



TR21070

5 Tools and Tricks I Learned from Teaching AutoCAD Civil 3D to Caltrans Employees

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Learning Objectives

- Learn the hidden tips and tricks embedded in surface DTM routines
- Discover tips and tricks to implement data shortcuts for your organization
- Learn profile creation commands that you might not know
- Learn hidden alignment commands

Description

California Department of Transportation implemented AutoCAD Civil 3D 2012 software as its primary design software, and AutoCAD Civil 3D software instructors like me have been training their employees on their specific AutoCAD Civil 3D workflow. In this one hour, you will learn the hidden tips and tricks developed while training AutoCAD Civil 3D software to Caltrans employees. This session features AutoCAD Civil 3D.

Your AU Expert(s)

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Caltrans Civil 3D implementation

Caltrans implemented Civil 3D 2012 with customized launcher, interface, commands, reports, subassemblies and templates. This implementation is unique because Caltrans is replacing CAiCE with Civil 3D as their design tool but will keep using Microstation for drafting. I bring this up because this adds an extra step of exporting the completed design drawings to Microstation format for drafting/printing in Microstation.

Caltrans Civil 3D Launcher

At Caltrans, users launch Civil 3D using this launcher not the regular Civil 3D desktop icon. This sets, among other things, the AutoCAD profile (ARG file). There are two main profiles – mainly Survey and Design. The launcher sets two things: 1) the data shortcut system variable, DSSYSVAR; and through the profile ARG sets the template for QNEW command.

Caltrans Standards

Caltrans created two main Civil 3D drawing templates (DWT) – one for Survey and one for Design. Survey template is for Survey Department and includes styles for both Survey & Right of Way Department. Design template includes all the styles for roadway design standards.

Object Styles - Analysis & Production

Further, both drawing templates include two types of styles – Analysis and Production. Production styles display Civil 3D objects as per the Caltrans printing & drafting standards. These styles not only display the Civil 3D objects correctly per Caltrans standards in Civil 3D but also make sure that they translate correctly to the right level in Microstation upon export to Microstation for drafting/printing. In digital format, however, the production styles display all Civil 3D objects in plain white color which does not facilitate analysis while designing, hence, another sets of styles for analysis. The Analysis styles show objects in greater details to aid in design such as displaying the curves and tangents in different colors.

Caltrans Design Standards (based on Highway Design Manual)

This is the design criteria XML file used primarily to assign superelevation to an alignment and create superelevation diagram. It is also used to design curves based on design speed as per the design criteria. You can use the design criteria to design profile vertical curves as well.

Caltrans Training

The Caltrans training involved training multiple users in multiple districts geographically separated across the whole state. This meant setting up training labs in each location with the machines powerful enough to run the Caltrans Civil 3D launcher, custom Caltrans commands, other customization, and the dataset for various courses. This was a challenge considering their customization was constantly being updated, the template was constantly being revised. All the above made it inevitable to revise the courseware manuals and datasets.

Approach

Training can be delivered in two broad formats – feature based and workflow based. Feature based training teaches the users on software features and leaves it up to them to apply the features learnt to their own projects. Project based training is delivered



using project workflow and lets users apply the concepts learnt immediately. At Caltrans, the training plan was to train users in their own departmental workflow using a workflow based courseware manual.

For a project based training the dataset & courseware is based on a typical project workflow. Feature based training, on the other hand, is delivered on standard feature based courseware manuals.

Key User training

The key to a successful training is to identify power users and train them on the typical project workflows. Caltrans trained the key users in their HQ in Sacramento. Then, based on the key user feedback, workflows were vetted and improved. Based on this Upon completion of this, training was implemented for rest of the 4000 users at Caltrans.

Training Courses

Caltrans training courses were broadly classified in two departmental categories: 1) Survey and 2) Design. Survey users were trained for digital terrain modeling (DTM) workflow and right of way (ROW) workflow. The design department conducted multiple training courses such as ramp design, retaining wall design, structure design, roadway rehabilitation.

The most amazing thing about the training was how the design workflows were beautifully amalgamated with the basics of AutoCAD. I should suffice here that Caltrans had been using CAiCE for design and Microstation for drafting, not AutoCAD. To train users on Civil 3D they need to understand the basics of AutoCAD. Hence the manuals were designed to include the basics of AutoCAD. From my experience this was very beautifully done. A typical AutoCAD training runs into three days but the three-day course was stripped to include getting started, basic drafting, object creation and basic editing on one day in two chapters. Because the annotation and printing is being done in Microstation this training did not include any AutoCAD annotation or printing.

