

# Carlson Grade Release 1.1

## Table of Contents

1. About Carlson Grade .....	4
2. Software Components and Options .....	6
Telescope .....	6
Stargazer .....	8
Productivity Tools.....	8
3. Hardware Components and Options .....	9
Required Components	
GPS or Robotic Total Station .....	10
GPS Setup .....	11
GPS Correction Radio Link .....	12
Computer.....	13
Optional Components	
Tilt Sensors .....	13
Reverse Sensors .....	14
Rotation Sensors .....	14
Depth Sensors .....	14
Light Bars.....	15
Mast.....	15
Hydraulic Blade Controls .....	16
Wireless Radio Systems.....	16
4. Loading and Configuring Carlson Grade.....	17
Product Registration.....	19
Re-Installation.....	22
Configuration File Descriptions.....	22
Installation Tips .....	22
5. Files and Formats Used in Carlson Grade .....	23
Localization File .....	23
Plan View File.....	23
Guideline/Centerline File.....	24
Profile File .....	24
Coordinate File.....	25
Lower Coordinate File .....	25
Special Coordinate File.....	25
DTM Surface Files and Flat Pads .....	25
Primary Surface .....	26
Existing Surface .....	26
Other Surfaces.....	26

Changing Surface Properties.....	27
Other File Descriptions .....	28
6. Operator Interface .....	29
Starting and Exiting Carlson Grade .....	29
Selecting Projects and Job Files.....	31
Change Project.....	32
New Project.....	32
Edit Project.....	33
Field Design: Ramps, Slopes, Flat Pads .....	34
New Slope/Ramp .....	34
Field Design: Drill Pattern Layout.....	36
Switch To Slope, Flat Pad, or Primary Design .....	37
Hold Slope .....	37
Select Files .....	37
Tasks and Delays - Identify and Log for Analysis .....	38
GPS Monitor Screen and Satellite Forecast.....	38
Reverse Button.....	41
Screen Views and Controls .....	42
Magnifying Glasses for Zooming .....	42
Pan the Plan View .....	42
Vertical Offset (Up-Down Arrows) .....	42
Tools .....	42
Screen Options .....	43
Display Options .....	44
Pick and Setup Centerline (Guideline) for Station/Offset Reporting .....	44
Delete Drilled Hole .....	46
Navigating to Points.....	46
Logging and Storing Points, Singly or At Interval .....	48
Warning and Hazard Zones .....	48
Messaging .....	48
7. Manager and Advanced Operator Interface.....	48
Advanced Tools Menu.....	48
Position Source or GPS/TPS Setup.....	49
Receiver .....	50
Settings.....	51
Radio.....	52
RTK.....	52
QuickStart .....	52
Reset Driver .....	53
Send Command.....	53
Equipment Options .....	53
Reverse Sensor.....	53
Second GPS .....	53
Configuring and Calibrating Sensors.....	54

Tune Hydraulics.....	57
Choosing Vehicle Type.....	60
Vehicle Settings .....	61
Set Time Zone.....	62
Localize.....	63
Check For Correct Projection .....	63
Load Existing Localization File.....	63
Create New Localization File .....	63
Edit Point .....	65
Vertical/Horizontal Component Control.....	65
Discussion of Localization Techniques .....	65
Radio .....	65
System Options .....	65
Localization Options .....	66
Advanced Project Options .....	66
General Options .....	67
Logging Options .....	68
File Utilities .....	70
Navigation Options .....	71
Product Registration.....	71
 8. Typical Operation Scenarios	
Dozer, Scraper, Loader Cutting to Grade (Indicate).....	72
Dozer and Motor Grader Hydraulic Control (Control).....	79
Dozer Applications in Mining and Landfills .....	79
Excavator Operation .....	80
Drill Operation .....	88
Dragline Operation.....	103
 9. Troubleshooting .....	110
Hardware Configuration Issues.....	110
Hardware Selection Issues .....	110
Localization Problems—not in correct position (geoids, projections) .....	110
GPS Radio and Signal Problems.....	110
Dozers with 6-Way Blades .....	110
Adding Serial Port Options (e.g. Com 5, Com 6).....	110
 Appendix A—Special Navcom Starfire Setup .....	111
Appendix B—Carlson Grade Reporting and Replay .....	118
Appendix C—Topcon Dual Antenna Setup .....	119
Appendix D—Hardware Monitors for Install Diagnostics .....	124
Appendix E—Excavator Measurement Procedure .....	125
Appendix F—Making Vehicle Icons from Drawing (DWG) Files .....	128
Appendix G—Simulation Mode Key Strokes .....	130

# 1. About Carlson Grade

Carlson Grade is a machine control product introduced by Carlson Software in 2005 that is built from the ground up, taking advantage of 8 years of experience in the mining, landfill and construction markets dating back to 1997, the earliest days of 3D, GPS-driven machine control. Carlson Grade is designed with a special vision: to be all-purpose, all applications, all operating systems, all GPS equipment. This is a broad vision that runs counter to the “vertical” solution or “handcuff” visions of nearly all other products in the industry.

**All Heavy Equipment Configurations inside One Product:** Carlson Grade has configurations for blade-based applications (dozers and motor graders), for track-based applications (loaders, scrapers), for bucket position on excavators and certain front-end loaders, for drill navigation and logging and for dragline swing monitoring, all built into one software package. A single Carlson Grade purchase can be used one week on an excavator, another week on a dozer, and a third week on a drill, as needed. If purchased for a drill and drill work is suspended, Carlson Grade can go to work tomorrow on a dozer. You simply configure for the operating method and select the appropriate equipment icon.

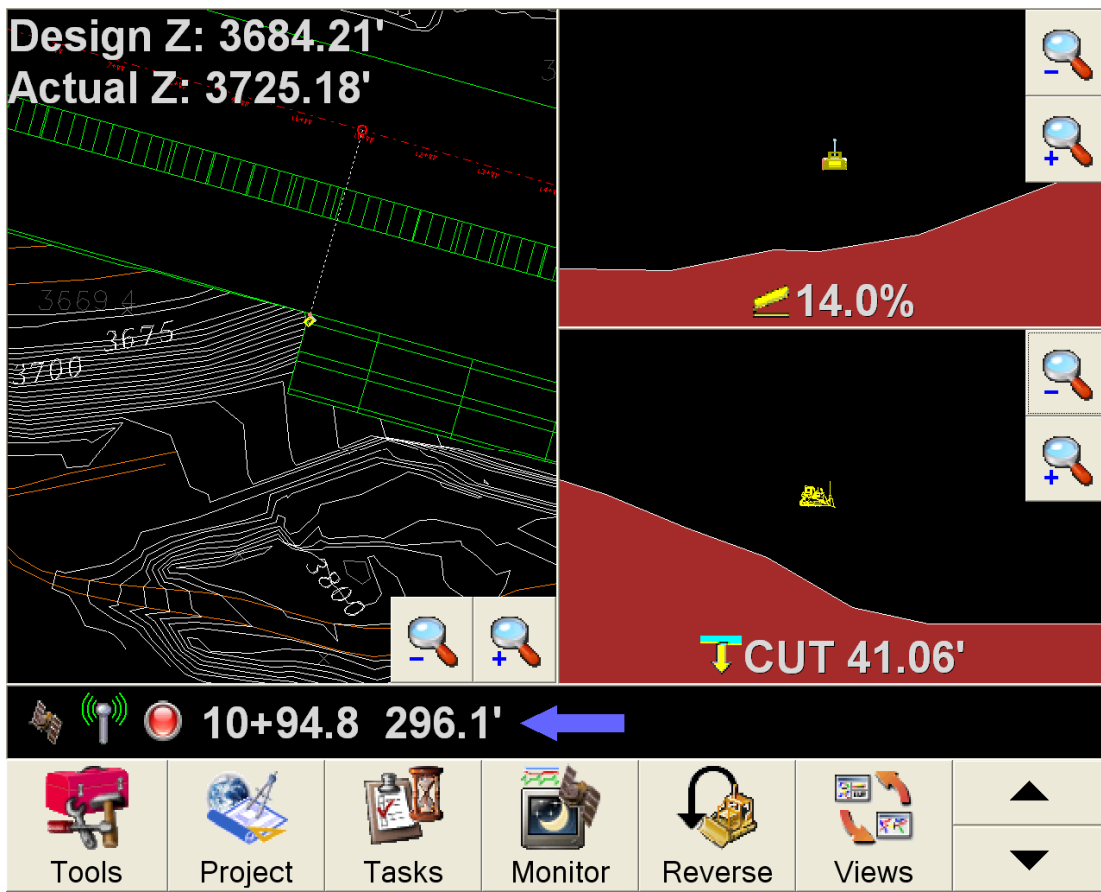
**All Major Applications (Mining, Construction, Landfills, Equipment Fleets):** Carlson Grade has 3 installs—for mining, construction or landfill applications. The mining install removes the up-down arrows for grade adjustment so popular in construction (surface vs. subgrades), eliminates the hydraulic control display areas, adds the option of coal or ore quality, maximizes screen “real-estate” for plan, section and profile views and generally simplifies the user interface. The construction version includes hydraulic blade control on-off status, up-down arrows for grade adjustment, and more screen space devoted to text outputs of pitch, roll and blade elevation. If tilt sensors are used, even “indicate only” grading (no hydraulics) shows forward slope and blade or track cross-slope. You can even apply tilt sensors to “slope boards” for precise grading of steep embankments. The landfill version has options for coloring the screen by number of passes and for presenting the depth drop accomplished with each pass. The operator can set what small threshold of drop represents “refusal” and indicates full compaction. For all applications (and particularly useful for mining), a “fleet” option can be activated for operator log-in, field check and reporting.

**All Operating Systems:** Carlson Grade was designed from the ground up to be structured for portability and easy expandability. The intensely organized code structure builds in product stability and enables enhancements without major re-writes or code overhaul. It is truly a product for the future. Carlson Grade will currently run on Windows (2000, XP or “Embedded”) and Linux and is portable, on demand, to Windows CE.

