

“Field to Finish” and the New Survey Tools in AutoCAD® Civil 3D® 2013

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Class Description

What is Field to Finish?

The ability to download field collected survey data and automatically “draw” an intelligent base map is called “field to finish”. Field to finish methods typically result in the automatic creation of: points, point symbols, point labels, topographic feature lines, and general descriptive line work.

The techniques for good field to finish are easy to implement with knowledgeable use of hardware and software throughout the data collection, download, and reduction process.

Learning Objectives

- Linework codeset setup
- Figure prefix database setup
- Figure collection techniques
- Figure creation
- Figure editing

About the Speakers:

Shawn has held several positions in the industry giving him exceptional experience in surveying, GIS, and design engineering. He has also gained incredible knowledge of the AutoCAD® Civil 3D® implementation process while working in CAD management for commercial and residential projects in Utah, Arizona, Nevada, and Idaho. Shawn has been a part of Civil 3D implementations for several Dept. of Transportation's as well as numerous local government and private entities. Shawn continuously speaks at multiple user groups and conferences across the country and this is his first time presenting at UCLS!!



Jason is a Professional Land Surveyor, Licensed in the State of Utah. He has 19 years' experience in surveying and land planning, with a strong background in Civil Engineering. He was the Chief Designer and CAD Manager for an engineering firm for 9 years and has owned his own surveying firm for the last 10 years. Jason is the most recent addition to the ProSoft staff and will be a valuable asset to the civil engineering and surveying community.

About Field to Finish

Huge efficiency gains may be realized in the survey data collection and reduction process. Knowledgeable use of hardware and software can not only save time but also assure accuracy. The ability to download and automatically “draw” survey data is called “field to finish” (F2F). F2F can be accomplished with and without the use of fieldbooks. This paper discusses the traditional use of fieldbooks.

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The techniques for good field to finish are easy to implement with knowledgeable use of hardware and software throughout the data collection, download, and reduction process.

The field to finish process includes these steps:

- Mission pre-planning
- Using consistent point descriptions
- Adding linework connectivity commands
- Applying description code keys
- Applying figure prefixes
- Download into a pre-set drawing environment

Why is Field to Finish so Important?

Survey data collection is an often overlooked task, yet it is one of the areas where great efficiency and accuracy can be achieved.

- Surveyors are the witnesses in the field – they see it, so they should draw it
- Errors and omissions can be discovered early and even checked before leaving the field.
- The additional time it takes to add proper field codes is small in comparison to the amount of work that it takes to reduce raw survey data in the office.
- Using linework often results in fewer survey points being required.
- Check work before leaving the field

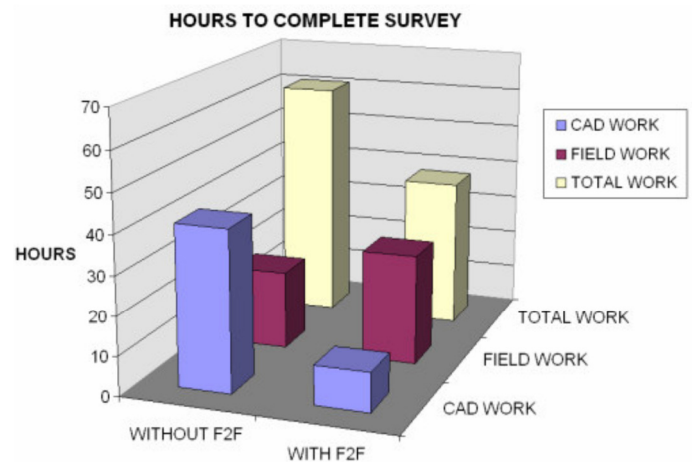
The use of field to finish will increase the time spent in the field by a small amount. This is due to the need for proper mission planning, code and figure determination, and the need to add connectivity commands as a prefix to point descriptors on certain points.

However, the increase in time spent in the field is more than offset by the time savings realized by the reduction in CAD drafting (connect the points) tasks.

