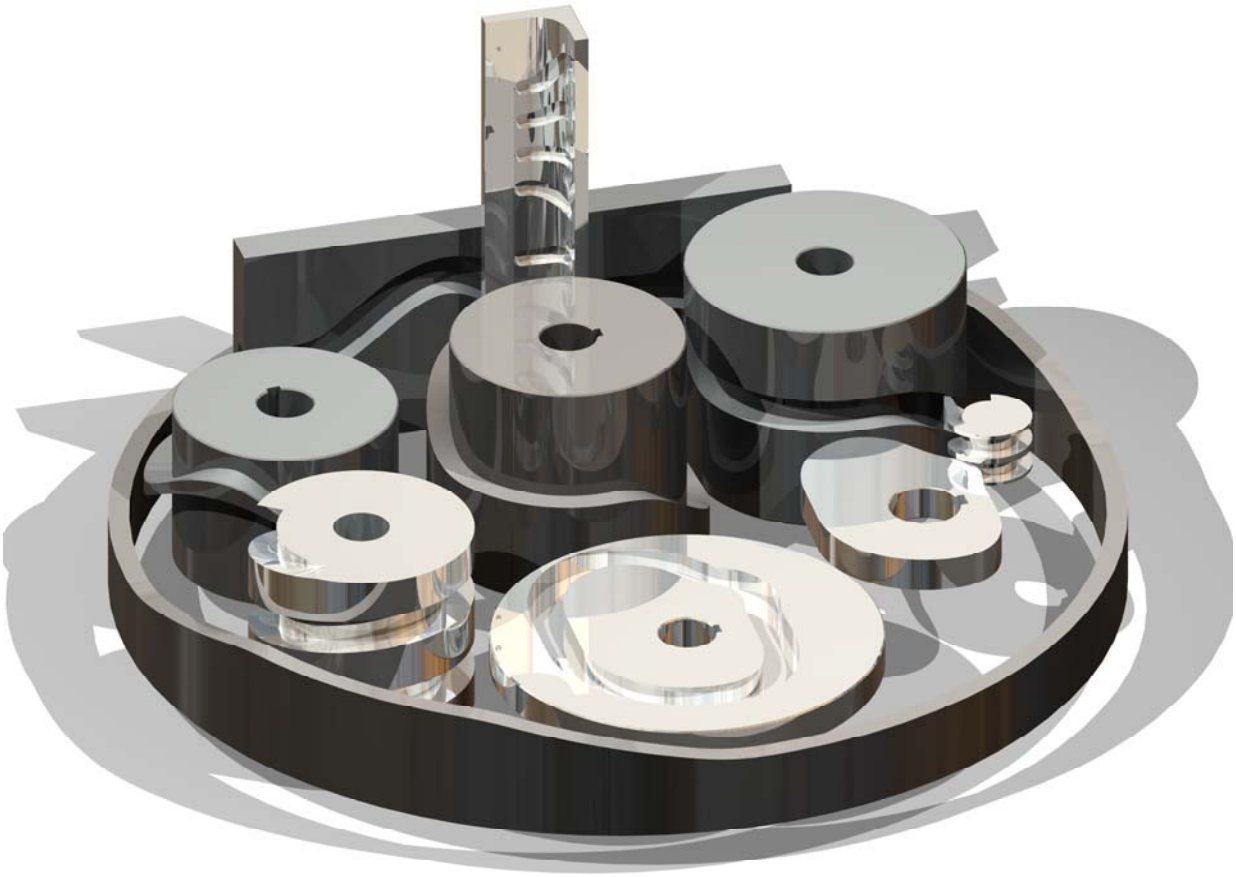
CamTrax64



Camnetics
INCORPORATED

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Introduction

CamTrax64 is an object oriented/property driven cam design program. It is not the intent of CamTrax64 to replace your CAD system but to augment the CAD system with a user interface that will allow the cam designer to accurately visualize the cam components before they are modeled in the CAD system.

A CamTrax64 base component is either a cylinder or a cube. A cylinder can have paths inserted on both ends and/or the cylindrical surface. A cube can have paths inserted on the upper or lower surface. Each path has a single cam follower. This follower can be translating or oscillating. A path may also be a dual follower (two cam followers of the same diameter) so a ridge is created along the centerline of the path.

A path may also be conjugate to another path (master). The conjugate path may have a follower of a different diameter than the master path.

CamTrax64 is programmed in the USA using 100% renewable energy.

Definitions:

CAD

CAD (Computer Aided Design) is the system this program was compiled to run with, either as an add-in or an add-on.

Component

A component is a single CamTrax64 cam base object, a cube or cylinder.

Part

A part is a single CAD part document file that contains one cam base object and one or more cam paths.

Assembly

An assembly is a group of CamTrax64 components or a group of CAD parts.

Annotation

An annotation is a text or Excel note placed on the CAD part or drawing document.

Model

A model is a CAD part document.

Cam

A cam is a cylinder or cube that contains one or more paths.

Path

A path is a groove or ridge (in the case of dual cam followers) in a cam. A path is made up of one or more segments. A single cam may have multiple paths.

Segment

A segment is a part of a path from one angle to another. Each path will have one or more segments. Each segment is defined by a start and stop position of angle and offset. There is a specified motion type for each segment. Most motion types can be further configured for that particular segment. The precision or number of points per degree can be specified;

the default is 1.0 per degree. Each segment's display color may be changed.

Common Angle

The common angle is a line extending from a disk cam center to the pivot point of an oscillating arm.

Motion Type Abbreviations

The CAD feature manager will display the name of the extrusions or lofts for each segment. The first number is the number of the path. The second number is the number for the segment. If the segment number is "0" then it is a single surface extrusion or loft, which may contain more than one segment.

The next set of characters defines the type of motion (not valid for single surface).

BP = By Pass
CA = Constant Acceleration
CV = Constant Velocity
Cyc = Cycloidal
CH = Cycloidal/Harmonic
HF2 - Double Harmonic Fall
HR2 = Double Harmonic Rise
Dw = Dwell
UP = User Points
Har = Harmonic
HC = Harmonic/Cycloidal
MS = Modified Sine
MT = Modified Trapezoid
P345 = Polynomial 345
P3456F = Polynomial 3456 Fall
P3456R = Polynomial 3456 Rise
P4567 = Polynomial 4567
P8F = Polynomial8th Power Fall
P8R = Polynomial8th Power Rise
TV = Terminal Velocity

The next two sets of numbers will be the start and end angles for the segment.

The next two sets of numbers will be the start and end offsets for the segment.

For example, a featured named "1-3-HC 90.0 240.0 6.000 2.000" will define the third segment of the first path that is a Harmonic/Cycloidal motion type. The segment starts at 90.0 degrees and ends at 240.0 degrees. The starting offset is 6.000 and ends at 2.000 offset.

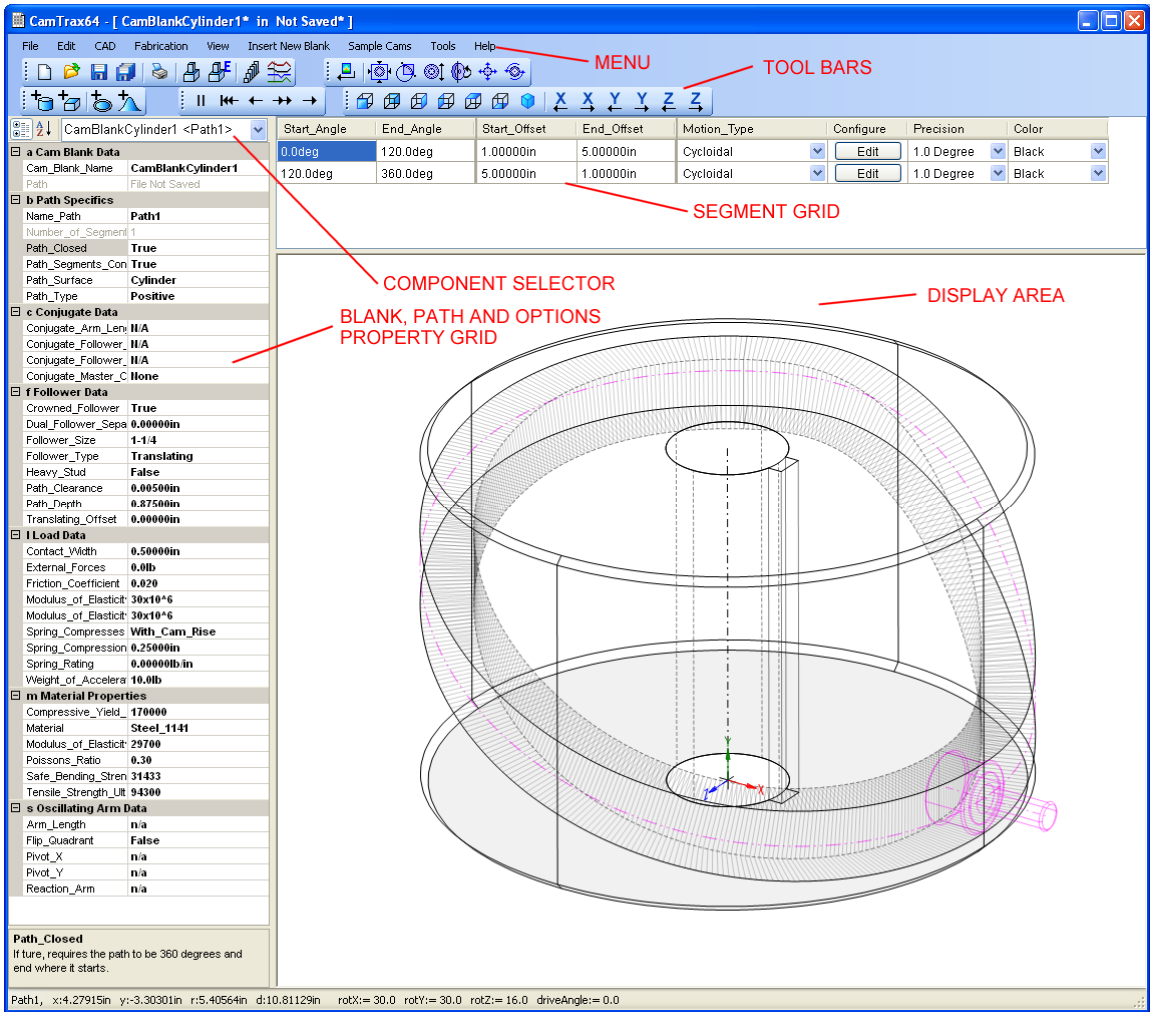
Do not rename the beginning ("1-3-") of these features if there is any chance that the cam may be changed using CamTrax64 in the future. CamTrax64 needs to know the path and segment designations to identify the correct path when editing the segment.

Double Follower

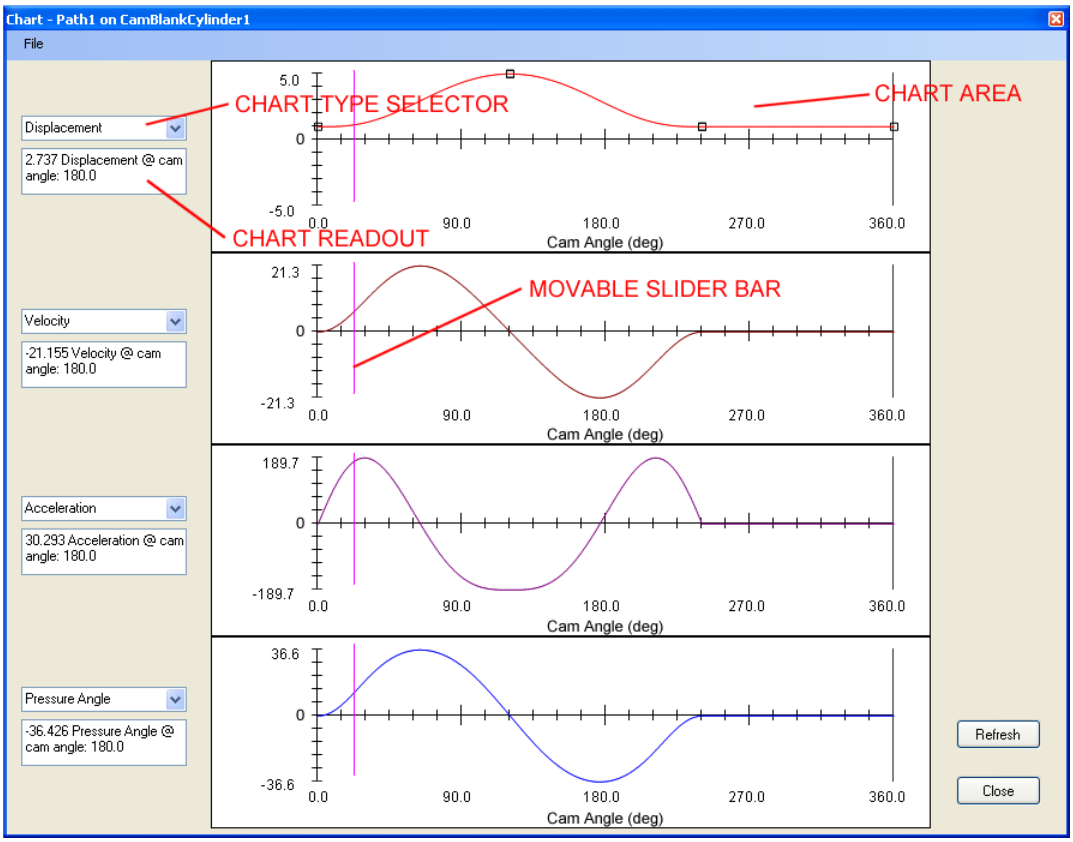
A cam with a double follower has two followers separated by a specified distance. This creates a "ridge" that the followers ride against. One of the advantages to this type of system is that the follow rotation never needs to change direction as a single follower would in a positive type of path.