**All GPS Equipment, Robotic Total Stations and Peripherals:** Carlson Grade has drivers for a variety of GPS equipment (Leica, Topcon, Navcom, Thales and Trimble, to name a few). We recommend board-level solutions in ruggedized, shock-mount housings

installed by qualified dealers, as opposed to standard backpack GPS bolted to equipment. Some applications like the drill and excavator require dual antennae on the body of the equipment, which meant in the past, selecting from the few available dual antenna systems, such as, Topcon, Thales, Novariant and Septentrio. However, Carlson Grade also has the ability to mix any two brands of GPS equipment to get position and heading. Radios used for GPS corrections can vary from Pac Crest, to the spread spectrum options of Freewave and Tait to MEA (corrections over wireless). For construction, robotic total stations are often preferred for accurate grading. Options include Leica and Topcon. Tilt sensors are necessary for the excavator and angle drill applications and optional for dozer grading and vertical drilling. The recommended tilt sensor is one manufactured by APS (Automated Positioning Systems of Brisbane, Australia), but others such as Mikrofyn and Leica may be substituted. Light bars may be used (Mikrofyn, Apache) for added operator feedback. There are recommendations for optional reverse sensors, rotation sensors and hydraulic controls. Carlson Grade is flexible—you the customer or dealer choose the equipment you prefer to install and Carlson Grade will accommodate. The only exception to this is equipment which we are prevented from accessing due to no third party interfaces being available, or equipment not on our list due to poor performance or lack of market acceptance.

Carlson Grade Main Screen (Construction, No Hydraulics Configuration)



## 2. Software Components and Options

Carlson Grade is the only software component needed for the installation on heavy equipment. It can be used on most any piece of equipment that has tracks or wheels and a blade or bucket. In addition, it runs on drilling and compacting equipment and other types of load, haul, and dump machines. Moreover, Carlson Grade will work in conjunction with communication, management, and productivity software also developed by Carlson Software. There are two communication software offerings: Telescope (using spread spectrum or wireless radio communication) and Stargazer (using a variation of internet protocol communication). These communication products allow for two-way real-time file transfer and data and log file retrieval and storage. They enable transfer of plan view, DTM, centerline and other such files from the office to the field equipment, and also enable transfer of logging information real-time from the equipment back to the office. These radio link programs can also be used to update new versions of Carlson Grade on the field computers. Without the radio link software, files must be transferred to and from the field equipment using PCMCIA cards or USB storage devices (sticks or thumb drives) when USB ports are available on the field computer.

The management software is wrapped in with the two communication offerings. Both Telescope and Stargazer provide the office monitoring piece that allows viewing heavy equipment for the entire site in real-time. Carlson Grade is also often used in conjunction with a program called “Productivity Tools”, from Carlson Software, which analyzes equipment movement, delays and tasks and is used to produce productivity reports. Productivity Tools can receive data over the radio link or from portable storage devices.

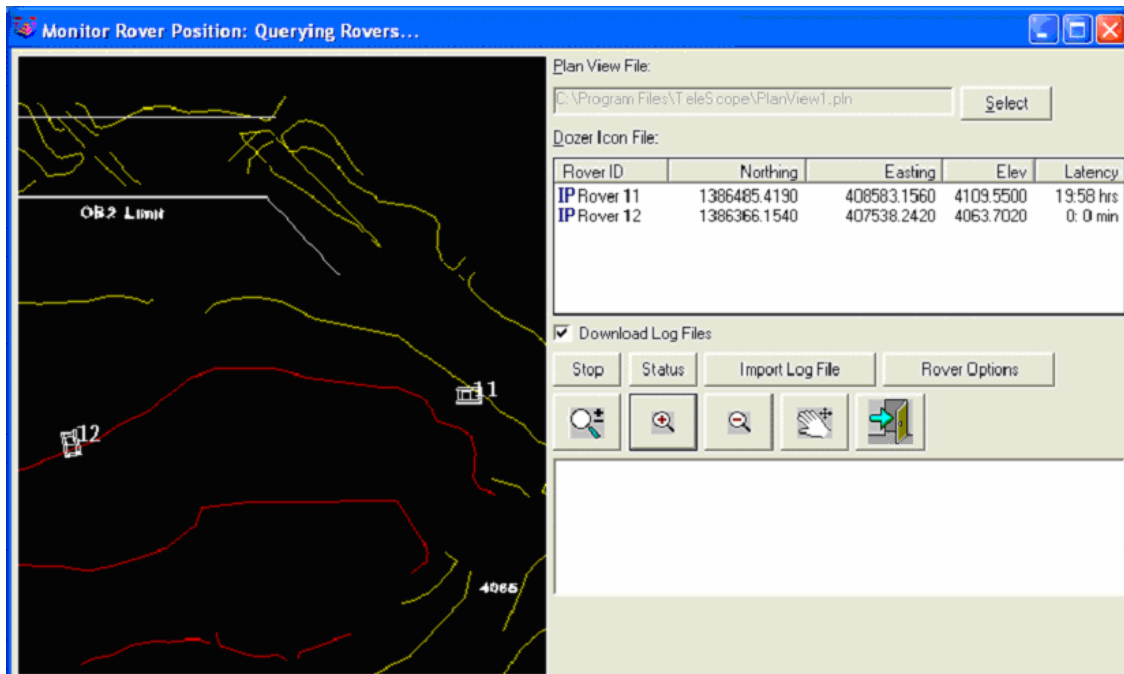
**Telescope:** Telescope can communicate between office and PC through dedicated spread spectrum radios or through 802.11b and MEA-compatible wireless radio systems. Telescope is not used to send or receive GPS corrections. That is done by dedicated GPS radios (although MEA wireless systems are capable of GPS corrections over IP). Telescope specifically is used to send and receive files to and from field equipment, to view field equipment operation at the office in plan view, to “drill down” and see ini files and operation sequence files for troubleshooting purposes, and to even take over operation of the field computer using VNC protocols. Telescope can even be used to re-initialize or re-boot a GPS receiver remotely from the office.

Previously to complete file transfers, an engineer would have to drive out to a vehicle and take it out of production while the files were transferred via PCMCIA card. With Telescope, the same files can be transferred without leaving the office and more importantly without stopping production. The transfer takes place in the background while the rover software continues to guide the operator. This functionality also provides a safer way for engineers and surveyors to interact with the heavy equipment. They are no longer "on the ground" next to the equipment or under highwalls with minimal protection. In addition, Telescope can be loaded on a computer with wireless network access and be used in a mine vehicle to allow a foreman, supervisor, engineer, or surveyor to monitor equipment locations for the site from the comfort of their climate controlled cab. No more driving to the wrong bench to find the loader or other equipment

has moved. In emergencies, response teams can be quickly dispatched to the correct locations.

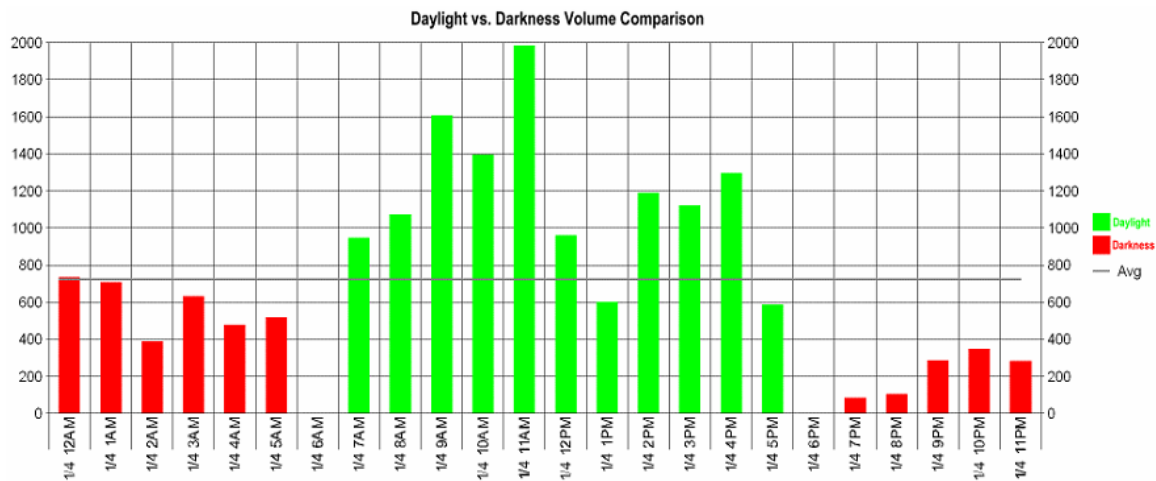


Telescope can be used to organize and send project files out to the field equipment, as new assignments occur. Entire “sets” of plan view, design surface, existing surface, centerline, coordinate and other files can be organized into a project and sent from office to field equipment, enabling the operator to see and load the new project without having to choose the individual files involved. Operators, of course, have the option to select files for grading “on-the-fly”, in the field using Carlson Grade, and can give any file set a project name for easy recall.



**Stargazer for Wireless Communication:** The Stargazer program applies only to sites with an Internet Protocol (IP) wireless system such as 802.11b or MEA. This program has a limited user interface and must be used with a server. It directs the communication over the wireless radios. Stargazer is loaded on the rover machines and also runs on the server. Stargazer provides a more advanced communication form than the radio link found in Telescope with the data being loaded directly into a database for real-time analysis.

**Productivity Tools:** Sometimes referred to as “Pro Tools”, this program takes the x,y,z logged positions from the heavy equipment and analyzes the data through user-defined reports on any aspect including cut and fill production rates, push lengths and slopes, idle times, rehandle, volumes per hour, day versus night productivity and all manner of extracted information. The program uses data that is radio-linked using Telescope or Stargazer, or that is loaded from PC Cards which can store the data on the field computers. If a radio link is involved, the data can be viewed real-time for monitoring of idle time and production rates. Productivity Tools also has “playback” features showing equipment movement in plan view, profile view and in 3D view. Because all logged points have time stamps, Productivity Tools can distinguish the work rates of individual dozers and other equipment working in the same area. Operator actions can be assessed to bring all operators' performance to the same level. It is software that aides in "best practice" evaluations. When Productivity Tools is combined with Carlson Grade, it can ultimately lead to increased productivity and optimal performance from your heavy equipment.