The statistics of using field to finish procedures is proven to be approximately:

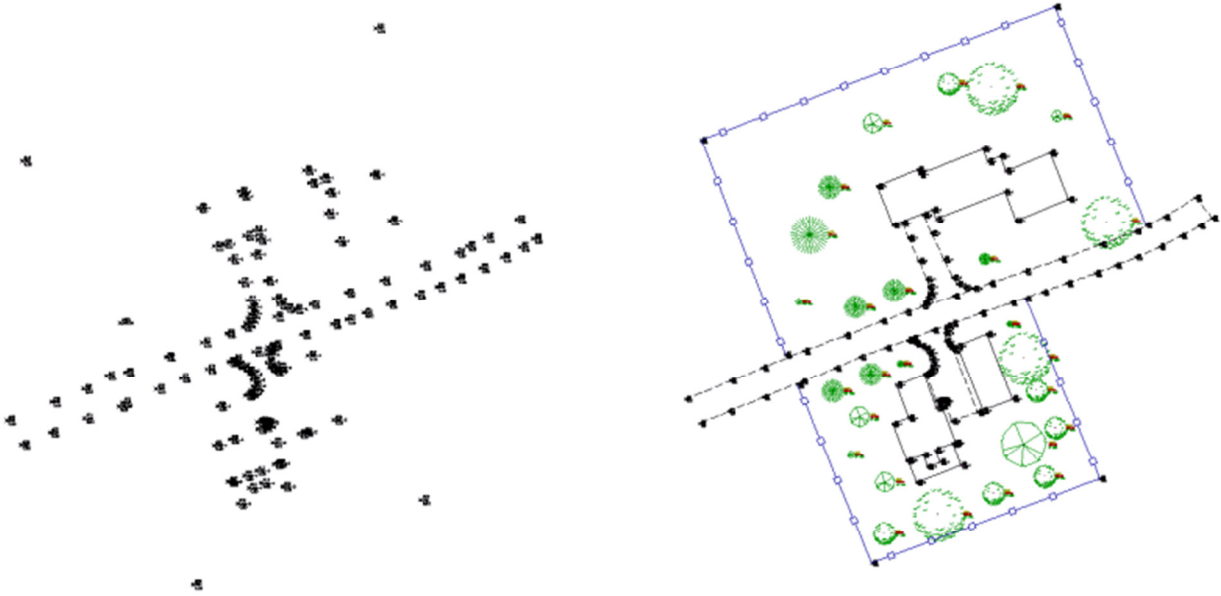
Increase in field time ~5%

Decrease in CAD time ~75%



Examples of Field to Finish Line Creation Using Autodesk Fieldbook Methodology

The example - on the left in the image below shows a normal survey data import – just COGO points with descriptions. The example on the right shows the same data with the simple addition of a few linework commands and use of description keys and figure prefixes.

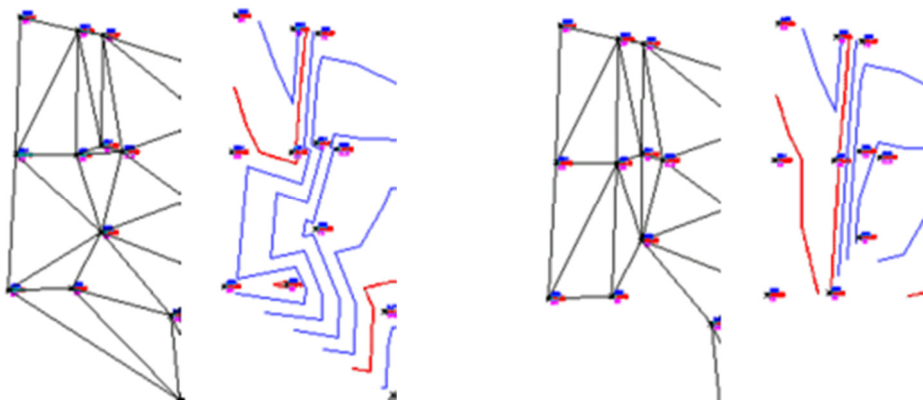


This is also important to describe topographic features, and can result in the creation of much more accurate surface models than without. The field crews are in the field and are the first and best witness to the characteristics of the land, where there are surface perturbations such as edges of embankments, flow erosions, and piles of dirt.

One advantage of field to finish methods is the ability to download and check field work directly in the field. This quick and easy analysis can save time and accuracy issues by discovering problems and lack of good data before you break down the equipment set-up and drive back to the office.

Another example - of surface creation with and without field crew recognition of surface features is shown in the image below.

The exact same field point collection is shown – the TIN and the resulting contours shown on the left result from surface creation using only those points. The TIN and contours that are shown on the right are the result of the field crew identifying an edge of road during their point collection.



The difference in the interpretation of the points that were field collected to define an existing conditions surface in this example is significant. If the surface on the left is carried forward to the design and engineering analysis phase many things will be affected, such as earthworks, drainage, slope staking to name a few.