Starting CamTrax64

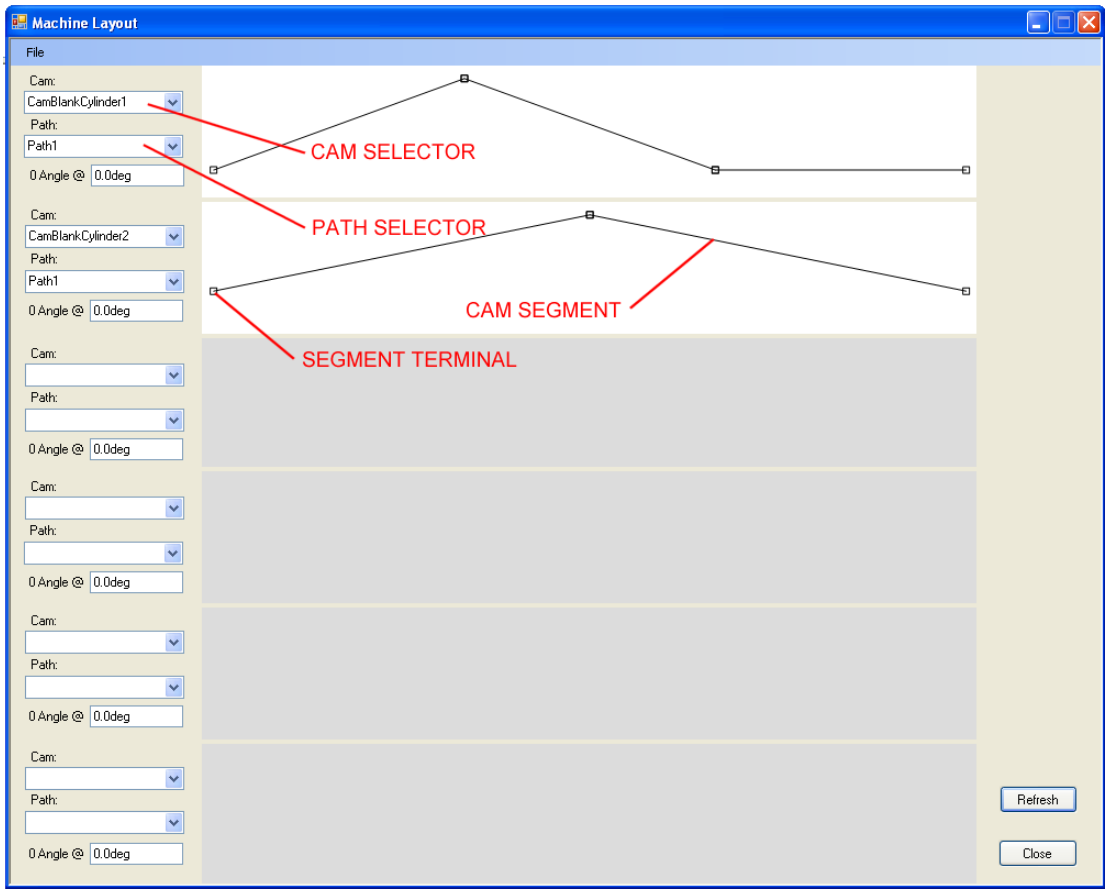
This release of CamTrax64 requires it to be started using the Windows Start menu.



CamTrax64 Main Window



CamTrax64 Chart Window



CamTrax64 Machine Layout Window

CamTrax64 Menus

File

New

New removes all components and clears CamTrax64 to start a new assembly or component.

Open Components

Open Components opens a previously saved component document. Component files have .ctxcom as the extension.

Open Assemblies

Open Assemblies opens a previously saved assembly document. Assembly files have .ctxasm as the extension.

Add Path from File

Add Path from File inserts an existing path into the component. The path data is not linked to the path from the file, so any changes made to the inserted path will not be reflected in the path file.

Save Path As

Save Path As saves the current active path. Path files have ctxpth as the extension.

Save Component

Save Component saves the active component. The component name will change to reflect the name of the file. Component files have .ctxcom as the extension.

Save Component As

Save Component As saves and changes the name of the active component. The component name will change to reflect the name of the file. Component files have .ctxcom as the extension.

Save All

Save All saves the assembly. The assembly will change to reflect the name of the file. Assembly files have .ctxasm as the extension and component files have the .gtc extension.

Save All As

Save All As saves and changes the name of the assembly and components. The assembly will change to reflect the name of the file. Assembly files have .ctxasm as the extension and component files have the .ctxcom extension.

Save Assembly As

Save Assembly As saves and changes the name of the assembly. The assembly will change to reflect the name of the file. Assembly files have .ctxasm as the extension.

Print the CamTrax64 Window

Print CamTrax64 Window prints the CamTrax64 window using the default printer, including borders.

Capture CamTrax64 screen to a file

Capture CamTrax64 screen to a file captures the CamTrax64 screen, including borders, to a bit map file.

Capture CamTrax64 screen to the clipboard

Capture CamTrax64 screen to the clipboard captures the CamTrax64 screen, including borders, to the clipboard.

Capture CamTrax64 screen and open in bit map editor

Capture CamTrax64 screen and open in bit map editor captures the CamTrax64 screen, including borders, to the default bit map editor.

Empty Clipboard

Empty Clipboard clears the clipboard of any data. This will free up any memory the screen capture is using.

Recent files

Recent files displays recent files. Click on the recent file to open it in CamTrax64.

Exit

Exit closes CamTrax64. The user is prompted to save any unsaved data.

Edit

Remove Segment

Remove Segment removes the active segment from the active path. There must be more than one segment on the path to remove a segment. The user is prompted before the segment is removed.

Remove Path

Remove Path removes the active path from the cam blank. There must be more than one path on the cam blank to remove a path. The user is prompted before the path is removed.

Remove Cam Blank

Remove Cam Blank removes the active cam blank from the assembly. There must be more than one cam blank to remove a cam blank from the assembly. The user is prompted before the cam blank is removed. All paths associated with the cam blank will be removed.

CAD

Create CAD Models and Assembly

Create CAD Models and Assembly opens the Create CAD Models dialog window.

Insert Segment List into Drawing

Insert Segment List into Drawing opens the dialog window for inserting a segment list into a CAD drawing.

The list is a table of data that refers back to the part file's custom information section. The table itself does not contain any data except how many segments should be displayed and whether or not to include constant velocity or terminal velocity information. If the part file's custom information is changed the table will be updated automatically.

Edit CAD Models

Edit CAD Models opens the dialog window for editing CAD Models.

Component Template File

Component Template File opens a dialog box for specifying the CAD template to be used when creating new CAD models.

Assembly Template File

Assembly Template File opens a dialog box for specifying the CAD template to be used when creating new CAD assemblies.

Fabrication

Activate Fabrication

Activate Fabrication loads the fabrication settings for the current active path into the property grid.

Process NC File

Process NC File will generate the NC code for the current path using the fabrication properties. The data will be opened using Notepad. The file may be saved to another name or location. Use the Notepad "Save As" command to save to another name or location. Change the "Save as type" to "All Files", otherwise the .txt file extension will be added to the file.

Simulate Fabrication

Simulate Fabrication opens a dialog box that allows CamTrax64 to view an NC file in action.

Save as Default Fabrication Settings

Save as Default Fabrication Settings saves the current fabrication settings as the default settings. When a new fabrication is started, these default settings will be used.

Open Default Fabrication Settings

Open Default Fabrication Settings allows the user to open a previously saved version of the fabrication settings that were saved as the default. This will overwrite the current fabrication settings of the currently active path.

Save Fabrication Settings as

Save Fabrication Settings as allows the user to save the current fabrication setting as a Fabrication file. Fabrication files have the .ctxfab extension.

Open Saved Fabrication Settings

Open Saved Fabrication Settings reads a saved version of the fabrication settings and overwrites the current fabrications settings of the currently active path. Fabrication files have the .ctxfab extension.

View

Redraw - fit all

Redraw – fit all redraws the assembly to fit on the screen with the front view and resets the drive position to zero.

Set Drive Angle to 0

Set Drive Angle to 0 rotates the cam blank back to the starting position.

Show XY Readouts

Show XY Readouts indicates whether or not the current component information should be displayed in the status strip at the bottom of the CamTrax64 window.

Collapse Grid

Collapse Grid collapses the property grid to the main paragraphs. The short cut key is F11.

Expand Grid

Expand Grid expands the property grid to display all items. The short cut key is F12.

Toolbars

Standard
: If checked, the Standard tool bar will be displayed.

View
: If checked, the View tool bar will be displayed.

Standard Views
: If checked, the Standard Views tool bar will be displayed.

Simulation
: If checked, the Simulation tool bar will be displayed.

Insert
: If checked, the Insert New Component tool bar will be displayed.

Open Chart Window

Open Chart Window.

Open Machine Layout Window

Open Machine Layout Window.

Insert

Insert New Cylinder into Assembly

To insert a new cylinder into the assembly:

1. Select Insert from the CamTrax64 menu.
2. Then select Insert New Cylinder into Assembly.

Insert New Cube into Assembly

To insert a new cube into the assembly:

1. Select Insert from the CamTrax64 menu.
2. Then select Insert New Cube into Assembly.

Insert New Path into Active Blank

Cylinder Surface
: This menu item is enabled if the current active cam blank is a cylinder.

Top Surface
: This menu item is enabled if the current active cam blank is a cylinder.

Bottom Surface

This menu item is enabled if the current active cam blank is a cylinder.

Upper Surface

This menu item is enabled if the current active cam blank is a cube.

Lower Surface

This menu item is enabled if the current active cam blank is a cube.

To insert a new path into the active blank:

Select Insert from the CamTrax64 menu.

Next select Insert New Path into Active Blank and then select the surface.

Insert Segment into Active Path

To insert a segment into the active path:

Select Insert from the CamTrax64 menu.

Next, select Insert Segment into Active Path. The segment will be inserted after the active segment.

Sample Cams

No Dwell

Disk

This sample disk cam has a single path with two segments. The segments are both harmonic and symmetrical.

Cylindrical

This sample cylindrical cam has a single path with two segments. The segments are both harmonic and symmetrical.

Linear

This sample linear cam has a single path with two segments. The first segment is cycloidal/harmonic and second segment is harmonic/cycloidal.

Single Dwell

Disk

This sample disk cam has a single path with three segments. The path starts with a cycloidal/harmonic motion then changes to a harmonic/cycloidal motion and finishes with a dwell. The two motions are not symmetrical. The first motion has a beta of 90 degrees and the second motion has a beta of 150 degrees. The symmetry 'n' value has been adjusted for both motions, 2.000 and 0.375 respectively. The helps facilitate a more continuous motion.

Cylindrical

This sample cylindrical cam has a single path with three segments. The path starts with a cycloidal/harmonic motion then changes to a harmonic/cycloidal motion and finishes with a dwell. The two motions are not symmetrical. The first motion has a beta of 90 degrees and the second motion has a beta of 150 degrees. The symmetry 'n' value has been adjusted for both motions, 2.000 and 0.375 respectively. The helps facilitate a more continuous motion.

Linear

This sample linear cam has a single path with three segments. The path starts with a cycloidal/harmonic motion then changes to a harmonic/cycloidal motion and finishes with a dwell. The two motions are not symmetrical. The first motion has a beta of 90 degrees and the second motion has a beta of 150 degrees. The symmetry 'n' value has been adjusted for both motions, 2.000 and 0.375 respectively. The helps facilitate a more continuous motion.

Dwell-Rise-Dwell-Return

Disk

This sample disk cam has two cycloidal motions separated by dwells.

Cylindrical

This sample disk cam has two cycloidal motions separated by dwells.

Linear

This sample disk cam has two cycloidal motions separated by dwells.

Oscillating Arm

Disk

This sample oscillating arm disk cam has a single path with three segments. The path is single dwell that starts with a cycloidal/harmonic motion rise to a harmonic/cycloidal fall and then finishes with a dwell.

Cylindrical

This sample oscillating arm cylindrical cam has a single path with three segments. The path is single dwell that starts with a cycloidal/harmonic motion rise to a harmonic/cycloidal fall and then finishes with a dwell.

Linear

This sample oscillating arm linear cam has a single path with three segments. The path is single dwell that starts with a cycloidal/harmonic motion rise to a harmonic/cycloidal fall and then finishes with a dwell.

Constant Velocity

Translating

This sample disk cam has two constant velocity motions that utilize a cycloidal motion to bring the follower to the start of the constant velocity section and then complete with the cycloidal motion.

The first segment has a constant velocity section of 30 degrees and has a displacement of 1.50 inches.

The second segment has a constant velocity section of 90 degrees and has a displacement of -3.21 inches.

Oscillating

This sample disk cam has two constant velocity motions that utilize a cycloidal motion to bring the follower to the start of the constant velocity section and then complete with the cycloidal motion.

The first segment has a constant velocity section of 30 degrees of cam rotation and an arm oscillation of 8.27 degrees.

The second segment has a constant velocity section of 60 degrees of cam rotation and an arm oscillation of -13.79 degrees.

Terminal Velocity

Disk

This sample disk cam has a terminal velocity motion that utilizes a cycloidal motion to bring the follower to the start of the terminal (or constant) velocity section and then completes with the cycloidal motion. The terminal velocity section is for 25 degrees and has a displacement of 0.25 inches.

Cylindrical

This sample cylindrical cam has a terminal velocity motion that utilizes a cycloidal motion to bring the follower to the start of the terminal (or constant) velocity section and then completes with the cycloidal motion. The terminal velocity section is for 25 degrees and has a displacement of 0.25 inches.

Linear

This sample linear cam has a terminal velocity motion that utilizes a cycloidal motion to bring the follower to the start of the terminal (or constant) velocity section and then completes with the cycloidal motion. The terminal velocity section is for 25 degrees and has a displacement of 0.25 inches.

Double Follower

Disk

Translating

This sample disk cam is a double dwell cam with two translating followers at 2.00" center distance. The path parameters specify an imaginary centerline between the two followers. Each follower is then offset 1.00" from this line.

Oscillating

Disk cams with double oscillating followers are not available. Use the conjugate option.

Cylindrical

Translating

This sample cylindrical cam is a double dwell cam with two translating followers at 2.00" center

distance. The path parameters specify an imaginary centerline between the two followers. Each follower is then offset 1.00" from this line.

Oscillating

This sample cylindrical cam is a double dwell cam with two oscillating followers at 2.00" center distance. The path parameters specify an imaginary centerline between the two followers. Each follower is then offset 1.00" from this line. The distance between each follower and the pivot equals the arm length.

Tools

Copy Hub Top Side

Copy Hub First Side copies the hub first side data to the copy hub clipboard for pasting to the second side hub or to either side of other components.

Copy Hub Bottom Side

Copy Hub Second Side copies the hub second side data to the copy hub clipboard for pasting to the first side hub or to either side of other components.

Paste to Hub Top Side

Paste to Hub First Side pastes the data stored in the hub copy clipboard to the hub first side of the current active component.

Paste to Hub Bottom Side

Paste to Hub Second Side pastes the data stored in the hub copy clipboard to the hub second side of the current active component.

Swap Hub Sides

Swap Hub Sides swaps the hub data of the two sides for the current active component.