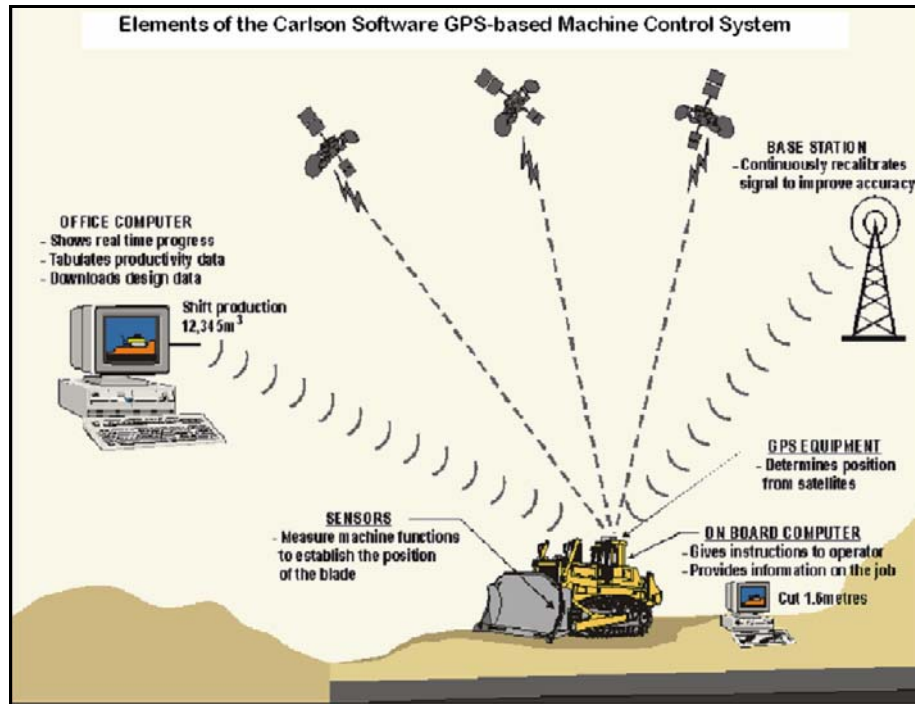


Telescope, Stargazer, and Productivity Tools have been used primarily in mining and landfills but it is anticipated that, over time, they will find an audience in the construction market, as fleet efficiencies and knowledge and use of actual (as opposed to published) equipment production rates become critically important to competitiveness.



### 3. Hardware Components and Options

The Carlson Grade program requires 3 hardware components at a minimum: Base and Rover GPS with associated antenna, radios at the base and rover positions to transmit the GPS corrections, and an onboard touch screen computer to receive the GPS rover position (through serial or CAN port) and run the Carlson Grade program. A typical dozer setup, with the added option of radio linkage of x,y,z logging data, is shown below:



Carlson Grade is installed by a dealer network associated with Carlson Software. We recommend the use of “kits” in pelican cases containing the software, touch screen computer, and tilt sensor and ruggedized housing containing the GPS and radio (such as the Astrum “box” for Topcon GPS). Shown below is a typical kit in a pelican case containing many of the components, including the APS tilt sensor (2 kits shown).



In the two kits above the APS tilt sensor is at the upper left of each kit, a JLT touch screen computer is in the left kit and a Kee touch screen computer is in the right kit. Both contain ruggedized mounting brackets toward the bottom of each kit.

**Required Components—GPS or Robotic Total Stations:** Carlson Grade uses only GPS or Robotic Total Stations as the source of the x,y,z position used for determining cut and fill, for guiding the blade when hydraulic control is activated, and for navigation and general display purposes. This is often referred to as “3D Machine Control”. Carlson Grade does not work with lasers for elevation determination, sometimes referred to as “2D Machine Control”. GPS equipment which is used includes Leica (MC1000 and 500 Series), Topcon (Legacy and Hiper series), Thales (Z-Xtreme and Aquarius), Trimble (5700/5800), Navcom (including Starfire), Garmin 18 (used for dragline swing monitoring), Novariant, Sokkia Radian IS and the NovAtel OEM4. A Septentrio driver is coming on-line. The Topcon, Thales and NovAtel GPS systems are available at the “board” level for inclusion in special ruggedized housings. Shown below is a housing known as the “Astrum” from APS that includes a Topcon GPS board and spread spectrum radio card, all shock mounted and ruggedized.



Here is an Astrum mounted with magnetic brackets in the battery compartment of a John Deere 650H Dozer.



Robotic Total Station options are limited to Topcon 800 series and Leica 1100 series. (Note: Total stations are not supported at this time) Both GPS and robotic total stations require radio link from the rover GPS or prism back to the base GPS receiver or total station.

**Required Components—GPS Setup:** GPS operation requires setup of the base GPS and the rover GPS. The setup procedures vary by GPS equipment. Typical procedure is to set up the base GPS antenna on a high point (top of building, silo or hill position with power) and use a handheld data collector such as Carlson SurvCE to Configure Base. This process identifies the correct antenna type used at the base, sets the antenna height and elevation mask, sets the radio type and port, sets the message string type, reads or identifies the base position and tells the receiver it is to perform as a base and broadcast GPS corrections. At that point, a rover “localization” is conducted (discussed under “Manager and Advanced Operator Interface” below). Once Configure Base has been

conducted on the base GPS and localization is completed one time, daily operation can proceed by simple “power-up” of the equipment. The antenna for the base GPS must remain at the same position for operation, or else Configure Base must be executed again to enter the new antenna height or base position. SurvCE and Carlson Field handle many Configure Base scenarios, and the base can also be configured by other software. Carlson Grade, loaded on a ruggedized computer, is then connected usually by serial cable to the rover GPS receiver on the equipment, which receives the base position by radio link and outputs the rover position. Note that for the dragline swing monitor routine, no base position is required. In that case, the position comes solely from the rover GPS, which can be as inexpensive as a Garmin 18.

GPS receivers normally communicate by sending a proprietary message stream from the base to the rover for RTK operation that optimizes things like update rate (e.g. 1 Hz, 5 Hz, 10 Hz, or 10 per second). For example, a Leica 500 GPS system can communicate from base to rover at 10 hertz, or a 10 per second rate, which is ideal for automatic, blade-control grading, especially on dozers. But you can also “mix” GPS receivers by specifying use of the CMR or RTCM messages string within Carlson Grade. Using CMR or RTCM, a Trimble base can communicate with a Leica, Topcon or other type of rover GPS. The only downside is that if the base GPS is a “legacy” or older piece of equipment with a maximum 1 Hz update rate, the rover equipment must conform to the lower rate. (A 1 Hz update is fine for mine and dozer “indicate” applications). The use of a mix of base and rover GPS products is a common scenario at mines, where a GPS base is already in place, and a mix of GPS equipment may be preferred for cost or performance reasons.

Both the low accuracy Garmin 18 GPS for dragline applications and the 10 cm-accuracy Navcom Starfire system (for scraper work, for example) can work without a base. For more information on the Navcom Starfire setup, see Appendix A.

**Required Components—GPS Correction Radio Link:** It is essential that the GPS corrections from the base GPS receiver be relayed out to the rover equipment. At minimum, this requires a base radio and a rover radio. The base radio is usually mounted on top of a building, silo or other highpoint, as shown below:



The rover radio is mounted on top of the equipment. Sometimes the radio signal from the base is too weak to be received on all rover equipment. In that case, it is necessary to add



“repeaters” that pick up the signal and re-transmit. Repeaters are often placed on the top of draglines, or high hills, or rims of highwalls. Repeaters need power, so in remote locations like hilltops, solar repeaters are often used, as shown below:

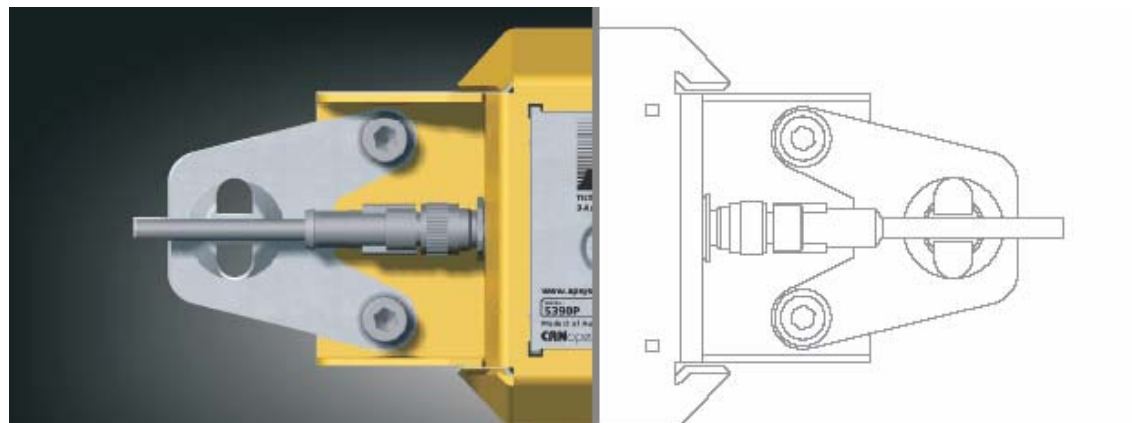


For most mine applications, spread spectrum radios are used for GPS corrections. Manufacturers include Freewave and Tait. These radios can also be used for data transfer from office to field equipment, but this requires a separate, redundant set of radios. Only with the Leica GPS can the same spread spectrum radios be used for GPS corrections and data transfer. The new wireless protocol known as MEA (technology developed by the Defense Department) enables GPS correction and data transfer over IP (Internet-Protocol) radios.

**Required Components—Computer:** There are 5 brands of computers recommended by Carlson Software for machine controls installations. These are J.L. Teknik of Malmo, Sweden (JLT for short, sometimes referred to by the Trafficom model), Hammerhead RT800 Walkabout Tablet, DataMetrics (Florida), Kee (Australia) and Novariant (California). The Novariant computer uses the Linux operating system and the others use Windows. It is recommended to use Windows 2000, Windows XP or Windows XP Embedded for Windows-based computers. Carlson Grade is not certified to work on Windows 98, due to some function calls requiring more recent versions. Super VGA screen resolution (800x600) is recommended, as well as 2 serial ports and at least 1 PCMCIA slot or USB port for file transfer and program updates. If no tilt sensor is involved, a single serial port for the GPS may be sufficient, which can be tapped for the reverse sensor option as well. For ample data storage and operation, it is recommended that computers come with a minimum of 256 mb of RAM and a 20 gb solid state (or PC card) hard drive. All computers mentioned here run at 12 volts, so a power converter to 12 volts is needed for install on the heavy equipment.