Steps for Successful Field to Finish

The field to finish process includes these seven steps:

1. Mission pre-planning – the review of documents field sketches set-ups figures, descriptions
2. Using consistent point descriptions – ...EOP not EPVMT specifics covered in more detail
3. Adding linework connectivity commands - using Autodesk field methodology covered in more detail
4. Applying description code keys – specifics covered in more detail
5. Applying figure prefixes– specifics covered in more detail
6. Download into a pre-set drawing environment – importance of using **dwt's**
7. Check you work before leaving the field – download before equipment break-down



Successful Field to Finish Uses Autodesk Fieldbook Methodology

Understanding Field Book Files

Field book files (.FBK) are digital files that show a record of survey observations, settings, and notes that are made in the field. FBK files are coded in ASCII so they may be read, understood, and edited in a simple text editor.

The syntax of FBK files is Survey Command Language. It is space delimited.

The Autodesk Fieldbook file - .fbk and the methodology that makes it work was developed in the legacy software applications that eventually evolved into Autodesk Land Desktop and now AutoCAD Civil 3D. The purpose of this file was to hold raw survey observations in digital, or electronic, format and facilitate the creation of line work, both straight and curved. The original fieldbook files required a good knowledge of the survey command language that is used to create the linework. One had to know when to end, recall, and continue linework when data collection was not consecutive for surveyed features. The modern version of the fieldbook file is much easier to implement with only a few linework commands necessary, and the fieldbook is “smart” enough to automatically add the appropriate end, recall, and continue statements where needed. Also 3D curve and reverse curve features are now supported, however the ability to double code a single point to participate in the creation of more than one line feature is not supported.

The Simple Line Creation Commands Used in Autodesk Fieldbook Files

The ability to create linework as data is collected in the field is an essential step in the field to finish process.

The commands used in field data collection range from quite simple to complex.

One of the simplest ways to create linework as survey points are collected is by using the Autodesk Fieldbook methodology.

The method is simple: points are collected with descriptions, when a line is desired a connectivity command is placed directly in front of the point description; the data is exported from the data collector as raw observations or as a coordinate list; the exported file is converted into a fieldbook file using a conversion utility; the fieldbook file is imported into Civil 3D through a survey database; the points are inserted into the project drawing as COGO points and the linework is inserted as figures.

One of the simplest ways to create linework as survey points are collected is by using the Autodesk Fieldbook methodology.

For example a simple command to start the line work for a figure named EOP would be: BEG EOP

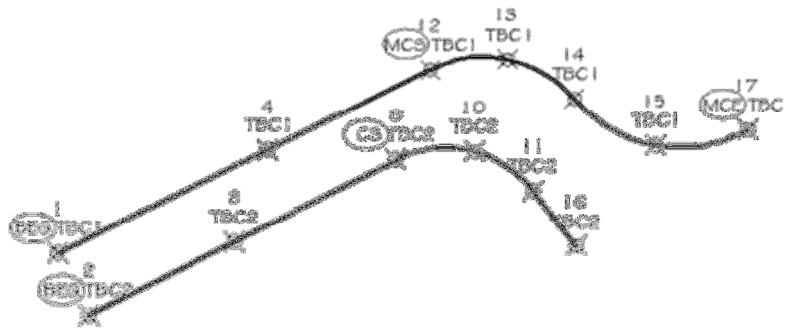
This instruction will connect any points with the description EOP, sequentially in the order in which they are collected. However other points may be collected and commands may be issued at anytime in-between the EOP points.

When the raw collection file is converted into an Autodesk fieldbook (.FBK), the intermediate instructions to stop and continue the EOP lines are automatically added. You do not need to add commands to control linework once started, you just need to be consistent with the naming.

Here are the few commands that you will need in the field:

BEGIN	Starts a figure
BEG	Starts a figure
C3	Creates a 3 point curve (must be collected consecutively)
MCS	Starts a multiple point curve (must be collected consecutively)
MCE	Ends the multiple point curve

The linework features in the image below are displayed along with the survey commands included as the prefix to the point description. These survey commands, shown inside the ovals, are automatically removed from the point description when the fieldbook is created.



Below, on the left, is the raw coordinate file that was used to create the fieldbook file, shown on the right, for the linework features in the above example.