Animation Speed

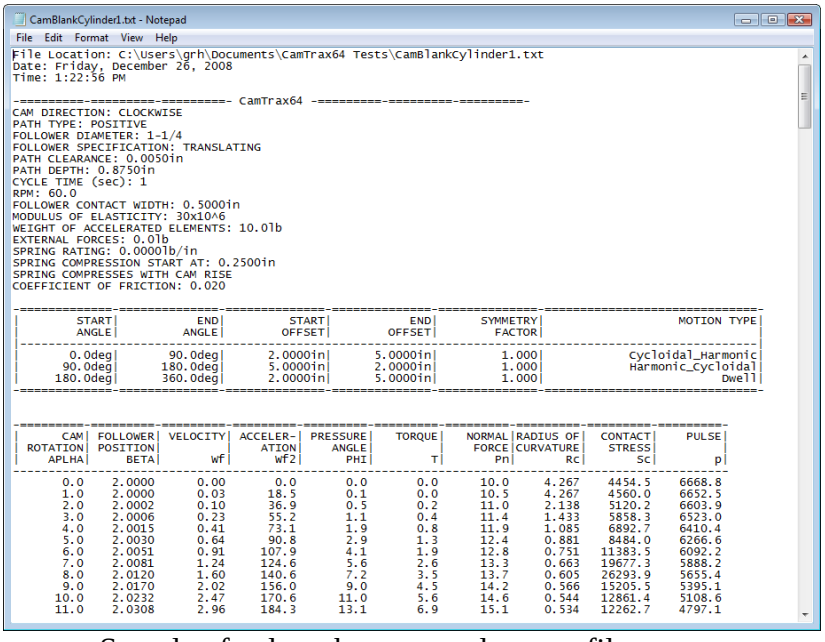
Animation Speed sets the animation speed for the simulation. The slower the speed the finer the angular steps in the simulation. Select between Very Fast, Fast, Medium, Slow and Very Slow.

Reverse Animation Direction

To reverse the direction of the animation, place a check in front of the Reverse Animation Direction menu item.

Create Data Sheet

A data sheet of the currently active cam path segments may be created in an Excel or text file format.



CamBlankCylinder1.txt - Notepad

File Edit Format View Help

File Location: C:\Users\grh\Documents\CamTrax64 Tests\CamBlankCylinder1.txt
Date: Friday, December 26, 2008
Time: 1:22:56 PM

--------- CamTrax64 ---------

CAM DIRECTION: CLOCKWISE
PATH TYPE: POSITIVE
FOLLOWER DIAMETER: 1-1/4
FOLLOWER SPECIFICATION: TRANSLATING
PATH CLEARANCE: 0.0050in
PATH DEPTH: 0.8750in
CYCLE TIME (sec): 1
RPM: 60.0
FOLLOWER CONTACT WIDTH: 0.5000in
MODULUS OF ELASTICITY: 30x10^6
WEIGHT OF ACCELERATED ELEMENTS: 10.0lb
EXTERNAL FORCES: 0.0lb
SPRING RATING: 0.0000lb/in
SPRING COMPRESSION START AT: 0.2500in
SPRING COMPRESSES WITH CAM RISE
COEFFICIENT OF FRICTION: 0.020

START ANGLE	END ANGLE	START OFFSET	END OFFSET	SYMMETRY FACTOR	MOTION TYPE
0.0deg	90.0deg	2.0000in	5.0000in	1.000	Cycloidal_Harmonic
90.0deg	180.0deg	5.0000in	2.0000in	1.000	Harmonic_Cycloidal
180.0deg	360.0deg	2.0000in	5.0000in	1.000	Dwell

CAM ROTATION APLHA	FOLLOWER POSITION BETA	VELOCITY wf	ACCELERATION wf2	PRESSURE ANGLE PHI	TORQUE T	NORMAL FORCE Pn	RADIUS OF CURVATURE Rc	CONTACT STRESS Sc	PULSE p
0.0	2.0000	0.00	0.0	0.0	0.0	10.0	4.267	4454.5	6668.8
1.0	2.0000	0.03	18.5	0.1	0.0	10.5	4.267	4560.0	6652.5
2.0	2.0002	0.10	36.9	0.5	0.2	11.0	2.138	5120.2	6603.9
3.0	2.0006	0.23	55.2	1.1	0.4	11.4	1.433	5858.3	6523.0
4.0	2.0015	0.41	73.1	1.9	0.8	11.9	1.085	6892.7	6410.4
5.0	2.0030	0.64	90.8	2.9	1.3	12.4	0.881	8484.0	6266.6
6.0	2.0051	0.91	107.9	4.1	1.9	12.8	0.751	11383.5	6092.2
7.0	2.0081	1.24	124.6	5.6	2.6	13.3	0.663	19677.3	5888.2
8.0	2.0120	1.60	140.6	7.2	3.5	13.7	0.605	26293.9	5655.4
9.0	2.0170	2.02	156.0	9.0	4.5	14.2	0.566	15205.5	5395.1
10.0	2.0232	2.47	170.6	11.0	5.6	14.6	0.544	12861.4	5108.6
11.0	2.0308	2.96	184.3	13.1	6.9	15.1	0.534	12262.7	4797.1

Sample of a data sheet created as text file

Create XY File

An XY file can be created for disk and linear cam paths. The file format may be an Excel, text or DXF File.

Open install folder using Explorer

Open install folder using Explorer opens the folder where CamTrax64 is installed using Windows Explorer.

Options

Options loads the CamTrax64 options into the property grid on the left side of the CamTrax64 window.

Help

CamTrax64 Help Topics

CamTrax64 Help Topics starts the CamTrax64 help system.

CamTrax64 Help for CAD

CamTrax64 Help for CAD starts the help system for your specific CAD system.

CamTrax64 Manual (PDF)

CamTrax64 Manual (PDF) opens the manual file. The Adobe Reader must be loaded on the computer.

CamTrax64 Quick Start Guide (PDF)

CamTrax64 Quick Start Guide opens the quick start file. The Adobe Reader must be loaded on the computer.

Registration

Registration loads the registration properties in the property grid. Starting a new component or selecting a component from the component selector will close the registration properties.

Create an Email with registration information

Create an Email with registration information loads the registration properties in the property grid and starts a new email using the default email program. Starting a new component or selecting a component from the component selector will close the registration properties.

View License Agreement

View License Agreement opens the license agreement in Notepad.

Check for Updates

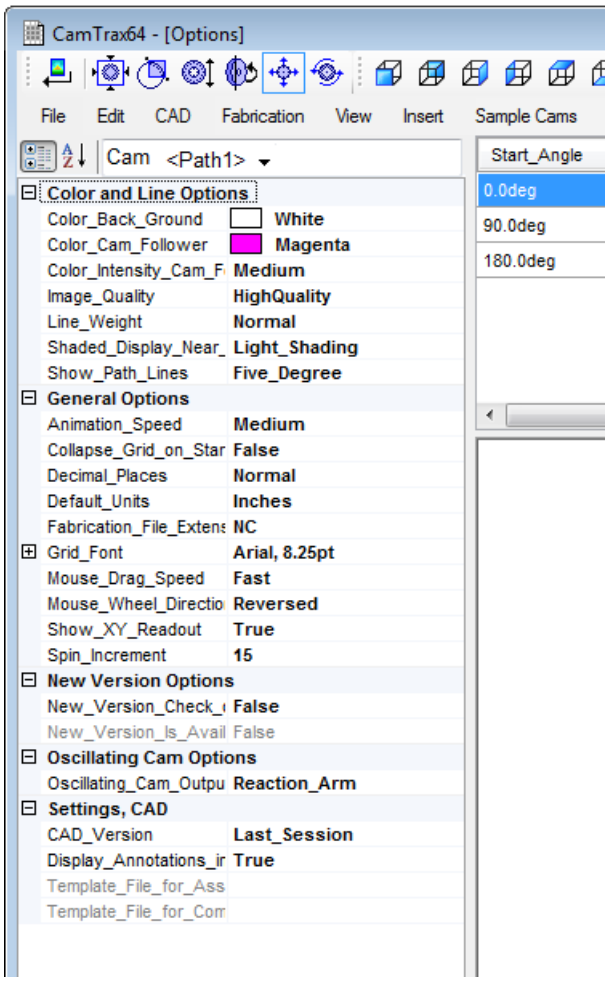
Check for Updates accesses the Camnetics, Inc. web site for a newer version of CamTrax64. The Internet must be available.

About CamTrax64

About CamTrax64 opens a dialog box that has some general information about Camnetics, Inc. and CamTrax64.

Options

The Options settings are made available through the CamTrax64 menu item Tools>Options. The Options are displayed in the property grid when CamTrax64 is started.



Color and Line Options

Color Back Ground

Color Back Ground defines the color to be used as the background on the GearTrax64 drawing window. This value is saved as a default for the next time CamTrax64 is started.

Color Cam Follower

Color Cam Follower defines the color to be used for displaying the cam follower in the display window. This value is saved as a default for the next time CamTrax64 is started.

Color Intensity Cam Follower

Color Intensity Cam Follower defines the intensity of the color used to display the cam follower in the CamTrax64 window. This value is saved as a default for the next time CamTrax64 is started.

Image Quality

Image Quality defines the quality of the components that are display in the CamTrax64 window. This value is saved as a default for the next time CamTrax64 is started.

Line Weight

Line Weight defines the thickness of the lines used to draw the components in the CamTrax64 window. This value is saved as a default for the next time CamTrax64 is started.

Shaded Display Near Side

Shaded Display Near Side defines the intensity of shading, if any, on the near side surface of the components in the CamTrax64 window. This value is saved as a default for the next time CamTrax64 is started.

Show Path Lines

Show Path Lines. This value is saved as a default for the next time CamTrax64 is started.

General Options

Animation Speed

Animation speed sets the animation speed for the simulation. Slower speed settings will produce finer steps in the simulation. Select between Very Fast, Fast, Medium, Slow and Very Slow. This value is saved as a default for the next time CamTrax64 is started.

Collapse Grid on Startup

Collapse Grid on Startup defines whether the property grid should be collapsed on startup. This value is saved as a default for the next time CamTrax64 is started.

Decimal Places

Decimal Places determines the number of decimal places from normal. The normal setting is x.xxxx for inches and x.xxx for millimeters. This option will not change the standard or add one or two decimal places to most of the values displayed or presented in any data sheets. This may not affect some settings.

Default Units

Default Units defines the units (inches or millimeters) to be used when creating a new CamTrax64 component. This value is saved as a default for the next time CamTrax64 is started.

Fabrication File Extension Name

The default extension name for fabrication files is "NC". The user may change the file extension name but it must be at least 2 characters and not exceed 6 characters.

Grid Font

Grid Font defines the font for the property and segment grid. The font is saved as a default for the next time CamTrax64 is started.

Mouse Drag Speed

Mouse Drag Speed defines the impact of mouse movements in conjunction with the Drive and Rotate the View toolbar controls. This value is saved as a default for the next time CamTrax64 is started.

Mouse Wheel Direction

Mouse Wheel Direction determines the zoom direction when zooming in or out in the CamTrax64 display window. This value is saved as a default for the next time CamTrax64 is started.

Show XY Readout

Show XY Readout defines if the XY readout will be displayed in the status bar at the bottom of the CamTrax64 window. This value is saved as a default for the next time CamTrax64 is started.

Spin Increment

Spin Increments defines the angle of increment when clicking on the simulation toolbar's forward and back buttons. Integers between 1 and 30 are valid. This value is saved as a default for the next time CamTrax64 is started.

New Version Options

New Version Check on Startup

New Version Check on Startup defines if CamTrax64 should check if a newer version is available on the web site. This value is saved as a default for the next time CamTrax64 is started. Access to the Internet is a must for this option to function.

New Version is Available

New Version is Available is a read only property that states if a newer version is available on www.camnetics.com. Access to the Internet is a must for this option to function.

Oscillating Cam Options

Oscillating Cam Output

The Oscillating Cam Output allows the user to select between:

Follower, as linear distance from the origin plane.
Arm Angle in Degrees from the common angle*.
Arm angle in Radians from the common angle*.
Reaction Arm (arc distance).
* The common angle is a line from the cam origin to the pivot point of the oscillating arm.

Settings, CAD

CAD Version

CAD Version defines which version of CAD to use with CamTrax64 when it is running as an Add-On. This option is not available when CamTrax64 is running as an Add-In. This value is saved as a default for the next time CamTrax64 is started.

Display Annotations in Upper Case

Display Annotations in Upper Case determines if annotations created in CAD are all upper case or a mix of case. This value is saved as a default for the next time CamTrax64 is started.

Template File for Assembly

Template File for Assembly displays the template file to be used when creating a new assembly document in CAD. This is a read-only value. Set the location and name of the template file in the CamTrax64 menu item CAD>Assembly Template File… This value is saved as a default for the next time CamTrax64 is started.

Template File for Component

Template File for Component displays the template file to be used when creating a new part document in CAD. This is a read-only value. Set the location and name of the template file in the CamTrax64 menu item CAD>Component Template File… This value is saved as a default for the next time CamTrax64 is started.

Cam Blank Cylinder

Cam Blank Cylinder is a base object that cam paths are cut into. Cylindrical and disk type cam paths may be added to a cylinder. Cylindrical cam paths are added to the curved surface of the cylinder. Disk cam paths are added to either end of the cylinder.

Cam Blank Data (Cylinder)

AXIS

Axis allows the user to select the axis for the cam center. Select X, Y or Z.

Blank Chamfer

Blank Chamfer defines the size of the chamfer for the edges of the cam blank.

Blank Diameter

Blank Diameter defines the size of the blank diameter.

Blank Height

Blank Height defines the size of the blank height.

Color Cam Blank

Color Cam Blank allows the user to select the display color for the cam blank.

Name Cam Blank

Name Cam Blank defines the name of the cam.

Path File

Path File is read only and is determined when the cam blank is saved.

Units

Units provides a method for the user to select between Inches or Metric units for the cam blank.

Cam Rotation

Cycle Time

Cycle Time defines the amount of time in seconds for the cam blank to make one full revolution.

Cycle Time = 60 / RPM

Direction Rotation

Direction Rotation provides a method for the user to change the rotation direction of the cam. The user may select Clockwise or Counter Clockwise.

RPM

RPM defines the frequency of rotation of the cam blank.

RPM = 60 / Cycle Time

Cam Position

X Delta

X Delta defines the distance between the origin of the cam blank and the origin of the assembly on the X axis.

Y Delta

Y Delta defines the distance between the origin of the cam blank and the origin of the assembly on the Y axis.

Z Delta

Z Delta defines the distance between the origin of the cam blank and the origin of the assembly on the Z axis.

Hub Data

Bore Chamfer

Bore Chamfer defines the size of the chamfer at the ends of the bore.

Bore Diameter

Bore Diameter defines the diameter of the bore.

Hub Bottom Side Chamfer

Hub Bottom Side Chamfer defines the size of the chamfer and fillet for the hub revolve on the bottom of the cylinder.

Hub Bottom Side Diameter

Hub Bottom Side Diameter defines the size of the diameter of the hub revolve on the bottom of the cylinder.

Hub Bottom Side Projection

Hub Bottom Side Diameter defines the size of the projection of the hub revolve on the bottom of the cylinder.

Hub Top Side Chamfer

Hub Top Side Chamfer defines the size of the chamfer and fillet for the hub revolve on the top of the cylinder.