**Optional Components—Tilt Sensors:** Carlson Grade currently only works with APS tilt sensors; however, support for the Mikrofyn and Moba tilt sensors are in progress. Many tilt sensors such as the APS sensor are gravity-based where centrifugal force has an effect on the readings, so very abrupt movements can lead to inaccuracies. For excavators where movements can be fairly quick, moving the bucket quickly can lead to

small errors in measurement of a few percent in the slope amount, which settle down in a matter of 2 or 3 seconds. The APS tilt sensor (shown below) is a dual slope sensor with 360 degrees of movement in one direction and 180 degrees in the other. The APS tilt sensor is a CAN sensor and comes with a CAN cable. These sensors are capable of working in series through one CAN port, but most computers only have serial ports. Therefore, you will need a CAN to serial dongle (adaptor) to convert from a CAN port to serial port. The Novariant Linux computer, however, can receive up to 3 CAN port inputs and would not require a serial conversion for the tilt sensors.



### Description

The NestLawn tilt sensor measures pitch and roll, with an accuracy of  $\pm 0.1$  degree of arc. The sensor can be mounted in a variety of positions and configured to measure roll and pitch via its three orthogonal tilt sensors.

The sensor has been designed to withstand the harsh environments for dozers, excavators and other earthmoving equipment

### Technical Specifications

Approvals:	C-Tick
Temp range:	-20°C to +85°C
Humidity:	0% to 100%.
Accuracy:	0.1° arc
Sampling rate	100Hz
Averaging rate:	User configurable
	0 to 20Hz
Communication:	CANopen or Modbus RTU

**Optional Components—Reverse Sensor:** This sensor is connected to the DSR pin on a serial port. This will require another serial port for operation.

**Optional Components—Rotation Sensor:** Hardware options are being reviewed. This product is not yet factored into the software.

**Optional Components—Depth Sensor:** Hardware options are being reviewed. This product is not yet factored into the software, but would be used on the drill for geologic recognition and “real-time” geologic modeling.

**Optional Components—Light Bars:** Two light bars are currently available for use with Carlson Grade. These are the Apache Light Bar (from Apache Corporation, Dayton, Ohio) and the Mikrofyn Light Bar (Odensa, Denmark). The Apache Light Bar is the most inexpensive and shows an up down arrow for cut or fill, which is bigger in bigger cut, and which flat lines when on grade. Carlson Grade is used to program the LED light displays. The Apache unit must be connected with a special adapter, as it is not by default RS232 (serial). The Mikrofyn Light Bar is more expensive and is a CAN system.



Apache Light Bar

**Optional Components—Mast:** Masts are used for mounting the GPS antenna (or prism with robotic total stations) on the blade of dozers and motor graders in particular. For other equipment, strong mounting brackets for cab mounting are more typical. Carlson Software can provide an internally manufactured mast or the mast used by the dealer of record can be used. Masts should be sturdy with very little whip motion in operation.





**Optional Components—Hydraulic Blade Controls:** Currently, the only blade control drivers in Carlson Grade are for the Leica SonicMaster and Leica ProControl. Drivers for the Moba and Mikrofyn systems are in progress, as well as direct controls for the valves.

**Optional Components—Wireless Radio Systems:** A wireless radio network for internet-protocol communication is becoming much sought-after at mines and landfills. For example, the Falkirk Mine in North Dakota and the Buckskin Mine in Wyoming have implemented wireless systems, as have mines such as at Collinsville in Australia. With such systems, the following features are possible:

- a. Viewing and Taking over Control of actual screens on the equipment using VNC and other programs.
- b. Fast loading of new data files for grading.
- c. Fast recall of logging files from field equipment.
- d. Ability to “clean-up” hard drives on field equipment remotely by offices staff.
- e. Greatly improved diagnostics, including remote analysis of wish lists and problems by software providers.
- f. Real-time productivity review and analysis.
- g. Real-time updating of the mine surface and geology grids, as every piece of equipment using RTK GPS can become a rover “surveyor”.

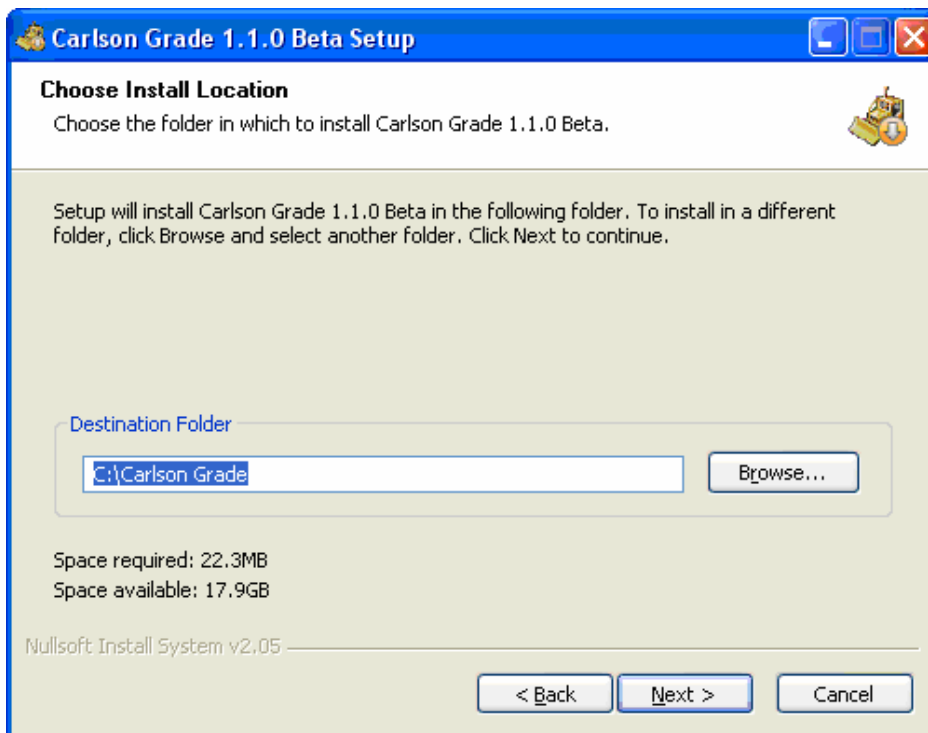
Two wireless protocols are emerging: Wi-Fi (802.11b, g, et. al.) and MEA. WiMax is coming in 2007. Only MEA and WiMax offer the distance and bandwidth for quality, manageable GPS corrections as well as data over wireless at large mine sites.



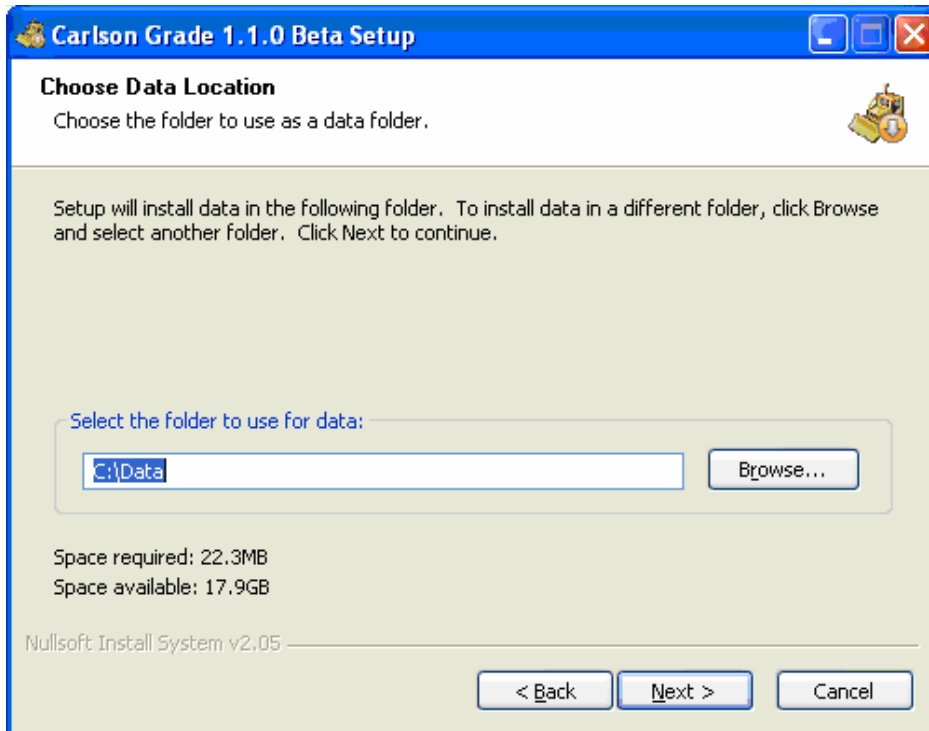
## 4. Loading and Configuring Carlson Grade

Carlson Grade can be installed from a PC Card or USB storage device (select computers) to a ruggedized field computer, or from CD, PC Card, USB device or via the internet on an office PC. The file used for installation is typically compiled into an exe file with the name, CarlsonGrade.exe. Simply click Start, Run and select CarlsonGrade.exe. A license agreement is presented which should be read. Click “I Agree” to continue.

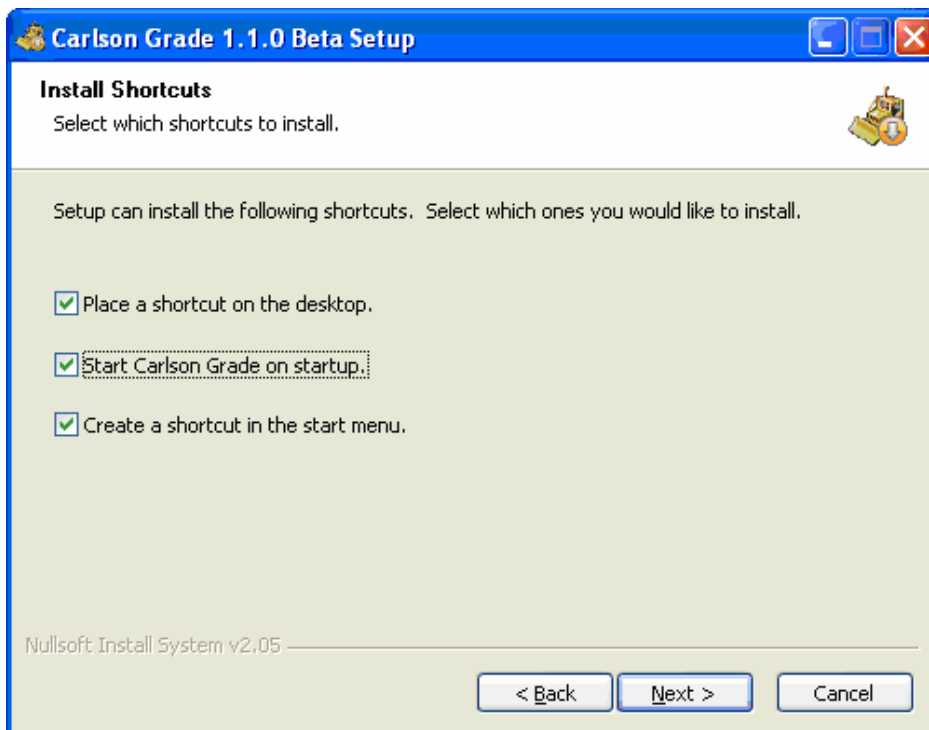
The next screen that appears shows the files to be installed, and confirms the size of the files in total (over 20 mb). It is recommended to install the “Sample Data Files” on your office PC, but not on the field installation (reduces incorrect file selection). You are then prompted for the install location, which is shown in the screen below. For field installs, always use the default presented (Carlson Grade), unless you are testing versions on the PC, in which case you can install to specific directories of your own choosing.