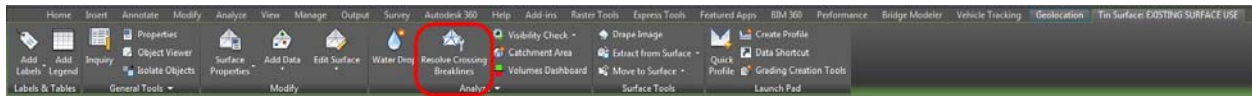
Courseware

Caltrans training was conducted using courseware manuals designed specifically to meet departmental needs. A separate courseware manual was written, for each department, based on that department's workflow keeping their deliverables in mind. As an example, there was a separate manual for Survey DTM, Right Of Way (ROW), Roadway Design & Retaining Walls, Structures, etc. Further, the training for design department had three levels of training, hence three manuals: Civil 3D Basics, Intermediate and Advanced.

Hidden Tips and Tricks

Surface DTM routines

The first thing that I want to highlight here is the resolve crossing breaklines tool. Specifically, within this tool there is an option to resolve the breaklines from the Survey database. This was heavily used at Caltrans to create a final DTM.



Data Shortcuts

Two Tiered

Data Shortcuts is the way to collaborate & share Civil 3D objects, that may be in multiple drawings, across a project team. But if your team creates multiple, let's say, small surfaces and stitches them together to create final deliverable you may want to share only the final deliverable. But you cannot work within your team without sharing the intermediate data (small surfaces) via data shortcuts.

So, Caltrans implemented 2 levels of data shortcuts for Survey. The lower tier is internal to Survey department and all the through put is created and shared at that level. When the team is ready to deliver the final topographical surface to the Design team the data shortcut is created at the top tier delivering the surface to the design team. Brilliant! Isn't it!

DSSYSVAR

This less known little documented environment variable plays a very significant role in pathing your data shortcuts and files. In a nutshell, when you use data shortcuts Civil 3D uses file paths and object names to find your Civil 3D objects in multiple drawings. These addresses are hard coded as an **absolute path**. With the help of the system variable DSSYSVAR you are able to make the paths relative. DSSYSVAR is saved outside of Civil 3D at Windows level; as an environment variable, and therefore you need to set it in Windows settings. Caltrans customized launcher took care of it.

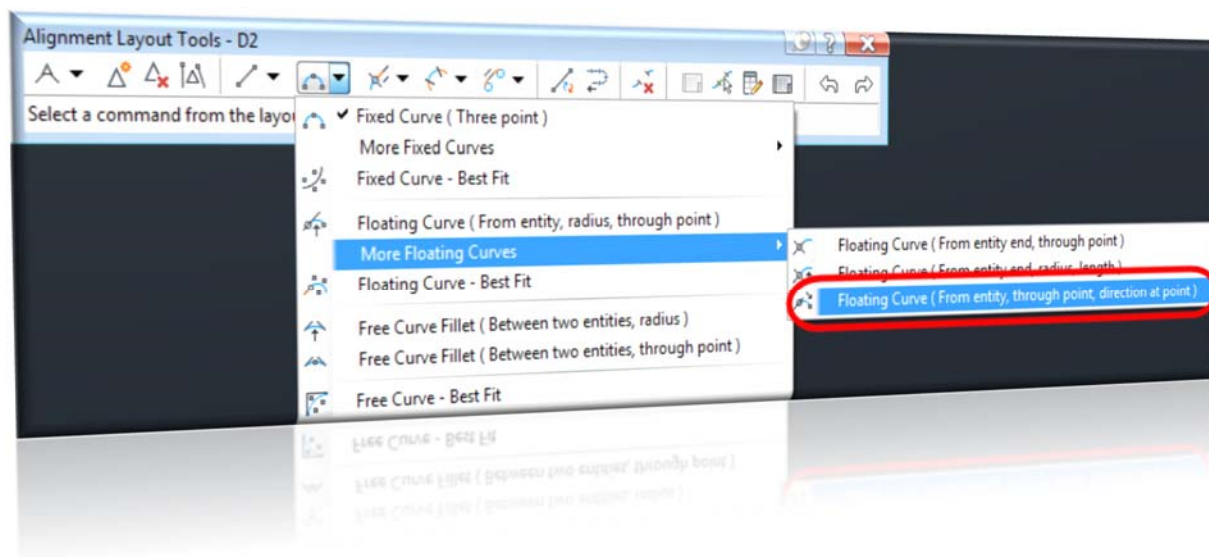
Alignments

While it is very easy to create an alignment by picking the PI points on the screen it becomes tricky when there are multiple constraints. For example, here is an on-ramp that must meet the design criteria for gore area length and deviation angle. It is adjacent to another ramp so its alignment is governed by the number of lanes on the ramp, typical section and grading between both. So, tools are needed to accommodate these complex and real time design situations. That leads me to introduce you to a lesser known tool in Civil 3D:



Floating Curve (From entity, through point, direction at point)

Adds a floating curve from an existing entity to a specified pass-through point.