Hub Top Side Diameter

Hub Top Side Diameter defines the size of the diameter of the hub revolve on the top of the cylinder.

Hub Top Side Projection

Hub Top Side Projection defines the size of the projection of the hub revolve on the top of the cylinder.

Keyway

Keyway defines the type of keyway, if any, to be created with the component. A valid bore diameter must be specified.

Keyway Angle

Keyway Angle defines the keyway relative to the 0 position.

Mounting Bushing Modeling

Mounting Bushing Modeling determines if the bushing should be created as part of the component or as a new part. Select 'Create as component feature' to have the bushing created as a feature in the CAD model. Select 'Create as new part' to have the bushing created as a new CAD model.

Mounting Bushing Side

Mounting Bushing Side defines on which side of the component the bushing will be mounted.

Mounting Split Taper Bushing

Mounting Split Taper Bushing defines, if any, the bushing to be used with the component.

Standard Set Screw

Standard Set Screw defines if a standard set screw should be used with a keyway. The setscrew hole will only be created if a hub and keyway are also created.

Cam Blank Cube

Cam Blank Cube is a base object that is used to cut cam paths. Linear cam paths are the only type of cam path that can be added to the cube. Linear cam paths are added to either the upper or lower surface of the cube.

Cam Blank Data (Cube)

AXIS

Axis allows the user to select the axis for the cam blank thickness value. Select X, Y or Z.

Blank Length

Blank Length defines the size of the blank length. The blank length is used for the direction of the cam path angle.

Blank Thickness

Blank Thickness defines the size of the blank thickness.

Blank Width

Blank Width defines the size of the blank width. The blank width is used for the direction of the cam path displacement.

Cam Paths

Cam Paths are grooves cut into a cam blank. A cam path is made up of one or more cam segments.

Cam Blank Date

Cam Blank Name

Cam Blank Name is a drop down box that allows the user to select the which cam blank is used with the path. A cam path must have a cam blank specified. If "none" is specified, the cam path will not be displayed on the screen or created in CAD.

Units

Units provides a method for the user to select between Inches or Metric units for the cam path. Each path may have its own unit setting that is different from the cam blank's unit setting. CamTrax64 may set the path units to match the cam blank unit setting while the cam is being created in CAD.

Path Specifics

Name Path

Name Path is the name of the current path, which will be used to name path features when they are created in CAD.

Number of Segments

Number of Segments is a read only value, which displays the number of motion segments in the current active path.

Path Closed

With Path Closed set to true CamTrax64 will change the start of the first segment to match the end of the last segment when it is changed. Likewise for the end of the last segment, if the start of the first segment is changed. The cam will have 360 degrees rotation. If the start angle of the first segment is changed to 20 degrees then the end of the last segment will be changed to 380 degrees.

Path Segments Continuous

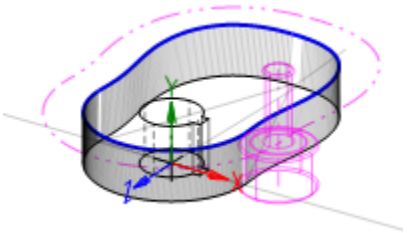
With Path Segments Continuous set to true CamTrax64 will automatically change the start of the next segment if the current segment end is changed. Likewise if the start of the current segment is changed then the end of the preceding segment will automatically be changed.

Path Surface

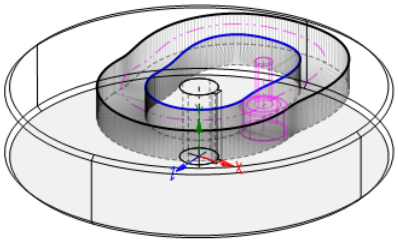
Path surface is used to select which surface the path is on. For cylinder blanks the options are Cylinder, Top and Bottom. For cube blanks the options are upper and lower.

Path Type

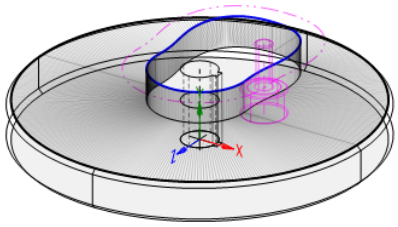
Path Type is used to select the type of path. For paths on the cylinder surface the options are Positive, Upper and Lower. For paths on the Top or Bottom surface of a cylinder blank the options are Positive, Inside, Outside and Inside Surface Only.



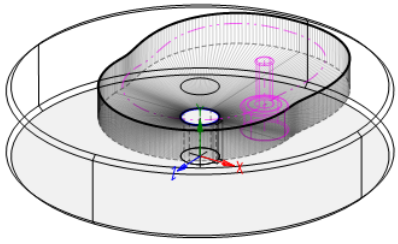
Inside Surface Only Path Type on a Top Surface



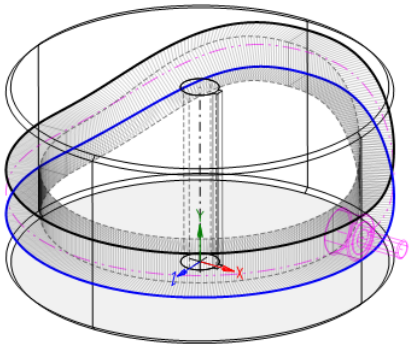
Positive Path Type on a Top Surface



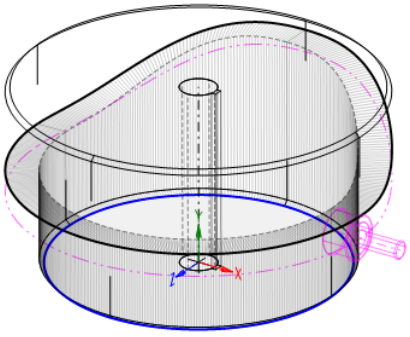
Inside Path Type on a Top Surface



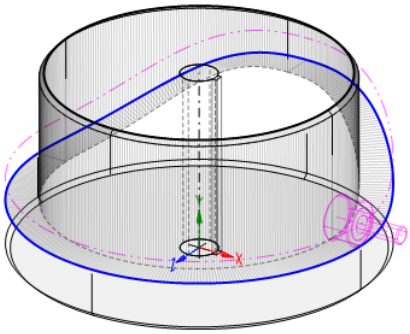
Outside Path Type on a Top Surface



Positive Path Type on a Cylinder Surface



Upper Path Type on a Cylinder Surface



Lower Path Type on a Cylinder Surface

Follower Data

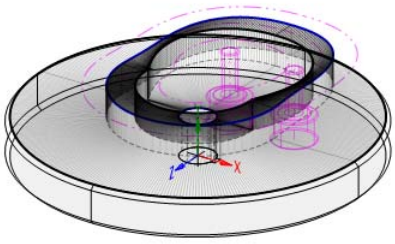
Crowned Follower

Select between true or false. Crowned followers should always be used for paths on the cylinder.

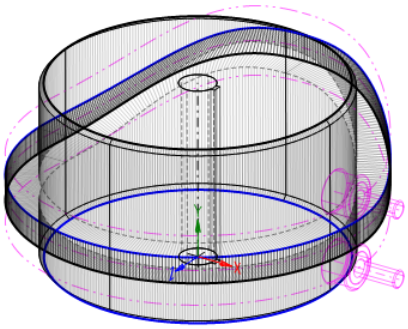
Dual Follower Separation

If a value is entered into the Dual Follower Separation property then the positive cam path is created with a ribbon that is encapsulated by two followers. The value for the Dual Follower Separation must be at least 10% greater than the diameter of the follower.

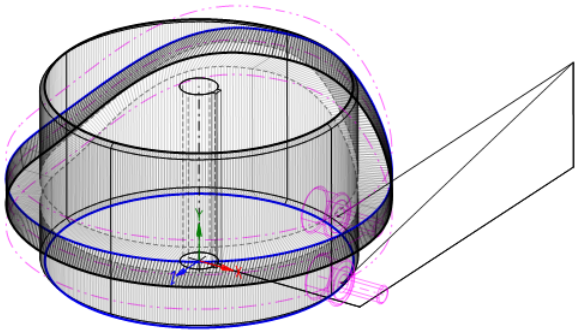
Both followers are of the same diameter.



Dual Follower on the Top Surface of a Linear Translating Disk Cam



Dual Follower on the Cylinder Surface of a Linear Translating Barrel Cam



Dual Follower on the Cylinder Surface of an Oscillating Barrel Cam

Follower Size Dimensional

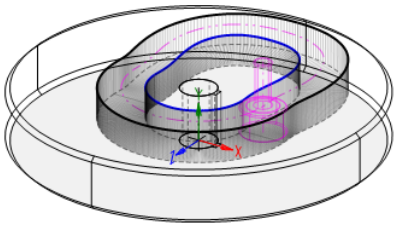
Follower Size Dimensional allows the user to enter a specific size follower that may or may not be a common size.

Follower Size Nominal

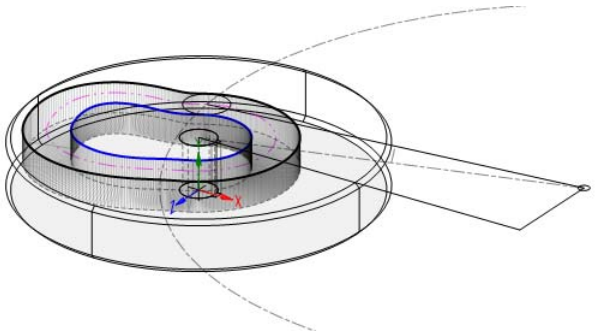
Follower Size Nominal allows the user to select from a list of common imperial and metric size followers. Use the Follower Size Dimensional property to enter a specific follower size.

Follower Type

Follower Type allows the user to select between Translating and Oscillating follower types.



Translating Follower on a Disk Cam with a Positive Path



Oscillating Follower on a Disk Cam with a Positive Path

Heavy Stud

The Heavy Stud property allows the user to select between true or false. Set to true for a heavy stud and false for a standard stud on the cam follower.

Path Clearance

Path Clearance defines the amount of clearance between the follower diameter and the path width. Setting the clearance to 0.005in on a 1.250in diameter follower will create a cam path width of 1.255in.

Path Depth

The Path Depth property defines how deep the cam path will be cut into the cam blank.

Translating offset

The Translating Offset property defines how far the cam follower is offset in a positive or negative direction for translating followers. Normally this value should be 0.000 as there is very little reason to ever develop a cam with an offset.

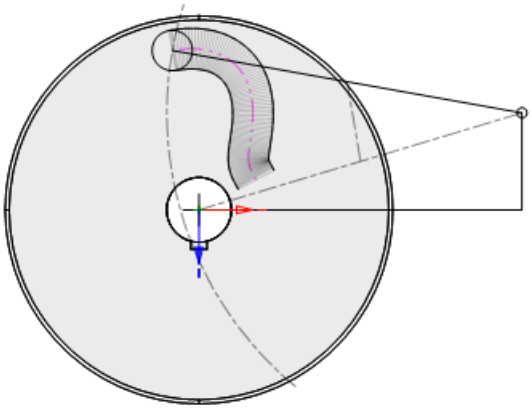
Oscillating Arm Data

Arm Length

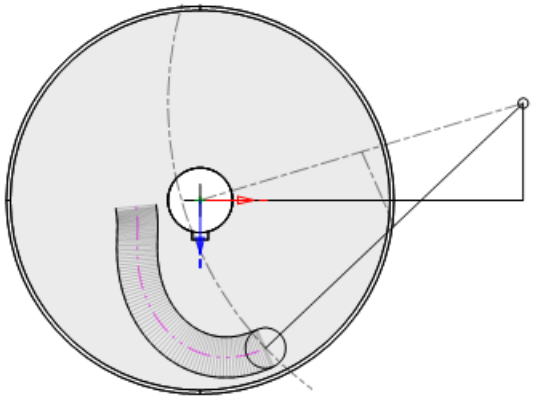
Arm Length is a linear distance between the pivot point and the follower center.

Flip Quadrant

Flip Quadrant moves the arm to the other side of the line between the cam center and the pivot point (sometimes called the common angle). This is only valid for disk cams with an oscillating follower type.



Flip Quadrant set to False



Flip Quadrant set to True

Pivot X

Pivot X defines the distance of the pivot point from the cam center in the X direction.

Pivot Y

Pivot Y defines the distance of the pivot point from the cam center in the Y direction.

Reaction Arm Length

Reaction Arm Length is the length of an imaginary line that extends from the pivot point and oscillates with the follower arm. This is valid for oscillating follower types only.

Conjugate Data

The Conjugate Data properties are used to convert the active cam path to a conjugate path. Start the conversion of a standard path into a conjugate by selecting the Conjugate Master Cam Path. Then define the other valid properties to complete the conversion.

Conjugate Follower Angle

Conjugate Follower Angle defines the angle between two lines extending from the pivot point to each of the cam follower centers. This is only valid if the master cam path is an oscillating follower type.

Conjugate Follower Center Distance

Conjugate Follower Center Distance defines the distance between the two followers of a conjugate cam. A good starting dimension will be the least offset plus the greatest offset of the master cam path. This is only valid if the master cam path is a translating follower type.

Conjugate Master Cam Path

Conjugate Master Cam Path defines which path is to be used as a master path.

Load Data

Contact Width

Contact Width defines the amount of contact between the follower face and the cam path surface. Normally this is the full width of

the cam follower unless the follower does not fully extend into the cam path.

External Forces

External Forces define any external force that will be applied to the follower. A good example of this type of force would be an air spring where there is very little mass relative to the amount of force generated.

Friction Coefficient

Friction Coefficient defines the coefficient of friction for any sliding device attached to the follower.

Modulus of Elasticity Follower

Modulus of Elasticity Follower defines the value for the modulus of elasticity for the cam follower. Entering 25 into the property will result in a 25x10^6 value.

Modulus of Elasticity Path

Modulus of Elasticity Path defines the value for the modulus of elasticity for the cam path. Entering 25 into the property will result in a 25x10^6 value.

Spring Compresses

Spring Compresses allows the user to switch between "With Cam Rise" and "With Cam Fall" options. If "With Cam Rise" is selected then when the follower is rising (moving away from the center of a disk cam or the base of a cylindrical cam) the spring will be compressing according to the amount of rise.

Spring Compression at Cam Zero

Spring Compression at Cam Zero defines the linear amount of spring compression for the follower position at the start of the first cam path segment.

Spring Rating

Spring Rating defines the strength of the spring. For a cam with inch units the rating is pounds per inch (lb/in) and for metric cams the rating is kilograms per meter (kg/m).

Weight of Accelerated Elements

Weight of Accelerated Elements defines the mass of all objects that are attached to the cam follower.

Cam Segments

Cam Segments are parts of a cam path. A cam path is made up of one or more cam segments. Properties of Cam Segments are displayed above the graphic window.