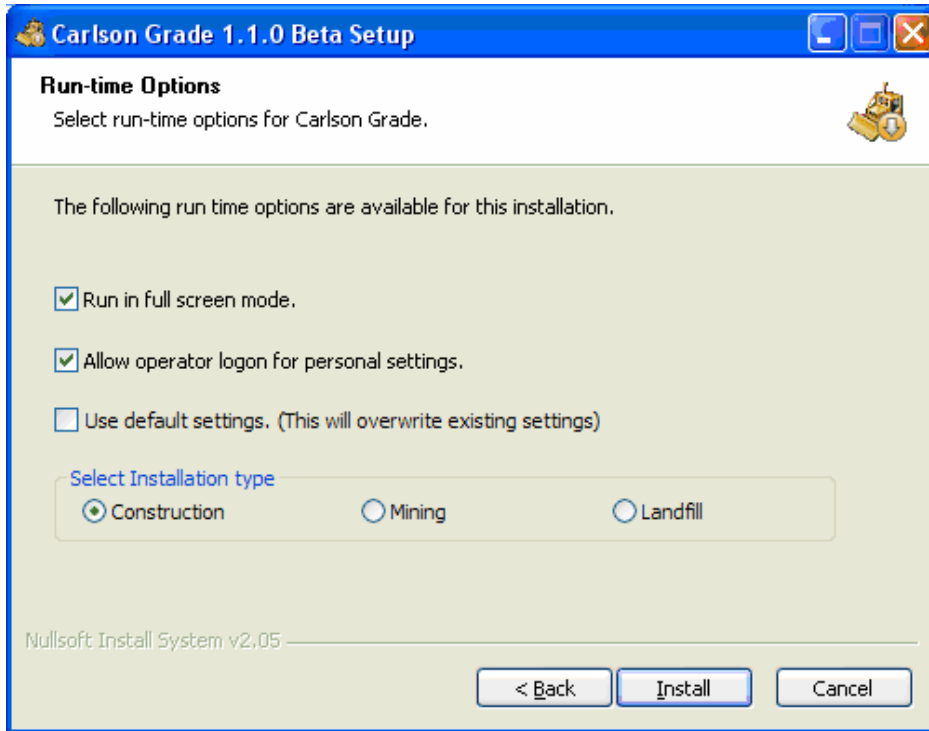
It is also important to use the data directory (the default shown below) for all data files, which was designed to reduce technical support and troubleshooting issues.



You are then prompted about shortcuts and auto-loading Carlson Grade. For field installs, it is highly recommended to click on “Start Carlson Grade on startup”.



Next, select the application (construction, mining, or landfill) and whether you wish to utilize the fleet-oriented prompting (operator logon), which will save personalized settings. Selecting Mining will use the operator login right now, so select construction for now if you do not want to use. You can also select full-screen mode and, for demo installs on the PC, you can choose use the default settings (demo project).





If a prior install of Carlson Grade is detected, all existing settings are maintained by default.

Carlson Grade then installs itself on the hard drive. This process takes between 10 seconds and a minute depending on the speed of the computer. If no prior install of Carlson Grade is detected you will be prompted to register the installer through the initial setup of the software. The installer can setup the GPS or Total Station, the initial toolbar placement and visibility options, time zone, localization and state grid settings, system options including password, vehicle type and settings, logging options, and sensors and optional hardware.

**Product Registration:** This product must be registered before continuing further, because Carlson Grade disables communication through the serial ports unless proper registration is in place. If you only want to run Carlson Grade in Demo/Simulation Mode on your office PC then just hit Close on this screen.

Carlson Grade Product Registration

Serial #: [Demo Mode]  
 Hydraulics: Disabled  
 Side Shift: Disabled  
 ProControl: Disabled  
 SonicMaster: Disabled  
 Tilt Sensor: Disabled  
 Dual Tilt: Disabled  
 GPS: Disabled  
 Total Station: Disabled

 Register  Close

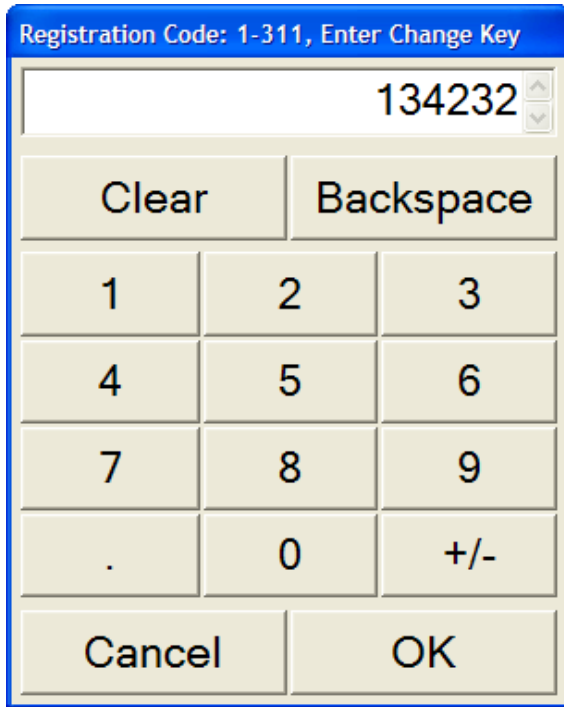
If registering though, press the register button to continue.

Enter New Serial Number

CG001130-0001-6153

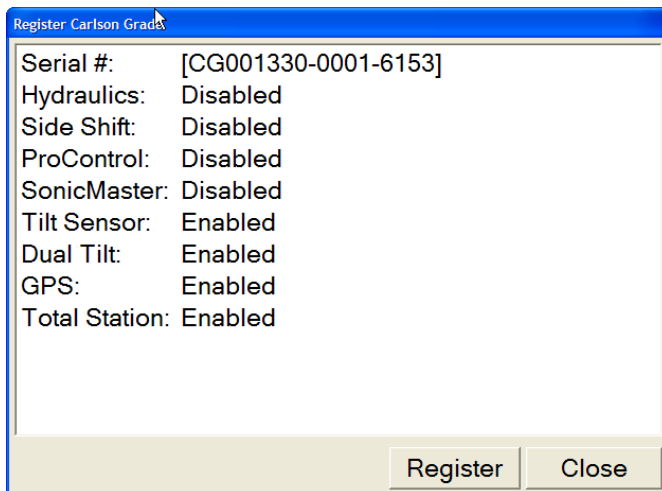
Escape				Clear				Backspace				
`	1	2	3	4	5	6	7	8	9	0	-	=
q	w	e	r	t	y	u	i	o	p	[	]	\
	a	s	d	f	g	h	j	k	l	;	'	
	z	x	c	v	b	n	m	,	.	/		
Caps Lock				Shift				Space				Enter

Using the on-screen keypad, enter the serial number provided to you at time of purchase. Note that the hyphens must also be entered. When you have entered the serial number correctly tap the enter button and the following dialog box will appear.



A dialog box titled "Registration Code: 1-311, Enter Change Key". It features a text input field containing the number "134232" with up and down arrow buttons on the right. Below the input field are two buttons: "Clear" and "Backspace". Underneath these is a numeric keypad with buttons for digits 1 through 9, a decimal point ".", a zero "0", and a plus/minus "+/-" symbol. At the bottom of the dialog are two buttons: "Cancel" and "OK".

Call your Carlson Grade sales representative to get a change key. You will need to be prepared to give the Registration Code found in the title bar of the dialog box (in this illustration 1-311). Using the on-screen keyboard enter the change key provided and tap the OK button. A registration screen similar to the one below will appear detailing the enabled functionality of your software.



A dialog box titled "Register Carlson Grade". It displays a list of software features and their status:

Serial #:	[CG001330-0001-6153]
Hydraulics:	Disabled
Side Shift:	Disabled
ProControl:	Disabled
SonicMaster:	Disabled
Tilt Sensor:	Enabled
Dual Tilt:	Enabled
GPS:	Enabled
Total Station:	Enabled

At the bottom of the dialog are two buttons: "Register" and "Close".

Tap the close button to complete registration.

**Re-Installation:** The old version should be uninstalled using Add/Remove Programs. Some of the files that are not uninstalled automatically, as shown in the example image below, include: user and vehicle configuration files. Consequently, the necessity of reconfiguring each vehicle is avoided. Unfortunately, if new items were added to the configuration files, the cfg will need to be regenerated from scratch. Currently the best way to do this is to make a backup of your cfg files, such as: measured\_excavator.cfg, and copy and paste the needed pieces into the newly generated vehicle configuration file. When the initial installation is complete, another good way of backing up detailed information about the install is by collecting screen captures of the important screens, which is easy to do by using VNC from your office PC if your rover machines are networked. If Stargazer is installed and running, it will also keep a historical record of measurements and settings.

