Valve Lift Designer Instructions.

This program uses Splines to generate the lift curve, with this approach it is fairly easy to copy any measured Cam lift curve and then modify it.

Splines aren’t as limited as the more common Polynomial curve approach and with Splines it’s easy to design an asymmetric lift profile. With the adjustable 2 stage smoothing function it’s also easy to get low Jerk values without compromising the lift curve.

The colors on the design Page are:

- Red: Lift curve.
- Green: Velocity, $1^{st}$ derivative.
- Blue: Acceleration, $2^{nd}$ derivative.
- Orange: Jerk, $3^{rd}$ derivative.

The left picture shows an unsmoothed curve and the right one uses 5 primary and 50 in secondary smoothing.

If a lift curve is smoothed more than necessary it will compromise engine performance, particularly because of the less aggressive lift curve transition from Ramp to Flank the smoothing produces.

The Program works in Valve lifts and Camshaft degrees.

This means that lift measurements taken directly of a Cam as it normally would be, have to be multiplied by the Rocker arm ratio (multiplier available in the Cam Explorer and the 3 Comparison Cam) before further work is done.

Exceptions are the “Duration Calc” and the “Cam report” pages.

On these pages the Camshaft degrees are converted to Crankshaft degrees.
The opening Page sets up the measurement units, loads / saves Cam designs and have a lift curve wizard.

The curve wizard can either be used for generating a new lobe from scratch, or for approximating a curve to best fit a measured cam lobe before doing the fine adjustments on the design page.

A lift curve generated from 15 deg ramp, 160 deg duration, 10mm lift and 13 control points.

Green line is the Duration span, the Camshaft duration in degrees excluding the opening and closing ramps.

Yellow lines are the opening and closing ramps, normal ramp lengths are 15-20 degrees. For a hydraulic Cam design the ramp height should be set to 0.02mm and a length of 10 degrees.

If a ramp that is not of the constant velocity type is desired, it can be designed by using some extra control points for it and setting ramp numbers like the hydraulic Cam.

Blue line indicates the high lift point. White crosses are the control points.
Jerk should not exceed 0.005 to 0.010 mm/deg - 0.0002 to 0.0004 in/deg for pushrod engines.

Directly opened valve trains (OHC, flathead) can use values of 0.010 to 0.020 mm/deg - 0.0004 to 0.0008 in/deg for Jerk.
After designing a new lobe, all the values are displayed on this Page.

If lift data from the designed Cam is to be used in one of the comparison Cam windows, the procedure is to right Mouse click in the leftmost “Lift data” window, then left click “Select all” so the column turns blue, next right Mouse click again and left click “Copy”.

Then open one of the comparison Cam Pages, right click in the “paste raw Lift Data” window and then left click “Paste” to fill it with the lift values.

For the Valve area function there are input fields for “Valve number”, “Valve diameter” and “Valve seat width”.

For “Area under curve” calculations there is the “Valve tolerance for area calc.” input field. The area will be calculated from the curve with the tolerance value deducted from the Lift.

“Kld factor” is the Gordon Blair Cam intensity number method.

“Base Circle Diameter” is only used to draw the Cam shape. “Tappet diam. Safety value” is deducted from the Tappet diameter to provide a safe value for max. Velocity.

“Tappet diameter” is used to calculate the max. Velocity for the Cam. This value is saved in the Cam file with the Lift and Duration numbers.
On this Page the different duration values from the Design Page and the 3 comparison Cams can be evaluated.

**Attention! The degree values on this page are in Crankshaft degrees.**

“Dist down from max. Lift point” is the same as when you zero the dial gauge at the top lift point of the valve and goes this distance down in valve lift on both sides of the Cam to find the center line point of the Cam.

“Valve clearance” for duration calc.” eg. 1.00mm - 1.27mm - 0.050” for the industry std. values.

“Safety check Degree spec.” the Crank degree value for checking before TDC (exhaust) and after TDC (intake) piston to valve distance.
The 3 comparison Cam pages are where the numbers from measured Cams are pasted in the leftmost window.

A manually measured Cam will normally need medium smoothing for especially Acceleration and jerk curves to be usable. On data taken from the design report page the smoothing value should normally be set to 0.

Text files loaded from the disk are placed directly in the lift per cam degree window, but will still need smoothing if coming from a manually measured Cam. The text file saved to disk comes from the same lift per cam degree window so it has none of the smoothing included.

Procedure with a manually measured Cam is to paste the lift values in the leftmost window, then select the correct number of degrees between the lift points and press the “Generate Lift per Degree” Button to fill the “Lift per Cam Degree” window. Last you select the appropriate smoothing value and click the “Generate smooth Lift ……” button.

The Clear All button clears all 6 windows of data.
Compare the designed profile from the “Design Page” with one of the 3 comparison Cam profiles.

The 2 zoom buttons are used to zoom in on the opening and closing ramps.
This page controls the Cam measuring machine interface and export of Cam designs.

The interface is based on a Stepper motor to turn the Cam in 1 degree steps and a Mitutoyo indicator to measure the lift.

First step is to open communication with the Control Box via the USB cable connection. This is done by selecting the correct Com Port number in the text window, then press the “Open Com port” Button, if the “Port status” symbol does not turn green then the Port is not opened correctly.

The procedure to zero set the Indicator reading on the Cams basecircle is to first press “Get Measurement” to get the actual value from the Indicator, then press “Zero set Indicator” to correct this to be 0.0. A press on “Clear Text” will then clear the 2 text windows and reset the degree counter.

To set up the start position of the Cam there are several ways to do this. First the rotation direction must be selected, Clockwise is the default choice, to select counter clockwise press the “Clockwise rotation” Button and it will display “Counter clockwise rotation”. To turn the Cam by Hand press “Release” this frees the Stepper motors lock. Remember to press “Lock” otherwise the motor will not engage. Also the “1 Deg. rotation” and the “10 Deg. rotation” Buttons can be used fine adjust the Cam position.

To start the measuring run, press the “Start 360 Deg. rotation” Button. This run can be stopped and restarted by the two corresponding Buttons.

After the measuring run, the Data can be transferred to the chosen comparison Cam number by the “Cam 1”, “Cam 2” or “Cam 3” Buttons.

The 2 columns on the right receives the lift data from the “Design report Page” when a Cam design is generated.

There are 2 options to save the lift files, with or without a leading degree count.

It is also possible to transfer the Lift data to the 3 comparison Cam windows.
Cam report and Cam Card Page.

Generate and Print Cam data report and/or a Cam specification Card.

Your own Logo can be loaded for the Cam Card.
Static Valve Spring Calculator.

Show Graph with static calculated Valve spring pressure curve contra Cam acceleration curve.

Input weights of the different moving components in the Valve train.

Valve spring installed height closing force and the kg force per mm compression in the Springs working range.

Static calculations like this are only intended to be a guidance, but the example above is based on Honda cbr600rr data and corresponds nicely with our real world experience where 16.500 Rpm is no problem.
Calculates the Harmonics of the Camshaft from Acceleration or jerk data.
Under development.