Start Angle

Start Angle is the cam angle at the start of the segment.

End Angle

End Angle is the cam angle at the end of the segment.

Start Offset

For disk cam paths:

Start Offset is the distance between the center of the follower at the start of a segment and the center of the cam.

For cylindrical cam paths:

Start Offset is the distance between the center of the follower at the start of a cam path segment and the cam origin plane.

For linear cam paths:

Start Offset is the distance between the center of the follower at the start of a cam path segment and the cam origin plane.

End Offset

For disk cam paths:

End Offset is the distance between the center of the follower at the end of a segment and the center of the cam.

For cylindrical cam paths:

End Offset is the distance between the center of the follower at the end of a cam path segment and the cam origin plane.

For linear cam paths:

End Offset is the distance between the center of the follower at the end of a cam path segment and the cam origin plane.

Start Arm Angle

For disk cam paths:

Start Arm Angle is the angle between the arm and the common angle line at the start of the segment. The common angle line is a line that extends from the center of the cam to the pivot point of the oscillating arm.

For cylindrical cam paths:

Start Arm Angle is the angle between the arm and a line that extends from the center of the pivot and is parallel to the origin plane, at the start of the cam path segment.

End Arm Angle

For disk cam paths:

End Arm Angle is the angle between the arm and the common angle line at the end of the segment. This property is only valid for oscillating disk cam paths. The common angle line is a line that extends from the center of the cam to the pivot point of the oscillating arm.

For cylindrical cam paths:

End Arm Angle is the angle between the arm and a line that extends from the center of the pivot and is parallel to the origin plane, at the end of the cam path segment.

Motion Type

Motion Type allows the user to select between most common types of cam motions.

Configure

Configure allows the user to make further adjustments to the parameters of the segment. For example, the symmetry 'n' value may be adjusted for a cycloidal motion.

Precision

Precision allows the user to select between 0.1, 0.2, 0.5, 1.0 and 2.0 degrees. This determines how often a point (at the center of the path) will be created to define the spline that creates the cam path segment.

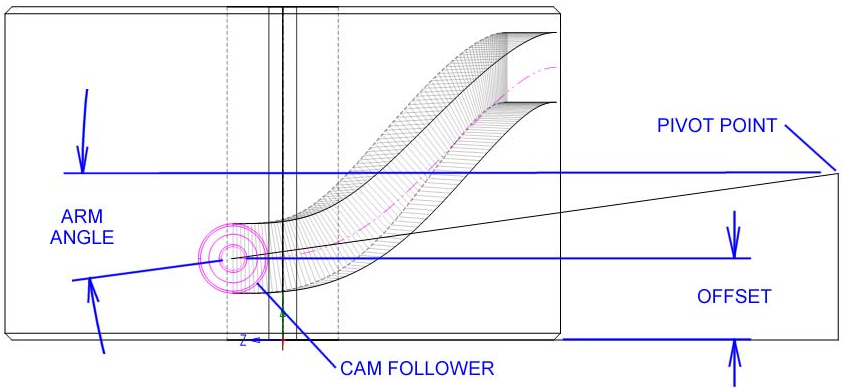
Color

Color allows the user to select between a limited number of colors to be used to display each cam segment in the display area.

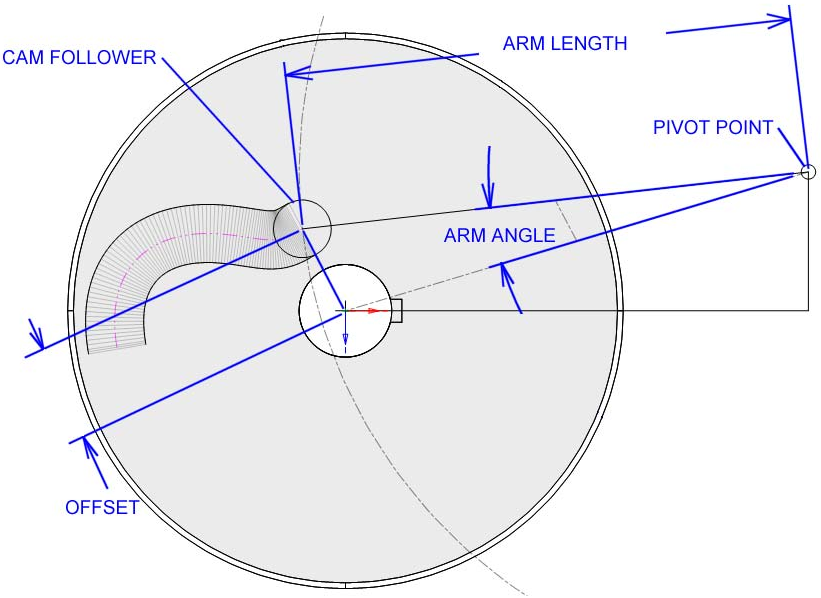
Oscillating Followers

The Arm Angle of a cylindrical cam path is from perpendicular of the cam axis to the pivot point to the center of the follower. The Offset is a linear dimension between the cam base and the follower center.

The Arm Angle of a disk cam is from the cam center to pivot point and to the follower center. The Offset is a linear dimension between the cam center and the follower center.



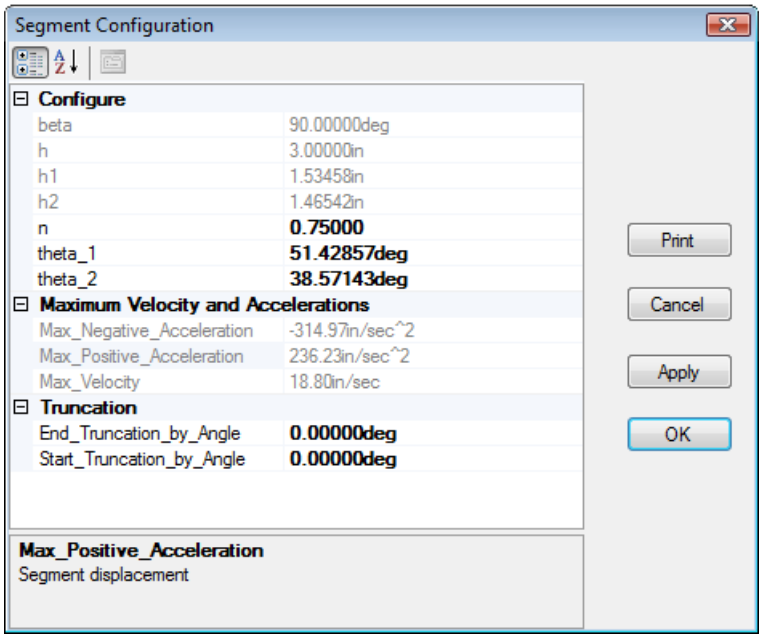
CYLINDRICAL CAMS



DISK CAMS

Segment Configuration

The Segment Configuration window varies with the type of motion used in that segment. The configuration properties below are valid for cycloidal, harmonic, modified sine, modified trapezoid, cycloidal/harmonic and harmonic/cycloidal motions.



Configuration

Start Angle is the cam angle at the start of the segment.

beta

beta is the angle of cam rotation for this segment of the cam path.

h

h is the total displacement for this segment of the cam path.

h1

h1 is the amount of acceleration displacement for this segment of the cam path.
h1 = h / (1 + n)

h2

h2 is the amount of deceleration displacement for this segment of the cam path.
h2 = h - h1

n

Symmetry factor n. If n = 1.0 then the segment will be symmetrical.

theta 1

theta1 is the amount of acceleration angle (cam) for this segment of the cam path.
theta1 = beta / (1 + n)

theta 2

theta1 is the amount of deceleration angle (cam) for this segment of the cam path.
theta2 = beta – theta1

Maximum Velocity and Accelerations

The maximum velocity and accelerations are displayed in the property grid for the current segment. These values are read only and are calculated using the parameters of the cam path segment.

Max Negative Acceleration

a.

Max Positive Acceleration

a.

Max Velocity

a.

Truncation

Truncation provides a method to shorten the cam segment without changing the cam parameters. This provides the designer with the ability to combine any cam motion with another cam motion. The Path Segments Continuous property of the cam path must be set to false to overlap (and combine) segments.

End Truncation by Angle

End Truncation by Angle defines the amount of degree that the cam segment should be shortened at the end of the segment.

Start Truncation by Angle

Start Truncation by Angle defines the amount of degree that the cam segment should be shortened at the start of the segment.

Buttons

Print

Pressing the Print button will open a print dialog window that will allow the user to send the Segment Configuration graphics to the default printer.

Cancel

Pressing the Cancel button will restore the original setting and close the window.

Apply

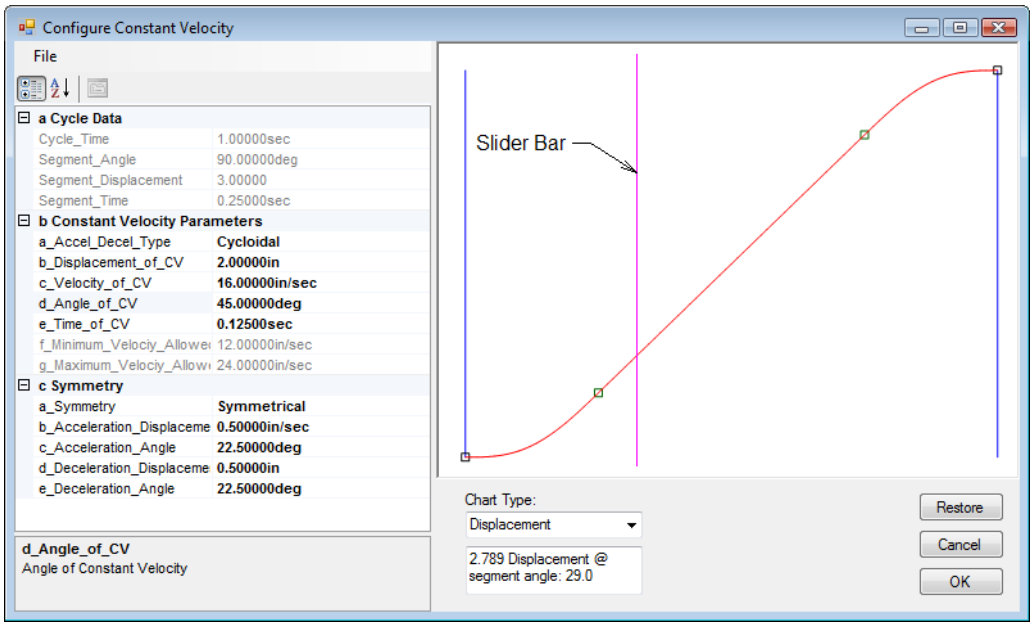
Pressing the Apply button will force the CamTrax64 display window to update with the new settings.

OK

Pressing the OK button will save the settings, update the CamTrax64 display window and close the configuration dialog window.

Configure Constant Velocity

Pressing the **Edit** button in the segment grid line of a Constant Velocity (CV) motion will open the Configure Constant Velocity Window.



The constant velocity section is always after the acceleration portion of the segment and before the deceleration portion. If you would like the constant velocity section to be within the acceleration or deceleration portion (for example, for a press operation) then consider using the terminal velocity motion type.

Tip: If you are laying out a cam that requires a specific velocity for the constant velocity during a certain period of time, start by centering the cam segment on the center of the desired layout. Then specify the velocity for the CV portion of the segment. Then change the amount of displacement and/or angle for the segment until the segment provides enough displacement at the constant velocity.

Cycle Data

Cycle Time

Cycle Time is the amount of time required for one revolution of the cam or 360 degrees of a linear cam. This value is read only.

Segment Angle

Segment Angle is the amount of angle in degrees for the complete terminal segment. This value is read only.

Segment Displacement

Segment Displacement is the amount of linear displacement for the complete terminal velocity segment. This value is read only.

Segment Time

Segment Time is the amount of time in seconds required to complete the entire terminal velocity segment. This value is read only.

Constant Velocity Parameters

Accel Decel Type

Accel Decel Type (acceleration/deceleration type) provides a method for the designer to switch between a number of different motion types to be used to control the acceleration before the constant velocity and the deceleration after the constant velocity portion of the motion.

Displacement of CV

Displacement of CV (constant velocity) provides a method for the designer to input the amount of displacement for the segment that will be at a constant velocity. Because of the laws of cam motions, velocity and the start and end positions of the constant velocity may change.

Velocity of CV

Velocity of CV (constant velocity) provides a method for the designer to input the velocity of the segment that will be at a constant velocity. Because of the laws of cam motions, displacement and the start and end positions of the constant velocity may change.

Angle of CV

Angle of CV (constant velocity) provides a method for the designer to input the amount of cam angle during the constant velocity. Because of the laws of cam motions, velocity, displacement and the start and end positions of the constant velocity may change.

Time of CV

Time of CV (constant velocity) provides a method for the designer to input the amount of time for the duration of the constant velocity. Because of the laws of cam motions, velocity, displacement and the start and end positions of the constant velocity may change.

Minimum Velocity Allowed

Minimum Velocity Allowed is a read only display of the minimum velocity allowed according to the specifications of the cam segment. If the Velocity of CV is changed, it must be equal to or greater than this value.

Maximum Velocity Allowed

Maximum Velocity Allowed is a read only display of the maximum velocity allowed according to the specifications of the cam segment. If the Velocity of CV is changed, it must be equal to or less than this value.

Symmetry

Symmetry

Symmetry allows the designer to create a constant velocity section that is asymmetrical. Select between Symmetrical and Asymmetrical modes.

An asymmetrical constant velocity motion can have a different amount of acceleration than deceleration. For example, the acceleration may happen over 20 degrees of cam motion but the deceleration over 30 degrees of cam motion.

The other items in this Symmetry paragraph are read only unless this property is set to Asymmetrical.

Acceleration Displacement

Symmetrical mode:

The Acceleration Displacement property is read only and displays the calculated displacement for the acceleration portion of the segment.

Asymmetrical mode:

The Acceleration Displacement property allows the designer to specify a set amount of displacement for the acceleration portion of the segment.

Acceleration Angle

Symmetrical mode:

The Acceleration Angle property is read only and displays the calculated cam angle used for the acceleration portion of the segment.

Asymmetrical mode:

The Acceleration Angle property allows the designer to specify a set amount of cam angle used for the acceleration portion of the segment.

Deceleration Displacement

Symmetrical mode:

The Deceleration Displacement property is read only and displays the calculated displacement for the deceleration portion of the segment.

Asymmetrical mode:

The Deceleration Displacement property allows the designer to specify a set amount of displacement for the deceleration portion of the segment.

Deceleration Angle

Symmetrical mode:

The Deceleration Angle property is read only and displays the calculated cam angle used for the deceleration portion of the segment.