Name	Size	Type	Date Modified
DOZER.CFG	2 KB	CFG File	4/25/2005 7:02 PM
EXCAVATOR.CFG	3 KB	CFG File	4/21/2005 11:57 PM
GRADER.CFG	2 KB	CFG File	2/25/2005 2:08 PM
measured_excavator.cfg	3 KB	CFG File	3/3/2005 6:04 PM
TRUCK.CFG	2 KB	CFG File	2/23/2005 1:10 PM
CLIENT.INI	1 KB	Configuration Settings	4/25/2005 7:02 PM
GRADE.INI	5 KB	Configuration Settings	4/25/2005 7:02 PM
schemes.ini	3 KB	Configuration Settings	4/25/2005 7:02 PM
grade.dlx	370 KB	DLX File	3/9/2005 5:41 PM
RCONFIG.DTA	1 KB	DTA File	3/14/2005 9:30 AM
activities.txt	1 KB	Text Document	3/3/2005 10:49 AM
delays.txt	1 KB	Text Document	3/3/2005 10:49 AM
ERRORS.LOG	47 KB	Text Document	4/25/2005 7:02 PM
OPERATORS.TXT	1 KB	Text Document	4/25/2005 1:51 PM

File Descriptions	Location	Name
Driver Config Files	\Carlson Grade\drivers	*.CFG
Vehicle Config Files	\Carlson Grade	*.CFG
Application settings	\Carlson Grade	*.INI
Activity names	\Carlson Grade	Activities.txt
Error log	\Carlson Grade	errors.log
Event log	\Data	log*.log

**Installation Tips:** One tool that is very helpful is a USB storage device (also known as: USB stick, memory key, or thumb drive). Load the installation file and the toolkit on it so you can easily use them on the target computer. You can use the tools from the USB storage device without installing them on the target computer.

Carlson Grade supports the Garmin 18 USB. It is a small, low quality GPS that can be used to confirm that the localization is in the general neighborhood of being correct without having to use the GPS being mounted on the machinery. Any NMEA GPS is supported but the USB is nice because you don't have to worry about power or getting

the baud rate set up correctly. You can get it with nRoute software for car navigation for approximately \$120 or \$85 without nRoute.

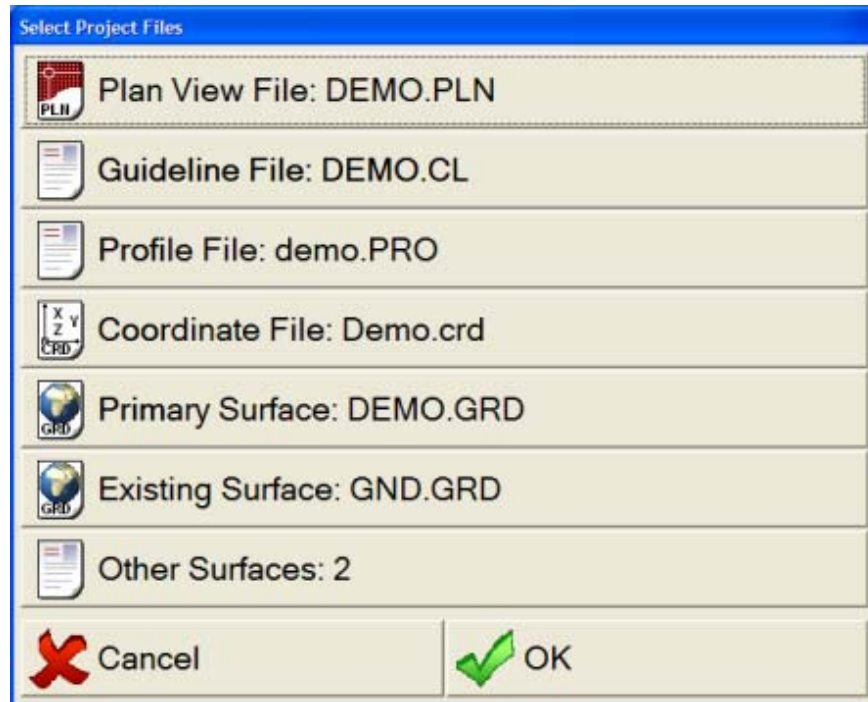
## 5. Files and Formats Used in Carlson Grade

Carlson Grade uses certain mandatory and optional files to display graphics and determine cuts and fills. Mandatory files include the Plan View, the design DTM surface and the Localization file. All other files are optional. DTM stands for “digital terrain model”. Technically, even the design DTM is optional, since operators can grade to an entered flat elevation. The various files are loaded into Carlson Grade on specific, recommended directories on the field computer. Plan View (DWG or PLN files) and Localization files (DAT files) go in the \data\ directory. The design DTM files and all other secondary DTM files (used mainly by the excavator and drill configurations) go in the \data\design\ subdirectory. The existing surface DTM files go in the \data\actual\ subdirectory. All other files used by Carlson Grade for data and display (e.g. centerline files, coordinate files, project files) go in the \data\ directory. Files are loaded into these directories using Windows Explorer from PCMCIA cards or can be transmitted by radio linkage using spread spectrum radios (distinct radio system separate from that used for GPS corrections) or using a wireless radio (802.11b or MEA) system. Only with Leica GPS can file transfer and GPS corrections occur on a single spread spectrum radio system. If the Telescope program is used for file transmittal, all files can be organized into a packet and lumped together as a project, and sent at one time. Telescope will then place these files into their correct directories over the radio link.

**Localization File:** This required file (not selectable in menu shown next) is created live within Carlson Grade using the Localization command in Advanced Tools. It works in conjunction with the configured projection (coordinate system), which may be UTM (by zone) or U.S. State Plane 27 or 83 (by state), for example. You can also load a localization file into Carlson Grade that was made using SurvCE or Carlson Field. The localization file is a Carlson-specific format. Since Carlson Grade does not currently use the geoid model for one-point localizations but relies on multi-point localizations to best fit the elevations, do not load into Carlson Grade a localization file that was made in SurvCE or Carlson Field using a geoid. The localization file can also be selected from under Advanced Tools / System Options / Project Options.

**Plan View File:** This is a required file. Carlson Grade will read “DWG” and “DXF” files as the plan view file directly, without conversion, and additionally supports “PLN” files created in Carlson Software office products such as SurvCADD, Takeoff, Carlson Survey, Leica Site Manager and TopSite. Colors that appear in the source file will appear in Carlson Grade. Text may appear on the screen in Carlson Grade only if first converted to polylines by the command “Text to Polylines” within the office products. Even if a “DWG” file is used, only the polyline elements on the file will be captured by Carlson Grade, so “Text to Polylines” should still be used in advance if viewing of text is important for the operators. It is recommended that files be simplified before loading into Carlson Grade. Of most interest are roads, buildings, streams, utilities, top and

bottom of slopes, and other distinguishing features. Contours and excessive text usually add too much clutter to the plan view and are not recommended. Warning zones, such as boundary lines and underground utilities, that are identified when exporting a “PLN” file from the Carlson Software office products, will be displayed as a bold orange polyline in the Carlson Grade plan view.



**Guideline/ Centerline File:** This optional file, sometimes referred to as the “horizontal alignment”, produces station/chainage and offset reporting when loaded. Whenever the equipment is perpendicular or radial (on curves) to the centerline, the station and offset will appear on the screen as a Display option. This is a useful reference for operators on highway projects, for example. This file can be loaded into Carlson Grade as created in Carlson office products like Carlson Survey, Carlson Roads, SurvCADD, Takeoff, etc., or a file can be named when an alignment (guideline) is selected directly from the screen. The centerline will be displayed as a dashed red line in the plan view and a dashed white vertical line in the back and side views with a CL indicator label.

**Profile File:** This optional file, sometimes referred to as the “vertical alignment”, when combined with a centerline file, produces vertical offset at a particular station or chainage when loaded. Whenever the station and offset normally appear for a centerline, so will the vertical offset as a Display option. This is a useful reference for operators on highway projects, for example. This file can be loaded into Carlson Grade as created in Carlson office products like Carlson Survey, Carlson Roads, SurvCadd, Takeoff, etc., or a file can be named when an alignment (guideline) is selected directly from the screen, albeit 3D information is saved in the plan view file. If the 3D information is missing, the user will be given the option to use a previously loaded profile. The profile is displayed



in back and side views as a dashed red line like the centerline file is displayed in plan view.

**Coordinate File:** This optional file is used in the “Navigate To”, “Auto Log Points”, and “Log Single Point” routines, along with being essentially a requirement for the drilling component of Carlson Grade. If points exist in this file, “Navigate To” can guide the vehicle to the point of interest. In addition, when positions are stored by the “Auto Log at Interval” or “Log Single Point”, these are stored to this “CRD” file. The drill routines are based on the “Navigate To” principle of guiding the vehicle to designed points; however, the collection of “Field Marked” points is allowed if a “CRD” file is set to collect the point information. Using a coordinate file created from the office is also useful when recalling points for localization. If the points are pre-entered in the coordinate file, the likelihood of a typographical error dramatically decreases, because the coordinates are recalled from file rather than entered, live, in the field during localization.

**Lower Coordinate File:** This file is used for angle drilling to give the heading (strike or bearing) and tilt (dip) of the hole. Unlike the Coordinate File which contains the collar information of the hole, this contains the bottom of hole information. If collection of “Field Marked” points is in progress, the hole bottom information will also be stored in this lower coordinate file.

**Special Coordinate File:** This optional file can contain any style of coordinate that you wished to be displayed in the plan view. These points are information (for display) only. An example of this is exploration holes, which will allow optimized placement of in-pit exploration drilling. These points will display with a special symbol format in the plan view.


**DTM Surface Files and Flat Pads:** In order to compute cuts and fills, Carlson Grade needs a design surface. This surface can be a grid file, a TIN file, or a fixed elevation entered by the operator. A grid surface is composed of grid cells of fixed size, and if the cell size is 10x10 or 20x20, it cannot “see” a 2-unit wide ditch or sharp break. However, a TIN file (triangulation file) is as accurate as the source data, and would “see” any ditch, wall or sharp break in grade. Grid files are used for mining applications and TIN files are typically used for construction and landfill applications. Grids have an advantage of covering large areas with reasonable file size (subject to grid dimension used) and are fast for processing purposes. Even though Carlson Grade can handle file sizes of 40mb, it is recommended to keep grid files under 5mb in size. TIN files, if sites are very complicated, with lots of breaks in grade, can quickly become very large. It is also recommended that TIN files be kept under 2mb, if possible, for maximum speed of processing.

For all vehicles, but especially for the excavator and drill configurations, surfaces can be specified in the form of primary, existing, and secondary or other design grids, tins, or flat-pad elevations. This includes coal seams, trenches, etc. Different colors, line types, fill patterns, and descriptions can be set for each surface. For the drill, cut depths to each of the defined surfaces are presented as drilling occurs.