This tool is used to create the curve number 4 in the diagram above which is tangent to tangent 1 and needs to be tangent to the **floating curve 3**.

Speaking of floating curve, Civil 3D accommodates three types of curves: fixed, floating & free. Fixed curves are fixed on three points such as a 3-point arc. Floating curves are tangent on one side such as a curve from end of object. Free curves are tangent on both sides such as a curve between two tangents.



Profile

Like alignment creation it is easy to create profile when you know the PVI points or know a certain grade & length or station to target. But when you have multiple constraints from the start of profile till the end the story changes. In this example, the Ramp profile starts from left at the center of the existing road so we know the elevation and slope at the starting tangent (point 1 in figure below). Similarly, we can determine the elevation and slope of the ending tangent of the ramp by matching the existing conditions (point 2 below). Furthermore, the ramp can have a maximum slope 8%.

To simplify a situation like this the tool of choice was **Solve Tangent Intersection**, as below.



Using this tool is simple and methodical. You start by defining the tangent 1 (1 in red above) and then the tangent 2 (2 in the picture above) and then this tool will find the PVI station & elevation for you. With the tangents defined it is easy to add vertical curves.

Intersection

Caltrans does not use the Civil 3D intersection design tool. While there may be other reasons for doing that but the one thing that stands out is that Caltrans uses data shortcuts for the alignments & profiles so they get locked for editing. And the intersection design tool needs them to be unlocked for editing in the drawing, in case, there is a need.

The other interesting part about intersection design is the brilliant frequency manipulation.

In the figure above look at the red rectangles. If the cross-section lines are not matched together there will be a slight difference in the elevation due to interpolations. And the contours would reflect that. So, at Caltrans, the corridor frequency of the curb return fillet regions was matched with the primary road frequency stations as manually added extra stations. Here is the same the same curb return after the correction:



You can clearly see the cross sections corrected at area 1 & 2 and the problem persists in the area 3. And here is the frequency dialog box – notice the arbitrarily large value along tangent and curves and the manually added station in the list below.



Property	Value
Corridor Information	
Horizontal Baseline	
Along tangents	1000.000'
Along curves	At an increment
Curve increment	1000.000'
Mid-ordinate distance to define curv...	0.100'
Along spirals	5.000'
At horizontal geometry points	No
At superelevation critical points	No
Vertical Baseline	
Along vertical curves	1000.000'
At vertical geometry points	No
At high/low points	No
Offset Target	
At offset target geometry points	No
Adjacent to offset target start/end	No
Along offset target curves	<None>
Curve increment	25.000'
Mid-ordinate distance to define curv...	0.100'

Station	Description
0+40.10'	
0+45.04'	
0+49.14'	At Intersection Point
0+50.63'	
0+52.66'	
0+55.00'	
0+57.60'	
0+60.58'	
0+63.97'	
0+67.76'	
0+71.98'	
0+76.55'	
0+81.40'	

Resources

Data Shortcut Setup

<https://knowledge.autodesk.com/support/autocad-civil-3d/learn-explore/caas/CloudHelp/cloudhelp/2017/ENU/Civil3D-UserGuide/files/GUID-0AC8F3A4-13D5-4C75-8CF0-64AD071CB2D9-htm.html>

Data Shortcuts Workflow Block diagram

<http://docs.autodesk.com/CIV3D/2012/ENU/filesCUG/GUID-313C6B30-8807-4A1F-A2A4-1C93991DA39-12.htm>

Alignment

<https://knowledge.autodesk.com/support/autocad-civil-3d/learn-explore/caas/CloudHelp/cloudhelp/2016/ENU/Civil3D-UserGuide/files/GUID-3569320A-976F-4087-9209-06516B91A258-htm.html>

Profile

<https://knowledge.autodesk.com/support/autocad-civil-3d/learn-explore/caas/CloudHelp/cloudhelp/2017/ENU/Civil3D-UserGuide/files/GUID-EE4DCA72-9291-4F67-BA25-FA5D825FF1F6-htm.html>

Caltrans Resource files

http://www.dot.ca.gov/hq/oppd/cadd/rsc_files/webpage.php

