen and wall or quantify area in function of color.

Calibration procedures are built-in and easy to perform with targets sold by microscope manufacturers. Different target models are supported.

Debris can be automatically filtered out by size, color or manually by editing the images.

Original images acquired from WinCELL, analysed or not can be saved in standard tiff or bmp files for opening in other application programs (MS Word, Photoshop...).

Batch processing is provided to analyse a series of images without operator supervision. This analysis mode works only for analyses that can be done automatically (non-interactively).

It is possible to store the analysis settings in configuration files for retrieving and reutilizing at a later time.

You can choose which data types are saved.

WinCELL can also be used as a general area meter (to measure leaf area for example) or a morphology analyser for other objects by modifying some of its default settings.

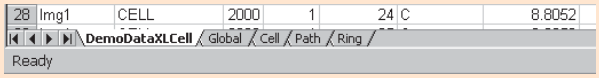
WinCELL Regular software comes for FREE when you buy WinDENDRO (Reg or Density).

XLCELL

Data post-processing and visualization companion software for WinCE*LL*

XLCell is a utility program written in VBA (Visual Basic Application) for Microsoft Excel. It allows to reclassify and visualize data produced by WinCELL.

It can separate measurements data into different sheets as a function of their type (global, individual cells, interactive paths, annual ring) for one or many images.

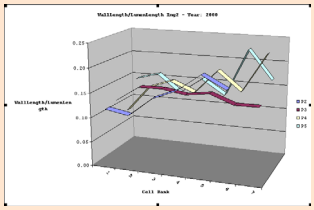


XLCell can merge sample data that has been analyzed in more than one image.

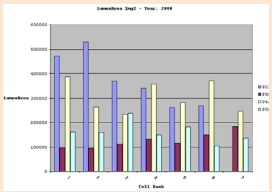
Sometimes a ring is too large or the camera resolution is too low to be digitized in a single image. A command is provided to merge the measurement data of an annual ring split into two or more images as if it was acquired as one.

XLCell can graphically display different measurements for visualization or validation.

Cell's morphological measurements can easily be visualized graphically.



Wall Length to Lumen Length ratio for cells of five image paths (for 1 image)



Lumen area for cells of five image paths (for 1 image)

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