1,29.7794,12.6854,0.00000,BEG TBC1	BEG TBC1
2,25.8546,14.6532,0.00000,BEG TBC2	NE SS 1 29.77940 12.68540 0.00000 "TBC1" BEG TBC2
3,30.4935,23.7821,0.00000,TBC2	NE SS 2 25.85460 14.65320 0.00000 "TBC2" NE SS 3 30.49350 23.78210 0.00000 "TBC2"
4,36.2636,25.8455,0.00000,TBC1	CONT TBC1
9,35.6563,33.9420,0.00000,C3 TBC2	NE SS 4 36.26360 25.84550 0.00000 "TBC1" CONT TBC2
10,36.1584,38.8947,0.00000,TBC2	C3
11,33.6959,42.5511,0.00000,TBC2	NE SS 9 35.65630 33.94200 0.00000 "TBC2" NE SS 10 36.15840 38.89470 0.00000 "TBC2"
12,41.3237,36.1152,0.00000,MCS TBC1	NE SS 11 33.69590 42.55110 0.00000 "TBC2" END
13,41.9463,40.9547,0.00000,TBC1	CONT TBC1
14,39.4722,45.1603,0.00000,TBC1	MCS
15,36.5535,50.2603,0.00000,TBC1	NE SS 12 41.32370 36.11520 0.00000 "TBC1" NE SS 13 41.94630 40.95470 0.00000 "TBC1"
16,30.2109,45.2755,0.00000,TBC2	NE SS 14 39.47220 45.16030 0.00000 "TBC1" NE SS 15 36.55350 50.26030 0.00000 "TBC1"
17,37.5119,56.0579,0.00000,MCE TBC1	CONT TBC2 NE SS 16 30.21090 45.27550 0.00000 "TBC2" END
	CONT TBC1
	NE SS 17 37.51190 56.05790 0.00000 "TBC1" MCE END

Note, in the raw file, the placement of the survey commands before the point description and separated with a single space. Note, in the resulting fieldbook file, the removal of the survey commands from the point description and the automatic addition of the continue and end commands.

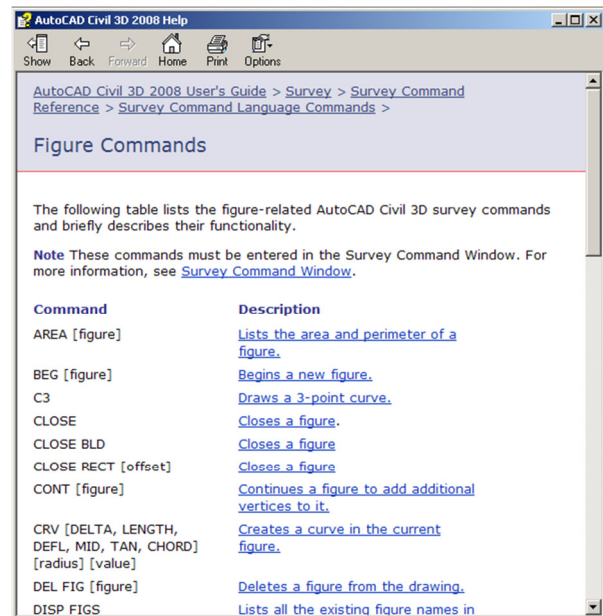
Line Creation Rules of Thumb

Here are a few rules to remember for successful linework creation in the field:

- The survey command is placed in front of the point description and separated with a space
- The name of the figure is the point description immediately following the BEG or BEGIN command
- The linework will automatically end, re-start, and continue for each subsequent point with the same description as the figure name (the description following the BEG command)
- There is no practical limit to the number of named survey figures that can be used in one file
- Older file conversion utilities, such as "Survey Link" do not recognize the MCS and MCE survey commands
- Other points may be collected and commands may be issued at anytime in-between the EOP points
- Double coding of points is not supported via Fieldbooks
- Fieldbook files may be opened, viewed, and edited in any simple text editor.
- Sweep in one direction

The complete listing of the Survey Command Language Commands is available in Help:

Search: *Survey Command Language*



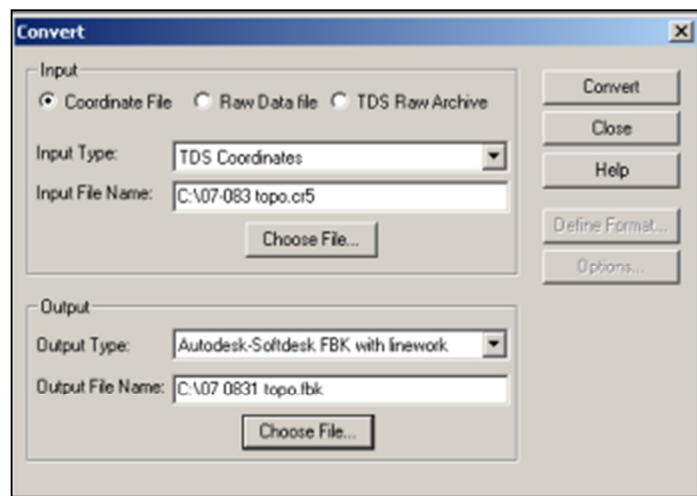
How are FBK Files Created

There are several ways to create an Autodesk .fbk file.

- Raw survey data to FBK using the Survey Link utility – available by download
- Raw survey data to FBK using a third party conversion utility typically provided by the survey equipment manufacturers
- Direct creation from data collector on-board application
- Using the Survey Command Line and manually creating/editing batch files
- Exporting fbk files from an existing Civil 3D Survey Database

Conversion Using Survey Link

FBK files are made from converting raw files that contain survey commands into FBK files using a conversion utility, such as Survey Link.



Converting an ASCII Point List into a Fieldbook File with Linework

Often survey data is delivered as plain ASCII point lists which are typically imported directly into the project drawing using the Point Insert command.

The resulting import only displays COGO points and, depending description key use or point group inclusion, a point symbol and label.

To create line work between the desired points you must have additional information from the surveyor – such as a field sketch or a listing of connected point numbers. In this instance a “connect the points task” must be undertaken in the office. This is where time is spent and errors can be introduced.

Clever use of the Survey Link utility in Civil 3D in some cases make a first step to connecting the dots.

About Figure Prefixes

Figures are used to represent features such as buildings, roadway centerlines, and edges of pavement, as well as topographic features such as tops of banks, bottom of slopes, and streambeds. Using figures in survey data can greatly increase productivity and the accuracy of base map drawings and surfaces.

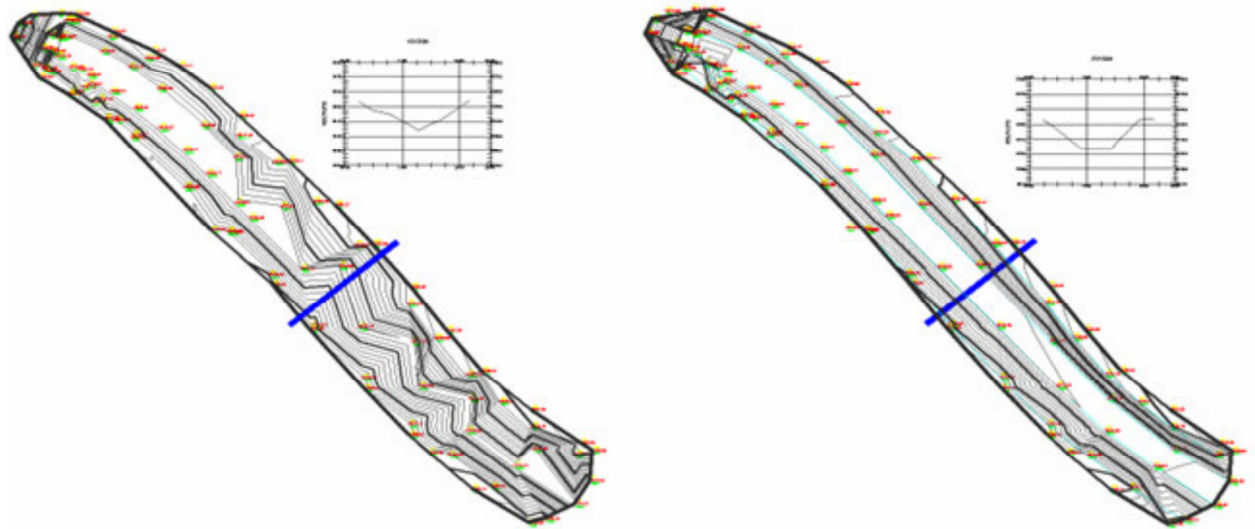
Figure prefixes are used to organize figures for graphical needs, for participation as surface breaklines, and as parcel defining boundaries. When the first few characters of a figure name are matched in the assigned Figure Prefix Database the corresponding style (or layer) is applied to the figure. If no match is found, the figure is created on the default layer using the default style. The defaults are established in the figure feature settings.