Asymmetrical mode:

The Deceleration Angle property allows the designer to specify a set amount of cam angle used for the deceleration portion of the segment.

Buttons and Slider Bar

Chart Type (drop down selector)

The Chart Type drop down selector allows the user to switch between different chart types. The default is displacement. The graphics window can also display velocity, acceleration, pressure angle, torque, normal force, radius of curvature, contact stress and pulse (or jerk).

The text box below the drop down selector displays data for the current slider position.

Cancel

Pressing the Cancel button will restore the origin setting and close the window.

Restore

Pressing the Restore button will delete any changes made to the configuration since the window was last opened.

OK

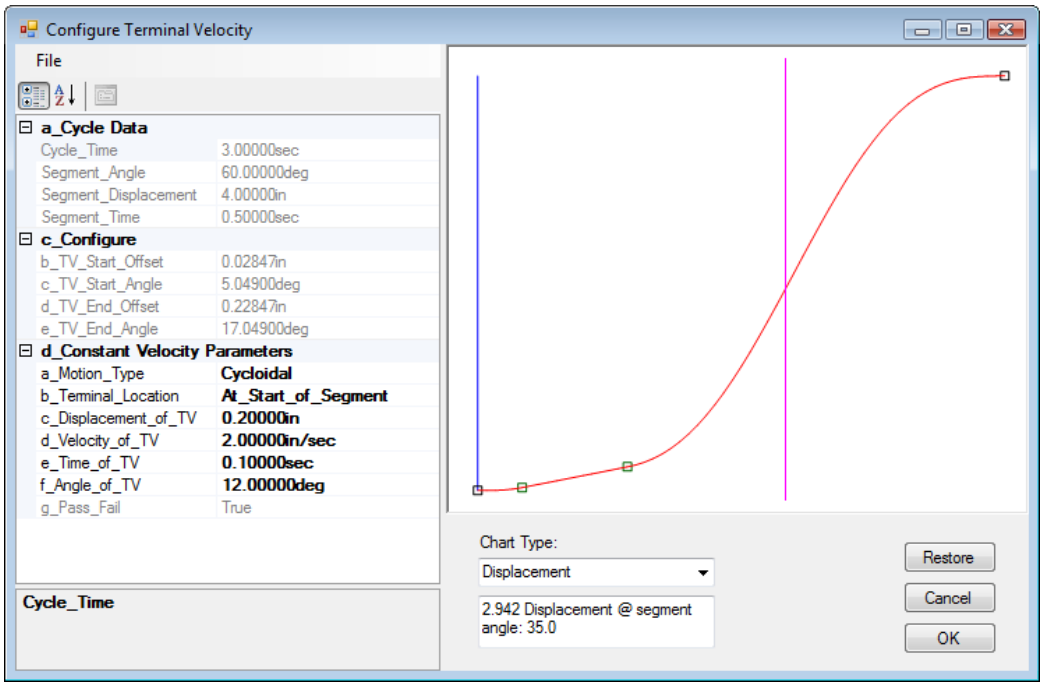
Pressing the OK button will save the settings, update the CamTrax64 display window and close the configuration dialog window.

Slider Bar

The Slider Bar provides a method for the designer to analyze the characteristics of the curve at any given position. Drag the bar left or right and the text box will display the current angle and the value for the type selected in the Chart Type selector.

Configure Terminal Velocity

Pressing the **Edit** button in the segment grid line of a Terminal Velocity (TV) motion will open the Configure Terminal Velocity Window.



Cycle Data

Cycle Time

Cycle Time is the amount of time required for one revolution of the cam or 360 degrees of a linear cam. This value is read only.

Segment Angle

Segment Angle is the amount of angle in degrees for the complete terminal segment. This value is read only.

Segment Displacement

Segment Displacement is the amount of linear displacement for the complete terminal velocity segment. This value is read only.

Segment Time

The segment time is the amount of time in seconds required to complete the entire terminal velocity segment. This value is read only.

Configure

TV Start Offset

TV Start Offset is a linear value of the amount of displacement at the beginning of the segment before the start of the constant velocity portion of the segment. This displacement will be acceleration and will include deceleration if the terminal location is at the end of the segment. This value will change with the type of motion selected. This value is read only.

TV Start Angle

TV Start Angle is an angular value in degrees for the amount of cam angle at the beginning of the segment before the start of the constant velocity portion of the segment. This displacement will be acceleration and will include deceleration if the terminal location is at the end of the segment. This value will change with the type of motion selected. This value is read only.

TV End Offset

TV End Offset is a linear value of the amount of displacement at the end of the segment after the end of the constant velocity portion of the segment. This displacement will be deceleration and will include acceleration if the terminal location is at the start of the segment. This value will change with the type of motion selected. This value is read only.

TV End Angle

TV End Angle is an angular value in degrees of the amount of cam angle at the end of the segment after the end of the constant velocity portion of the segment. This displacement will be deceleration and will include acceleration if the terminal location is at the start of the segment. This value will change with the type of motion selected. This value is read only.

Terminal Velocity Parameters

Motion Type

Motion Type determines the type of motion to be used in conjunction with the constant velocity to create a terminal type of motion.

Terminal Location

Terminal Location determines if the constant velocity portion will be at the start or end of the segment.

Displacement of TV

Displacement at TV sets the amount of displacement that will be at a constant velocity. Changing this value will also change the Velocity of TV value.

Velocity of TV

Velocity of TV sets the velocity for the constant velocity portion of the segment. Changing this value will also change the Displacement of TV value.

Time of TV

Time of TV determines how long the constant velocity portion of the segment will be in seconds. Changing this value will also change the Velocity of TV and the Angle of TV. The Displacement of TV will remain unchanged.

Angle of TV

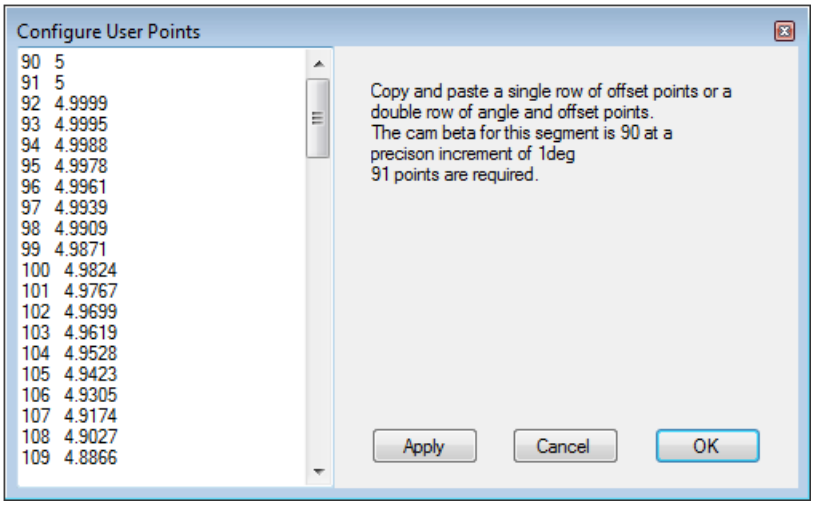
Angle of TV determines the amount of cam angle that will be used for the constant velocity portion of the segment. Changing this value will also change the Velocity of TV and the Angle of TV. The Displacement of TV will remain unchanged.

Pass Fail

Pass-Fail is a read only value that indicates if the set of values makes a valid terminal velocity motion.

Configure User Points

Pressing the **Edit** button in the segment grid line of a User Points motion will open the Configure User Points window.



Data Area

The Data Area contains the user entered points. A single column of data may be entered (copy and paste recommended) into this area. CamTrax64 will convert a single column of offsets to a double column of cam segment angles and offsets.

Apply

Apply will force the CamTrax64 display window to update with the new settings.

Cancel

Cancel will restore the original setting and close the window.

OK

OK will save the settings, update the CamTrax64 display window and close the configuration dialog window.

Motion Types

Motion Types define the type of motion that is used for a single cam path segment. Each motion has its own characteristics.

Dwell

A **Dwell** has no change in displacement of velocity. The end offset always equals the start offset.

Cycloidal

Cycloidal motions have smooth starts and ends. The acceleration rates at the start and end are 0.000. The cycloidal motion is an acceptable motion to use between two dwells.

$$\text{Displacement:} \quad s = h\left[\frac{\theta}{\beta} - \frac{\sin 2\pi(\theta/\beta)}{2\pi}\right]$$

$$\text{Velocity:} \quad v = h\left[\frac{1-\cos 2\pi(\theta/\beta)}{T}\right]$$

$$\text{Acceleration:} \quad a = h\left[\frac{2\pi \sin 2\pi(\theta/\beta)}{T^2}\right]$$

The value for n may be configured, which alters where the acceleration rate changes from positive to negative during the duration of the motion.

Harmonic

Harmonic motions start and end with maximum acceleration rates. This makes a poor motion to be used in conjunction with a dwell.

$$\text{Displacement:} \quad s = 0.5h\left(1-\cos \pi \frac{\theta}{\beta}\right)$$

$$\text{Velocity:} \quad v = \frac{0.5\,\pi\, h\,[\sin \pi(\theta/\beta)]}{T}$$

$$\text{Acceleration:} \quad a = \frac{0.5\,\pi^2\, h\,[\cos \pi(\theta/\beta)]}{T^2}$$

The value for n may be configured, which alters where the acceleration rate changes from positive to negative during the duration of the motion.

Modified Sine

Curve Characteristics of the Modified Sine Curve:

From 0 to $\beta / 8$:

$s = h\,(0.43990\,(\theta/\beta) - 0.03501 \sin[4\pi\,(\theta/\beta)])$

$v = h\,[0.3890 - 0.3980 \cos 4\pi\,(\theta/\beta)]$

$a = h\,[4.88812 \sin 4\pi\,(\theta/\beta)]$

From $\beta / 8$ to $\beta * 0.875$:

$s = h\,[0.43990\,(\theta/\beta) - 0.31505 \cos((4\pi/3)(\theta/\beta) - (\pi/6)) + 0.28005]$

$v = h\,[0.43990 + 1.31967 \sin((4\pi/3)(\theta/\beta) - (\pi/6))]$

$a = h\,[5.528 \cos((4\pi/3)(\theta/\beta) - (\pi/6))]$

From $\beta * 0.875$ to β:

$s = h\,[0.56010 + 0.43990\,(\theta/\beta) - 0.03501 \sin(2\pi\,[2\,(\theta/\beta) - 1])]$

$v = h\,[0.43990\,(1 - \cos 2\pi\,[2\,(\theta/\beta) - 1])]$

$a = h\,(5.528 \sin 2\pi\,[2\,(\theta/\beta) - 1])$

Modified Trapezoid

Characteristics of the Modified Trapezoid Curve:

From 0 to $\beta / 8$:

$s = h\,(0.3890\,(\theta/\beta) - 0.03095 \sin[4\pi\,(\theta/\beta)])$

$v = h\,[0.3890 - 0.3980 \cos 4\pi\,(\theta/\beta)]$

$a = h\,[4.88812 \sin 4\pi\,(\theta/\beta)]$

From $\beta / 8$ to $\beta * 0.375$:

$s = h\,([2.44406\,(\theta/\beta)^2 - 0.22203\,(\theta/\beta) + 0.00723])$

$v = h\,[4.88812\,(\theta/\beta) - 0.22203]$

$a = h\,(4.88812)$

From $\beta * 0.375$ to $\beta / 2$:

$s = h\,(1.61102\,(\theta/\beta) - 0.03095 \sin(4\pi\,(\theta/\beta) - \pi) - 0.30551)$

$v = h\,(1.61102 - 0.38898 \cos[4\pi\,(\theta/\beta) - 2\pi])$

$a = h\,(4.88812 \sin[4\pi\,(\theta/\beta) - \pi])$

From $\beta / 2$ to $\beta * 0.625$:

$s = h\,(1.61102\,(\theta/\beta) - 0.03095 \sin(4\pi\,(\theta/\beta) - \pi) - 0.30551)$

$v = h\,(1.61102 + 0.38898 \cos[4\pi\,(\theta/\beta) - 2\pi])$

$a = h\,(-4.88812 \sin[4\pi\,(\theta/\beta) - 2\pi])$

Cycloidal/Harmonic

The **Cycloidal/Harmonic** motion is a combination of a cycloidal and harmonic motion. The acceleration portion (from a dwell) is cycloidal and the deceleration is harmonic. This motion is normally used in conjunction with the **Harmonic/Cycloidal** motion. **Dwell** motions normally precede and follow this set of motions. A rise and return cycle would be ½ cycloidal acceleration to ½ harmonic deceleration to ½ harmonic acceleration to ½ cycloidal deceleration.

Harmonic/Cycloidal

The **Harmonic/Cycloidal** motion is a combination of a cycloidal and harmonic motion. The acceleration portion (starting from a

Cycloidal/Harmonic motion) is harmonic and the deceleration is cycloidal (to dwell). This motion is normally used in conjunction with the **Cycloidal/Harmonic** motion. Dwell motions normally precede and follow this set of motions. A rise and return cycle would be ½ cycloidal acceleration to ½ harmonic deceleration to ½ harmonic acceleration to ½ cycloidal deceleration.

Constant Velocity

A **Constant Velocity** motion has a set velocity during all or part of the motion. This velocity is equal to the maximum velocity of the motion. CamTrax64 allows for a motion to be specified for acceleration and/or deceleration. Cycloidal, harmonic, modified sine, cycloidal/harmonic, harmonic/cycloidal and constant acceleration motions may be used. The acceleration/deceleration portions may be symmetrical or asymmetrical.

Terminal Velocity

A **Terminal Velocity** motion has a constant velocity during a portion of the motion. Unlike the constant velocity motion, which has a set velocity at the maximum velocity, the terminal velocity has a specified velocity near the beginning or the end of the segment. This type of motion can be used for a press operation where greater forces are required near the beginning or end of the stroke. There may be some undesirable spikes in pulse at the transition to and from the constant velocity portion of the motion. Cycloidal, harmonic, modified sine and constant acceleration motions may be used.

Polynomial 8th Power Rise

A **Polynomial 8th Power Rise** when used in conjunction with a **Polynomial 8th Power Fall** and a dwell makes a single dwell cam. The angle of each of the polynomials should be equal to each other to avoid any pulse at the transition between the two motions.

Polynomial 8th Power Fall

A **Polynomial 8th Power Fall** when used in conjunction with a dwell and a **Polynomial 8th Power Fall** makes a single dwell cam. The angle of each of the polynomials should be equal to each other to avoid any pulse at the transition between the two motions.

Polynomial 345

The **Polynomial 345** is very similar to the **Cycloidal** motion. It has slightly less peak acceleration and velocity than the cycloidal motion.

Whereas the symmetry ‘n’ in a cycloidal motion can be specified there is no such option for the **Polynomial 345**.