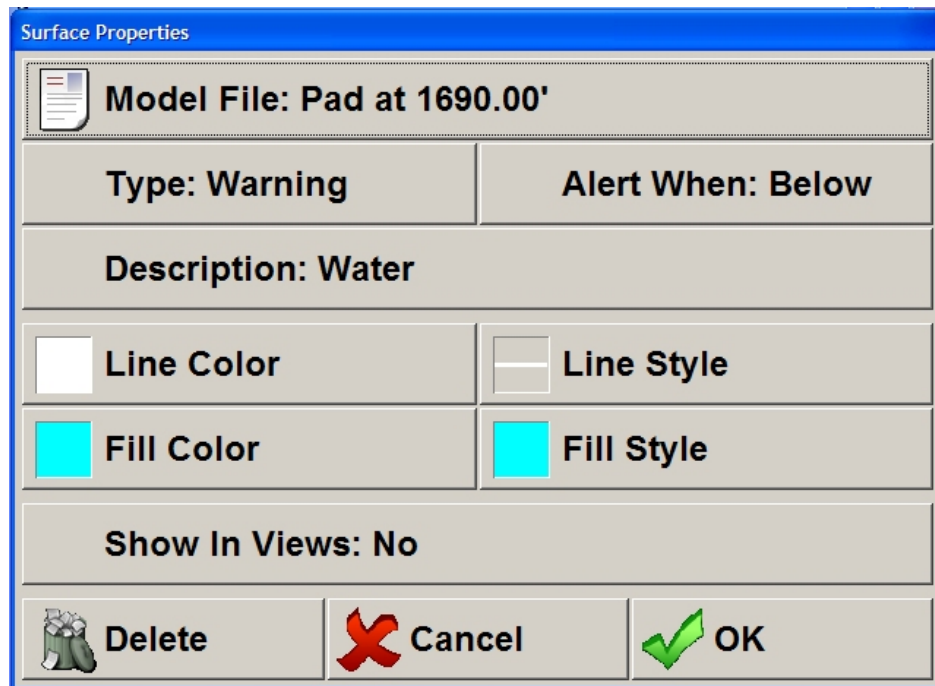
**Primary Surface:** The primary design surface drives the cut and fill values that are displayed in the status screens. Only one primary surface is allowed at a time. You will learn in Chapter 6 how this can be swapped with one of two field designs making it the “primary” cut-to surface. If it is desired to change the color or fill properties of this surface, it must be done from within Edit Project.

**Existing Surface:** This surface is generated by the vehicle as it alters the current surface and can be used to update your primary design surface. In addition, there is a setting for if the existing surface changes for cut only or for both cut and fill. For example, when digging a trench with an excavator, you will likely want this set to cut only, or else every time you raise the bucket, the surface will be filled back in. A good time to set this to ‘both’ is when a dozer is working an area that is an active dumping site. Only one existing surface is allowed at a time. The existing surface DTM grid has a predefined scheme of an empty fill and a dashed white line, so it appears as a line overlaying the other surfaces. To change the color or fill properties of this surface, it must be done from within Edit Project.

**Other Surfaces:** These surfaces can take the type of: other, warning, or attribute. DTM grid surfaces, used as warning grids, issue a warning when the vehicle is either above the grid (particularly useful for feeder applications) or below the grid (such as a water surface). DTM grids used to present a quality attribute (like sulfur, sodium, ash, or BTU) during grading will display this labeled value on the plan view, or other view when plan view is not activated. Only one attribute grid is allowed at once; however more than one warning surface or other surface is allowed at any one time. If a slope or flat pad has been chosen and made for quick swapping (*see Chapter 6*), then they will also show up in the listing of other surfaces. The only thing that can be done to these surfaces, however, is deleting them and changing the color and pattern scheme. See example below:

Other Surfaces		
Name	Type	Visible
SLOPE.FLT	Slope	No
Pad at 1234.00'	Flat Pad	No
AlfordAttrib.grd	Attribute	No
Pad at 1690.00'	Warning	No
Pad at 1700.00'	Other	No
 New...	Modify	Cancel
		OK

When Other Surfaces is selected, the previous screen is displayed. If adding a surface, select New. If removing a surface, select Modify, then Delete from the next screen. Both instances will bring up the screen below.



The image shows a 'Surface Properties' dialog box with a blue title bar. It contains several fields and buttons:

- Model File:** Pad at 1690.00'
- Type:** Warning
- Alert When:** Below
- Description:** Water
- Line Color:** (white color swatch)
- Line Style:** (dashed line style swatch)
- Fill Color:** (cyan color swatch)
- Fill Style:** (solid fill style swatch)
- Show In Views:** No
- Buttons:** Delete (trash icon), Cancel (red X icon), OK (green checkmark icon)

**Changing Surface Properties:** When an Other Surface is selected from New or Modify, the screen above allows for changing the properties of the surface, including type and description. This screen will also be displayed for Primary and Existing Surfaces, but only from within Edit Project. The various settings are explained below.

**Model File** – A grid or tin file can be selected or an elevation for the surface can be entered. Elevation will display: “Pad at” specified elevation.

**Type** – This can be either: attribute, warning, or other.

**Alert When** – If a warning surface is selected, then this indicates if it will warn when above or below the surface. Examples of this are, warn when below a water surface and warn if above an open slope.

**Description** – A clearer name for what the surface represents. If a warning surface, this is what will be displayed in the warning message. If an attribute grid, then this is what will label the value displayed.

**Line Color** – The line color of surface to be shown in side and back views.

**Line Style** – The line style of surface to be shown in side and back views.

**Fill Color** – The fill color of surface to be shown in side and back views.

**Fill Style** – The fill style of surface to be shown in side and back views.

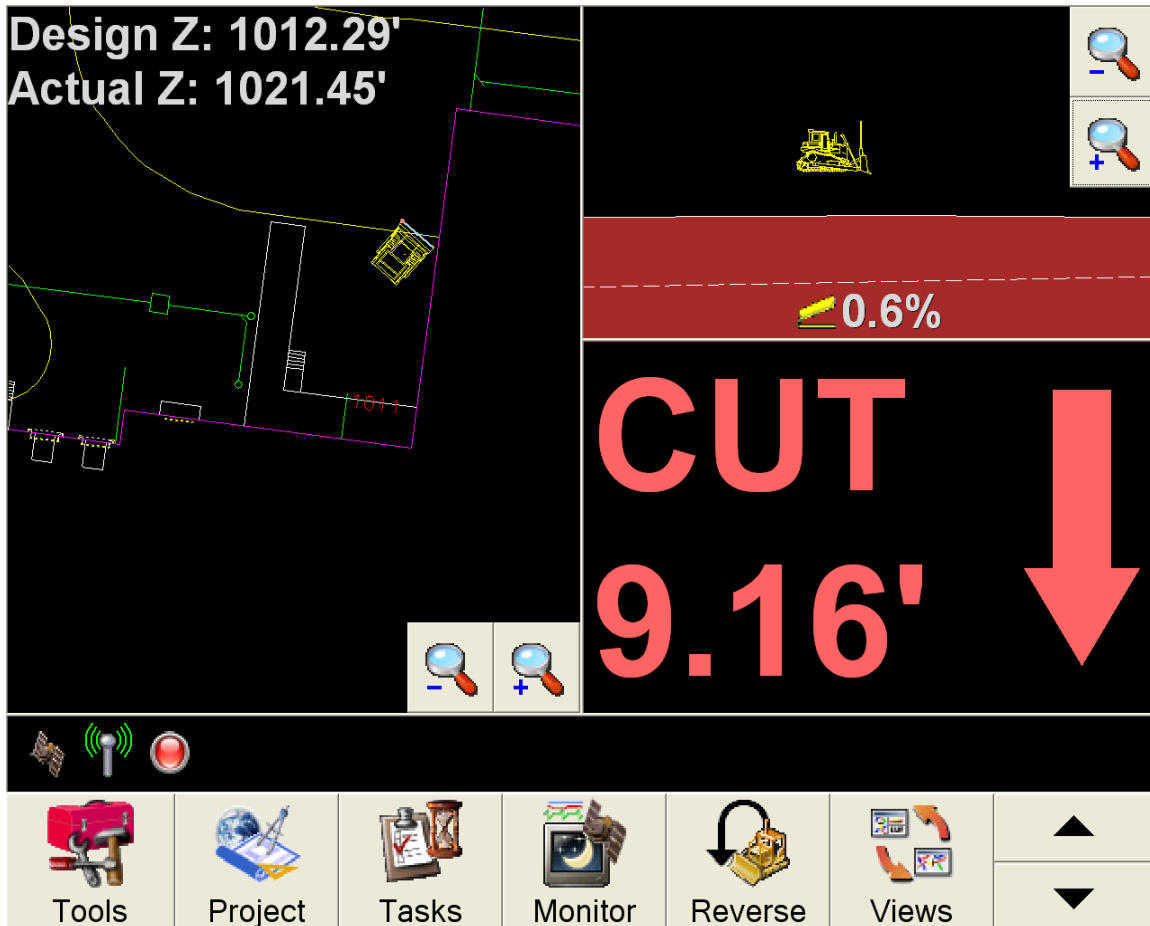
**Show In Views** – Can be shown (yes) or turned off (no). Turning the surface off will make it so it is not drawn and not have the cut/fill displayed for it. It will not delete it.

<b>Other File Descriptions</b>	<b>Location</b>	<b>Name</b>
Driver Config Files	\Carlson Grade\drivers	*.CFG
Vehicle Config Files	\Carlson Grade	*.CFG
Application settings	\Carlson Grade	*.INI
Activity names	\Carlson Grade	Activities.txt
Error log	\Carlson Grade	errors.log
Event log	\Data	log*.log

The CFG and INI files contain user settings for setting up the vehicles, drivers and other settings. Hopefully changes to the formats of these files will not happen except between major version changes. If a change to the format is made between the old and new versions, the old files should be deleted.