Figure prefixes require only the first few characters of a figure name to create a match and they do not use wildcards. Figure prefixes are stored in the Figure Prefix database.

Name	Breakline	Lot Line	Layer	Style	Site
BB	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	C-TOPO-F	Standard	Survey Site
BC	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	C-TOPO-F	Standard	Survey Site
BLDG	<input type="checkbox"/> No	<input type="checkbox"/> No	BLDG	Buildings	Survey Site
BRK	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	V-TOPO-B	Standard	Survey Site
BW	<input type="checkbox"/> No	<input type="checkbox"/> No	V-FENC-B'	Barbed Wire Fence	Survey Site
CLRDR	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	V-ROAD-C	Road Centerline	Survey Site
DRV	<input type="checkbox"/> No	<input type="checkbox"/> No	DRV	Curb	Survey Site
EG	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	V-ROAD-E	Gravel Road	Survey Site
EOR	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	V-ROAD-E	Curb	Survey Site
EW	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	V-WETL-E	Wetland	Survey Site

Figures Marked as Breaklines

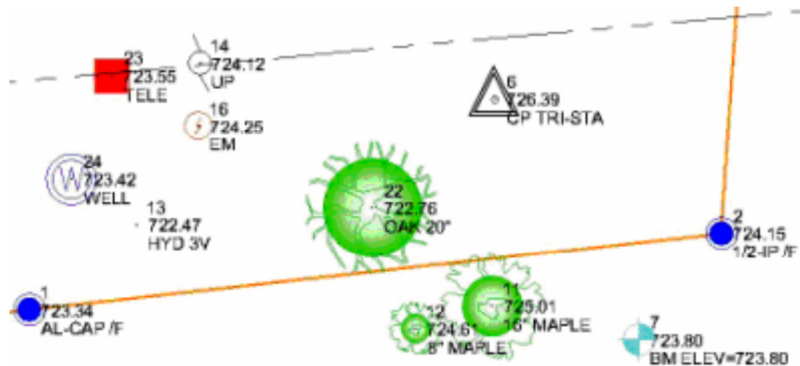
An important task of figure prefixes is the ability to mark figures for use as breaklines in the creation of surfaces. In the following image the surface on the left was built using only surveyed point data, the surface on the right was built using both point and figure survey data. The resulting differences are significant.



Description Keys

Description keys are used to match point descriptions much the same way figure prefixes work to with figures. Description keys can be used to interpret the description of a Civil Point and automatically apply an appropriate style.

For example, Control points may be styled to show a station symbol and display point number, elevation, and full description information. Tree points may be styled to show a tree symbol and only display description information. Description keys may also control the sizes and rotation of symbols that are applied to points.



Description keys work by using Codes and Formats:

Code – seeks a match to the point's raw description. If a code is matched then the point styling (or layer) and description format are applied.

Format - a format interprets a point's raw description for point label information in a drawing. If no interpretation is needed the \$* wildcard is used to pass the exact raw description through to the COGO point label

Code	Point Style	Point Label Style	Format	Layer
ASH*	<input checked="" type="checkbox"/> ASH - 3D	<input checked="" type="checkbox"/> Standard	\$1" \$0	<input checked="" type="checkbox"/> V-
OAK*	<input checked="" type="checkbox"/> Oak - 3D	<input checked="" type="checkbox"/> Standard	\$1FT \$0	<input checked="" type="checkbox"/> V-

Description Keys and Description Key sets are drawing dependent and not part of the Survey Database. They are defined, saved, and remain as part of the .DWG.

Description Code Wildcards:

Wild cards make code description matching more powerful. Wild cards are used to reduce the need for multiple description keys for points of similar, but slightly different, descriptions.

Wild Card	Definition	Example
*	Matches any single or multiple character	STA* will match STA100, STATRI, and STATION.

@	Matches any single alpha character	STA@ will match STAR and STAA.
#	Matches any single numeric character	STA# will match STA1 and STA9.

Importance of .DWT's

It is important to begin any Civil 3D project drawing with a Civil 3D specific template file (.DWT). The template file contains object and label styles in a general project environment that is specific to either metric or imperial units.

There are many sample templates available “out of the box” when you install Civil 3D. These templates are used as the starting point to develop your own custom styles, labels, and project settings.

The default location of these files is:

C:\Documents and Settings\login_name\Local Settings\Application Data\Autodesk\C3D 2013\enu\Template