Polynomial 4567

The **Polynomial 4567** is similar to the **Cycloidal** motion but has a slower start. The peek velocity and acceleration rates are greater than the cycloidal motion. Whereas the symmetry ‘n’ in a cycloidal motion can be specified there is no such option for the Polynomial 4567.

Polynomial 3456 Rise

The **Polynomial 3456 Rise** when coupled with the **Polynomial 3456 Fall** and a dwell makes for an acceptable single dwell cam. The angle of each of the polynomials should be equal to each other to avoid any pulse at the transition between the two polynomial motions. The symmetry ‘n’ value is not configurable.

Polynomial 3456 Fall

The **Polynomial 3456 Fall** when coupled with a dwell and the **Polynomial 3456 Rise** makes for an acceptable single dwell cam. The angle of each of the polynomials should be equal to each other to avoid any pulse at the transition between the two polynomial motions. The symmetry ‘n’ value is not configurable.

Constant Acceleration

The **Constant Acceleration** motion has infinite pulse at the terminals and switches from positive to negative (or negative to positive) at the mid-point of the motion.

Double Harmonic Rise

The **Double Harmonic Rise** is similar to the **Polynomial 3456 Rise** but has a slightly greater peak velocity and acceleration rate. The symmetry ‘n’ value is not configurable.

Double Harmonic Fall

The **Double Harmonic Fall** is similar to the **Polynomial 3456 Fall** but has a slightly greater peak velocity and acceleration rate. The symmetry ‘n’ value is not configurable.

User Points

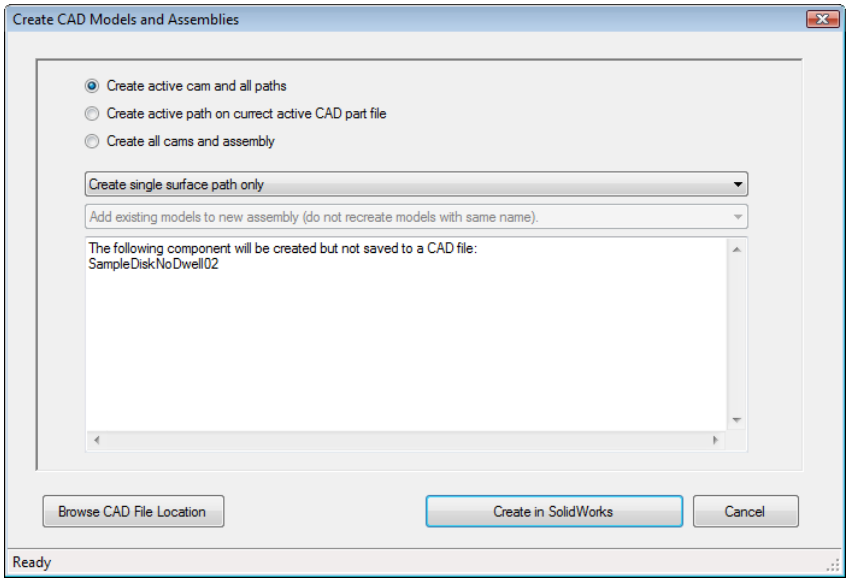
User Points gives the user the ability to specify each point along the motion. The number of points must match the number of degrees of motion multiplied by the precision increment plus 1. To enter points first select the **User Points** motion type then press the **Edit** button in the configure column and to the right of the selection.

By Pass

The **By Pass** 'motion' leaves a blank for that segment of the path. A By Pass type cannot be used when creating the CAD model with a single surface path.

Create CAD Models and Assemblies...

To open the dialog window to create CAD models and Assemblies click on the menu item CAD>Create CAD Models and Assemblies or click on the Create Cad Models and Assemblies bar button.



Options for creating cams and/or assemblies

Create active cam and all paths.

Select this option to create the active cam and all paths associated with the cam. The CAD part file will not be saved automatically.

Create active path on current active CAD part file

Select this option to create only the active path on the active CAD part file. A CAD part file must be active. The path is created about the X, Y or Z axis that is used to define the cam blank.

 It is highly recommended that as many of the non-base features of the CAD part file be suppressed before adding the cam path.

Create all cams and assembly

Select this option to have all cams created in CAD.

There are 3 options available when creating the assembly:

1. Add existing models to new assembly (do not recreate models with same name).
2. Overwrite existing models (existing models will be overwritten).
3. Overwrite any existing models and the assembly.

Path creation options

Each path may be created with one of the following 3 options:

Create single surface path only

This option will create the single surface path that can be used in CAD assemblies for use in animations. This allows the cam follower to be mated to the path for the full 360 degrees of rotation. The path must be a full 360 degrees and terminate where it starts.

Create individual path segments only

This option will create each individual path segment with its own loft or extrusion cut.

Create single surface path and individual segments (suppressed)

This option is a combination of the two other options. The individual segments will be suppressed as they are created leaving the single surface unsuppressed.

Browse CAD File Location

The CAD files may be saved in a location different from the CamTrax64 file location. Click the "Browse CAD File location" button and browse or create a new folder for the CAD files.

Create in "CAD"

Press the "Create in *CAD*" button after making any desired changes to the settings.

The button text will change depending on which CAD is being used. The version number may be included in the button text depending on which CAD Version option is selected in the CamTrax64 Options properties.

Edit CAD Models

To open the dialog window to edit CAD models click on the menu item CAD>Edit CAD Models or click on the Edit Cad Models tool bar button. The background color of the display area will change to a light blue while CamTrax64 is in the edit mode. The Edit CAD Models tool window will remain on top of other windows.

Link

Press the Link button to read the cam data in the CAD file.

Update CAD

Update CAD updates the CAD part file with the revised data in the CamTrax64 component.

Cancel

Cancel will close the edit window.

Close

Close will close the edit window.

Procedure to edit a cam model in CAD

1) Open the cam part file open in CAD.

2) Click on the Link button to read the data from the CAD model.
If there is not an active component in CamTrax64 a new cam will be started. If there is an active component in CamTrax64, the internal identification of the CAD model and the CamTrax64 component will be compared. If they match, CamTrax64 will use the data for the cam that is open in CamTrax64. If they do not match, a message will be displayed and the cam data from the CAD file will not be read. The CamTrax64 component will need to be closed and the link button pressed again.

3) Make the required changes to the component in CamTrax64.

4) Press the Update CAD button to implement the changes to the CAD model.

If the updated model includes a new path, each individual segment will be created and suppressed. Then a single surface path will be created.

If the revised path has less segments than the original path, those extra segments will remain on the CAD file in a suppressed state. Those segments may be manually removed.

Tips on how to have a successful edit:

> Never rename any of the CamTrax64 features. CamTrax64 uses these names to locate these features in the CAD model. This includes names of lofts, extrudes, sketches, guide curves and dimensions.
>
> If the model is manually modified, always do so by adding or subtracting to the features created by CamTrax64. Do not directly modify a CamTrax64 created sketch. For example, a stepped bore is required in the final part. Do not modify the sketch created by CamTrax64. Rather, start a new sketch and then extrude or revolve it.

Limitations to editing CAD models

1. A path on a surface cannot be changed to another surface.
2. The axis of the cam cannot be changed.

Fabrication

The Fabrication properties may be activated for the active path by clicking the Fabrication>Activate Fabrication menu item.

Finishing Tool

Diameter Finishing

Diameter Finishing specifies the diameter of the tool used for cutting the finish passes.

Feed Rate Finishing

Feed Rate Finishing determines the rate of feed for the finish passes.

Stock for Finishing

Stock for Finish determines the amount of stock the roughing passes leave for the finish passes.

Tool Number Finishing

Tool Number Finishing determines which tool number will be selected for finishing. This assumes the machining center has a tool changer.

Depth Cuts Finishing

Depth Cuts Finishing determines the number of depth cuts which will be made to cut the full depth of the path.

Number of Passes Finishing

Number of Passes Finishing determines how many finish passes will be made to cut the remaining stock that the rough cut left.

Spindle Speed Finishing

Spindle Speed Finishing determines the RPM of the tool for the finish passes.

Roughing Tool

Diameter Roughing

Diameter Roughing specifies the diameter of the tool used for cutting the rough passes.

Feed Rate Roughing

Feed Rate Roughing determines the rate of feed for the rough passes.

Tool Number Roughing

Tool Number Roughing determines which tool number will be selected for rough passes. This assumes the machining center has a tool changer.

Depth Cuts Roughing

Depth Cuts Roughing determines the number of depth cuts which will be made to cut the full depth of the path.

Spindle Speed Roughing

Spindle Speed Roughing determines the RPM of the tool for the rough passes.

Cuts

Surfaces to Cut

Select between:

Center Only
Center, Upper and Lower Surfaces
Upper or Outer Surface Only
Lower or Inner Surface Only
Center, Upper and Lower Surfaces

Cuts

Select between:

Finish Cut Only
Rough Cut Only
Finish and Rough Cuts

Feed Rate Z

Feed Rate Z controls the rate of feed for the Z axis when not in a rapid move.

Mill Direction

Select between:

Climb Mill
Conventional Mill

Coolant

Select between:

None
Flood
Mist

Controller

Machine Controller

There are three controllers available. Select between:

Generic G Code
HAAS
MAZAK

Please contact Camnetics support if you would like another controller added.

Program Number

Program Number defines the number that will be assigned to the program.

Mirror X Direction

Mirror X Direction is a user set true or false property. It may be necessary for the CNC machine setup to mirror the X axis.

Mirror Y Direction

The Mirror Y Direction is a user set true or false property. It may be necessary for the CNC machine setup to mirror the Y axis.

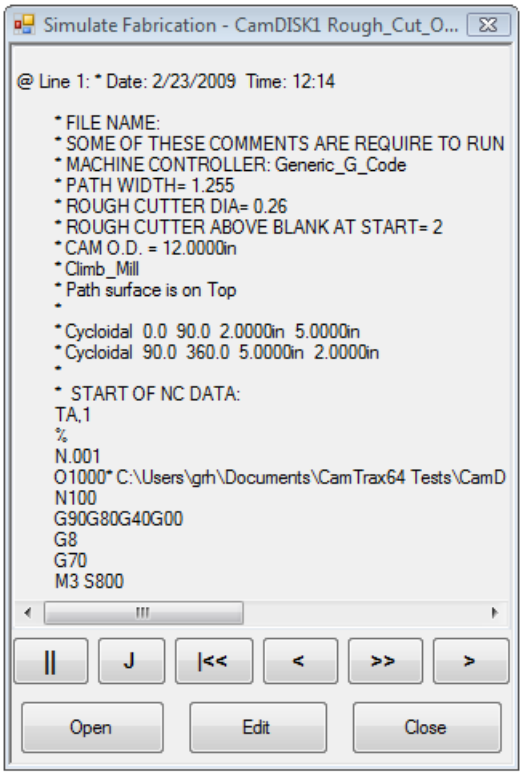
Mirror A Direction

The Mirror A Direction is a user set true or false property. It may be necessary for the CNC machine setup to mirror the A axis.

Simulate Fabrication

Simulate Fabrication allows the user to view a NC (numerical control) file created by CamTrax64 in action.

To Open the fabrication module, click on the GearTeq menu item Fabrication>Simulate Fabrication.



The text window will display about 20 lines of the NC program. The current line will be preceded by "@ Line" and the line number in the NC file.

Buttons

Open

Use the Open button to open a previously created NC file.

Edit

Pressing the Edit button opens the NC file in Notepad so it can be edited or viewed in its entirety. While the file is open in Notepad CamTrax64 will be in a wait mode until Notepad is closed.

Close

Press the Close button to close the Simulation window.

VCR Controls

|| Pause. If the "**||**" button is pressed while the program is being executed the program will halt at the current position.

J Jump out of sub-routine. If the "**J**" button is press while the simulation is being executed in a sub-routine, the program will jump to near the end of the routine.

|<< Go to first line. Pressing the "**|<<**" button will force the program to stop and reset to the first line.

< Go back one line. If the "**<**" button is pressed the program will take one step backwards.

>> Run NC program. If the "**>>**" button is pressed the program will run from its current position.

> Go ahead one line. If the "**>**" button is pressed the program will step ahead one line.

Tool Bars

Insert

 **Add New Cylinder to Assembly**

 **Add New Cube to Assembly**

 **Insert Path**

 **Add Segment**

Standard

 **New**

 **Open**

 **Save Active Component**

 **Save All**

 **Print the CamTrax64 Window**

 **Create CAD Models and Assembly**

Edit CAD Models

Open Chart Window

Open Machine Layout

Standard Views

Front

Front changes the view orientation to Front at the current view scale.

Back

Back changes the view orientation to Back at the current view scale.

Left

Left changes the view orientation to Left at the current view scale.

Right

Right changes the view orientation to Right at the current view scale.

Top

Top changes the view orientation to Top at the current view scale.

Bottom

Bottom changes the view orientation to Bottom at the current view scale.

Isometric

Isometric changes the view orientation to Isometric at the current view scale.

Index X Left

Index X Left changes the view orientation up by the spin increment specified in the Options.

Index X Right

Index X Right changes the view orientation up by the spin increment specified in the Options.

Index Y Left

Index Y Left changes the view orientation up by the spin increment specified in the Options.

Index Y Right

Index Y Right changes the view orientation up by the spin increment specified in the Options.

Index Z Left

Index Z Left changes the view orientation up by the spin increment specified in the Options.

Index Z Right

Index Z Right changes the view orientation up by the spin increment specified in the Options.

View

Last View

Last View changes the view orientation to previous view.

Zoom to Fit

Zoom to Fit changes the current view orientation to fit inside of the window.

Zoom Area

Zoom Area allows the user to draw a box over an area to be displayed at full screen.

Zoom In Out

Zoom In Out allows the user to use the mouse left button to zoom in or out by dragging the cursor on the screen. Dragging the cursor vertically up increases the scale of the display. Dragging the cursor down decreases the scale of the display. The amount of change can be increased by dragging from the upper left hand corner to the lower right hand corner. Conversely, the change can be decreased by dragging from the upper right hand corner to the lower left hand corner.

Rotate the View

Rotate the View allows the user to rotate the view by using either the mouse left or middle buttons to drag the cursor on the screen.

Pan

Pan allows the user to move the view by using either the mouse left or middle buttons to drag the cursor on the screen.

Drive

Drive allows the user to drive the components by using the mouse left button to drag the cursor on the screen.

Simulation

Stop

Stop will stop a running simulation.

Reset to 0

Reset to 0 will set the cam angle of all cams to 0.

Back

Back will drive the components back one spin increment. Set the spin increment in the options menu.

Play

Play will drive the components for a short simulation.

Forward

Forward tool drive the components forward one spin increment. Set the spin increment in the options menu.

Mouse controls

Current Mouse Position

The status bar at the bottom of the screen displays the current mouse position relative to the origin of the currently active component. All coordinates are normal to the screen.

On Screen Measurements

Right click and move for on screen measurements. This is an easy way to get an approximate measurement from the drawing window. All measurements are normal to the screen. The status bar at the bottom of the CamTrax64 window displays all measurements.

Mouse wheel

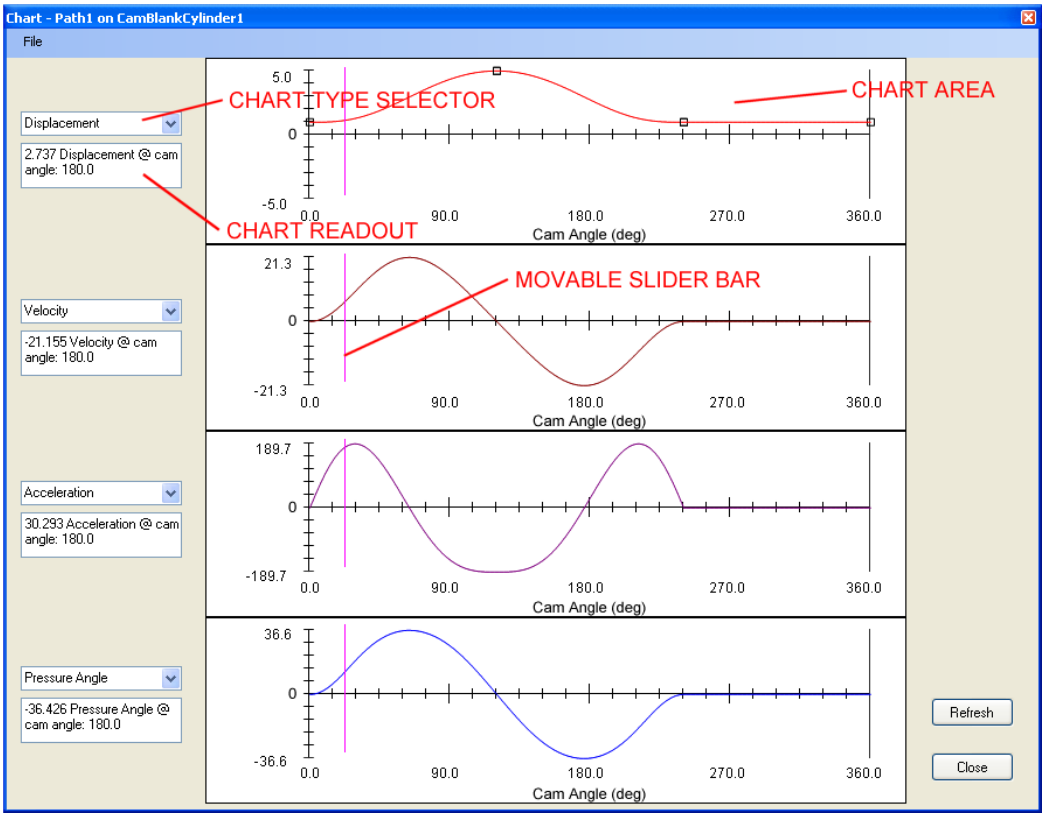
Wheel up and down scales the view of the components. All scaling is done from the center of the screen, not the mouse position. Pan the geometry to the center of the screen then use the mouse wheel to enlarge or reduce the view scale. The direction of the mouse wheel is controllable by a setting in the Options menu.

Middle Mouse Button (wheel)

Drag the view with the middle button held down. The wheel can be rotated at the same time to zoom the view.

Chart

The Chart window displays the current active path.

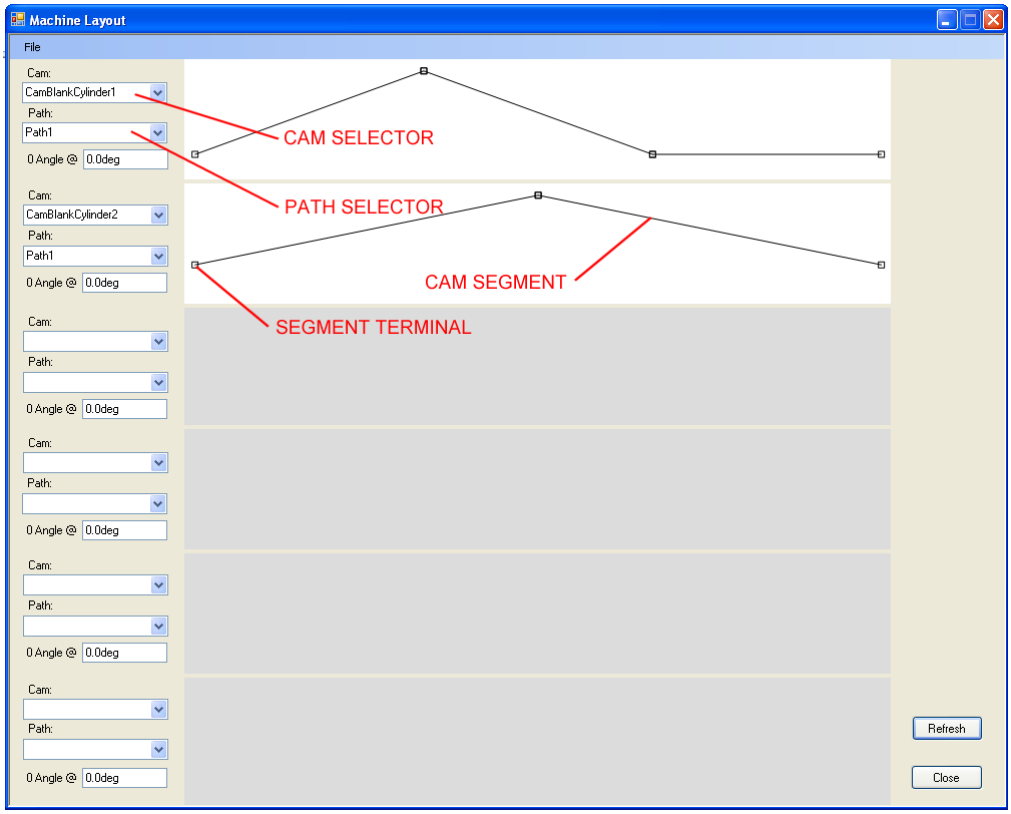


Displacement, velocity, acceleration, pressure angle, torque, normal force, radius of curvature, stress contact and pulse (jerk) may be selected for each of the 4 charts. In addition, the top chart has a layout chart. This shows the displacement of each of the segments in a straight line rather than the displacement curve.

Each of the charts has a slider bar that can be dragged to a new position. The box on the left of each chart displays the angle of the cam slider bar and the value associated with that angle. To drag the bar to a new position, place the cursor over the line, hold down the left mouse button and drag it to a new position.

Machine Layout

The Machine Layout window can display 6 different cam paths at a time.

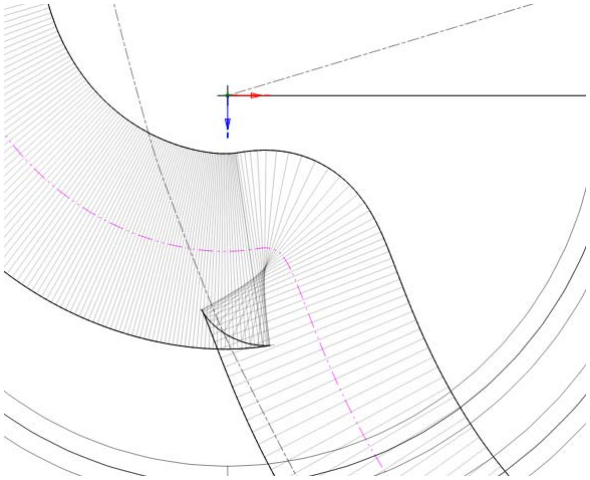


Cam Design 101

Common Cam Design Errors

Under Cutting

Under Cutting is a condition that presents itself often in cam design. Designers are almost always constrained in the amount of space they have to create a cam of adequate size. CamTrax64 can visually help find these problem areas.



Under Cutting of a Disk Cam

Changing any number of the cam and path parameters can help to rectify these occurrences. For example:

Smaller cam follower
Larger cam
Additional segment angle
Increasing the offsets

Motion types that should not follow one another

Cycloidal to cycloidal

Harmonic to cycloidal

Configuring a Constant Velocity Motion Type

Parameters:

Cam RPM: 60
Cycle time: 1.00 seconds
Minimum constant velocity displacement required: 3.50 inches
Constant velocity speed: 16.00 inches per second

Start a new cam by opening the **Sample Cams>Single Dwell>Disk** sample cam.

Change the first motion type from **Cycloidal/Harmonic** to **Constant Velocity.**

Edit the **Configure Constant Velocity** dialog window by clicking on the **Edit** button to the right of the motion type.

In the b paragraph, change the **Accel_Decel_Type** from **Cycloidal** to **Cycloidal/Harmonic**.

Change the **Velocity of CV** to 16.00 inches per second.

Note that the Displacement line is charted without any acceleration or deceleration. This would make an unacceptable cam motion.

Try changing the **End Offset** from 6.0000in to 5.7500in, and then reopen the Edit dialog window. Note that there is now a small section of acceleration and deceleration but the **Displacement of CV** is at 3.42in which is less than the 3.500 minimum required.

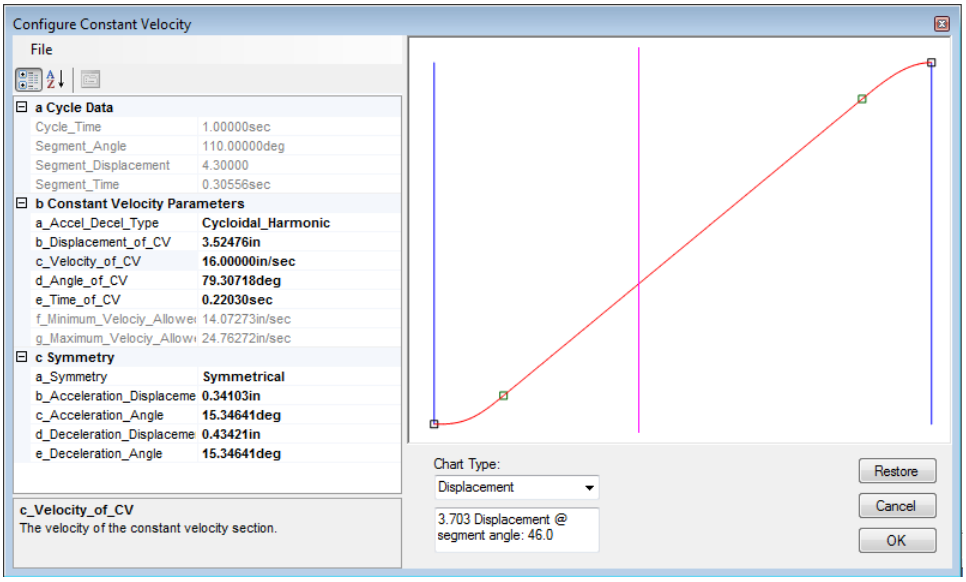
Close the dialog window and change the End Offset back to 6.0000in and change the End Angle to 110.0 degrees.

Reopen the Edit dialog window. Check that 16.00in/sec is specified for the Velocity of CV. Note that the Displacement of CV is at 2.82in, which is far below the required 3.5n inches.

Close the edit dialog window and change the End Offset to 6.50in

Reopen the Edit dialog window. Check that 16.00in/sec is specified for the Velocity of CV. Note that the Displacement of CV is at 3.982in, which is above the required 3.5n inches.

The Displacement at CV can be reduced by changing the End Offset to 6.30inches. The will provide 3.52 inches of constant velocity displacement at 16.00in/sec.



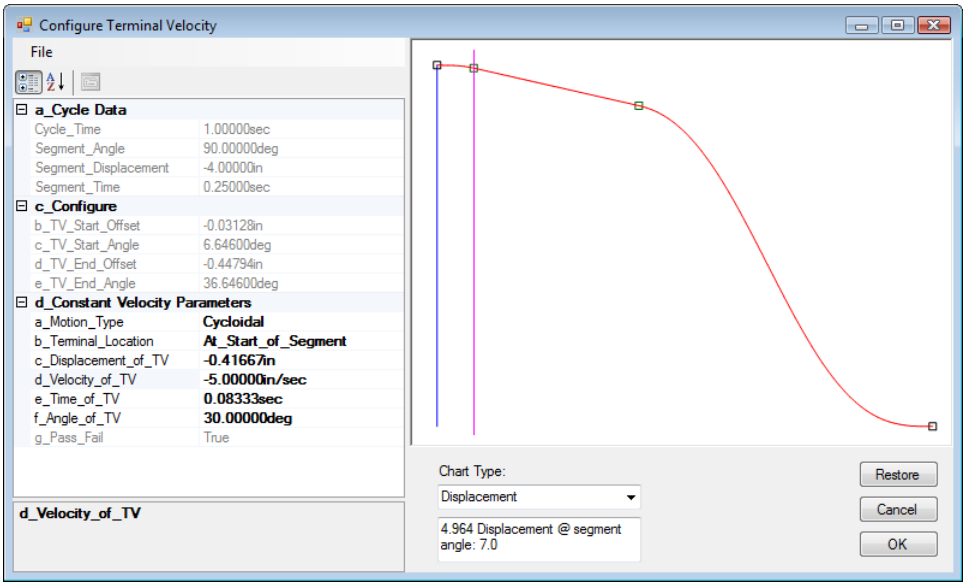
Other changes to the cam parameters will be required to reduce the pressure angle.

Configuring a Terminal Velocity Motion Type

The CamTrax64 Terminal Velocity motion allows the designer to insert a section of constant velocity into a standard cam motion. The section of constant velocity may be inserted near the beginning or the end of the motion.

To put it simply, CamTrax64 calculates the velocity along the motion until it finds the velocity that matches the constant velocity value. It uses that constant velocity for the prescribed distance and then completes the standard motion.

The type of motion used within the terminal velocity will affect the amount of cam angle and offset before the start of the constant velocity.



The above example is from a 90 degree segment that starts at 5.00 offset and falls to 1.00 offset.

The properties in bold maybe changed by the designer.

Select the **Motion Type** to be used for acceleration and deceleration.

Select either **At Start of Segment** or **At End of Segment** for the placement of the section of constant velocity.

Changing the **Displacement of TV** will also change the **Velocity of TV** value.

Changing the **Velocity of TV** will also change the **Displacement of TV** value.

Changing the **Time of TV** will also change the **Angle of TV** value. The value entered must be less than the segment time.

Changing the **Angle of TV** will also change the **Time of TV** value. The value entered must be less than the segment angle.

The **Chart Type** drop down box allows the user to select between a number of different chart types to be displayed in the graphic window.

The magenta slider bar can be dragged left and right. Values for the position of the slider bar are displayed in the text box below the graphic window.

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