## 6. Operator Interface

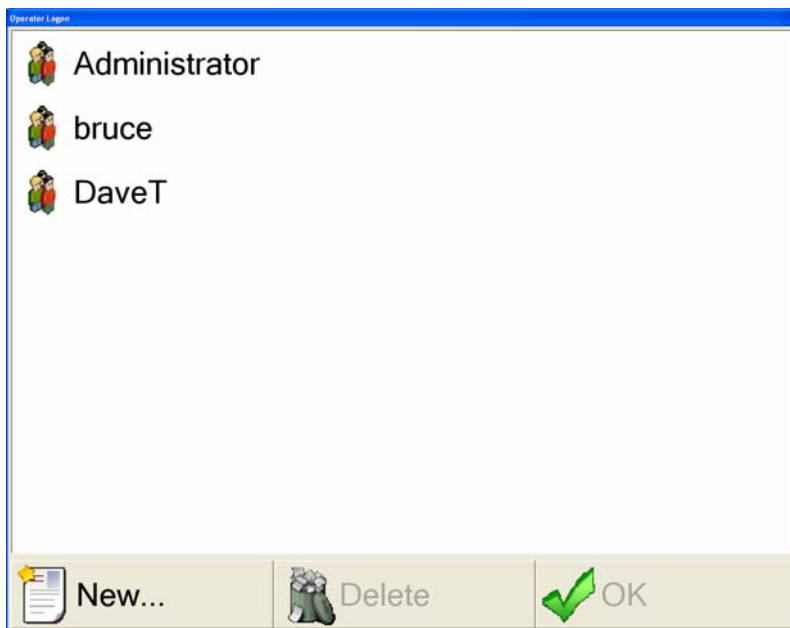
Carlson Grade starts right up into what is called the “Main Grading Screen” or “Main Screen”. This is a different approach than many menu driven machine control programs. Just power up and go to work in the current configuration. The screen is designed for a simple interface, allowing only a limited number of options for the operator, and reserving more complex setup procedures for “Advanced Tools”, accessible only by approved personnel. The Main Grading Screen is shown below.



**Starting and Exiting Carlson Grade:** The first procedure to master is how to start and stop (enter and exit) Carlson Grade. At present, Carlson Grade is installed to start when the computer is turned on (powered up), but can be exited at-will by the operator. If the program has been exited without shutdown, the computer “desktop” may be visible to the operator. If this is the case, to restart Carlson Grade, either double “click” the desktop icon of Carlson Grade or Select Carlson Grade from the Start Menu. If this is an office computer, it is recommended to have Carlson Grade **not** start on computer start. Future vehicle installations can optionally be tied into the vehicle power system to facilitate automatic power up and power down of Carlson Grade with the vehicle.

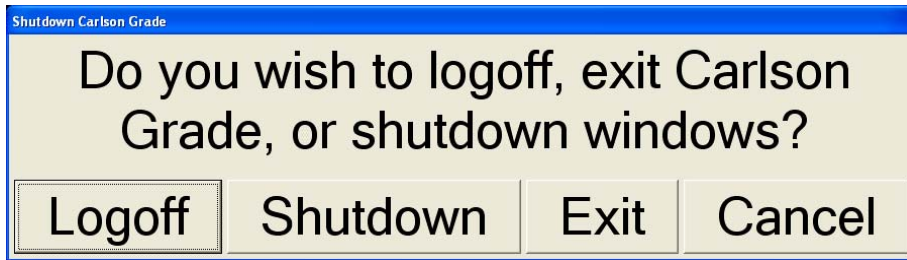


When Carlson Grade starts up, if Operator Login was specified during the install, you will obtain a log-in screen before going to the Main Grading Screen. The log-in screen appears below (as it might appear with a 2-shift system with 2 operators):



You must pick an operator to continue. Then press OK. You can also enter a new operator name. Please note that entered spaces will be removed for processing reasons. An added benefit of operator login is that the operator specific settings are saved. So for example, if DaveT usually works night shift, he may have set his color scheme to cut down on brightness. This would prevent DaveT from needing to change from daytime settings all the time.

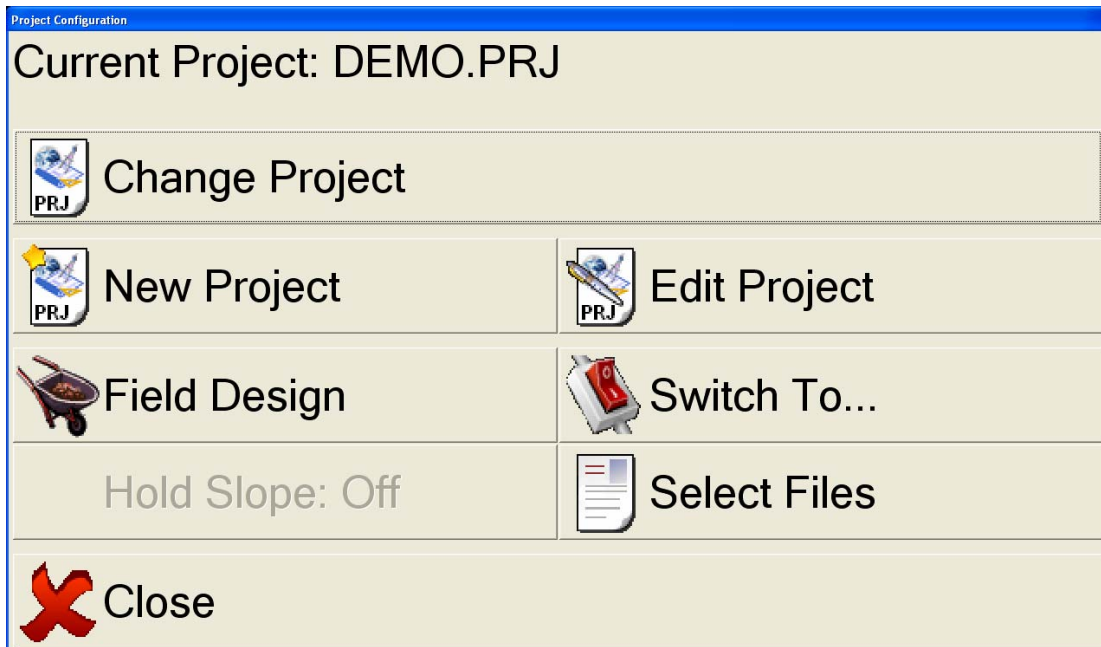
The procedure to exit is to hit Tools. Within Tools, just click the “Exit or Shutdown” button. This brings up the following screen:



Shutdown will turn the computer off. Exit will exit to the desktop of the computer in Windows. If you logged in, the Logoff option let's another operator select their name while the program stays running. Operator names are used for productivity analysis, general reporting, and personalized settings.



**Selecting Projects and Job Files:** The Project button leads to the following screen:

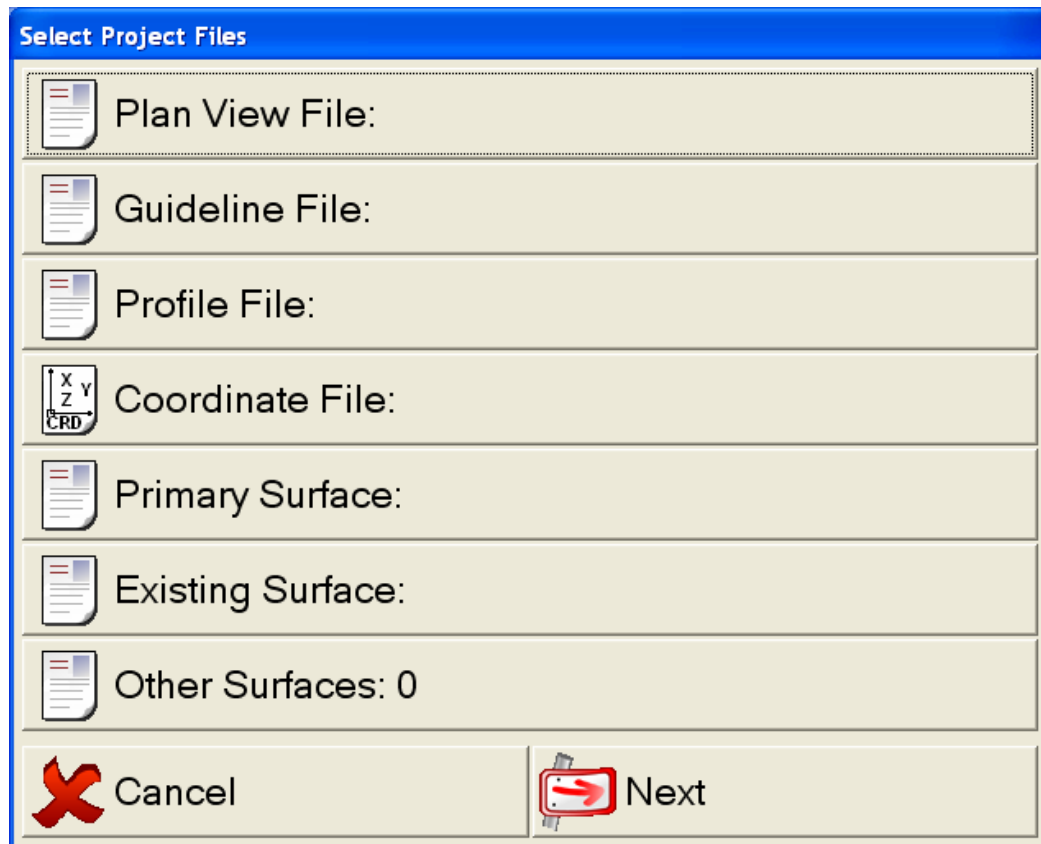


The current active project is displayed on the top line. A project is nothing but a collection of plan view, design DTM, localization and other optional files (including coordinate, centerline and existing surface files) that are lumped together in a single,

named project file. Since you can grade to a selection of files without organizing them into a project, the Current Project can be “None”.

**Change Project:** Click this option to see a list of other project files. On the project file display screen, click “More” to continue through the pre-stored list of project files to select the project desired. If the newly loaded project file does not display correctly, it may have been incorrectly saved (e.g. wrong localization file using the wrong GPS projection or an outdated project file).

**New Project:** This option allows you to create a new project. It will first prompt you for the file name of the new project. You can either overwrite an existing project by selecting one of the listed projects, or you can create a new project file by clicking the “Save As...” button. The next screen will ask you to enter an optional project description, followed by the screen shown next. {Refer to *Chapter 5, “Files and Formats Used in Carlson Grade”* for a complete description of files.}



Select Project Files

Plan View File:

Guideline File:

Profile File:

Coordinate File:

Primary Surface:

Existing Surface:


Other Surfaces: 0

Cancel Next

The “Plan View File” and “Primary Surface” are the most common files to have selected. It will give vehicle landmarks to the real-world and the cut and fill values to the design surface. Once files are selected, press next and move on to the Localization Options screen:



Localization Options


 State Plane 83: MA Mainland


Unit Mode: US-Survey Feet

Transformation: Plane Similarity

One Point Align Azimuth: Grid

Project Scale Factor: 1

 Cancel

 Next

**State Plane Zone** – This is the state plane zone of the project. Options are State Plane 83 and 27 zones, as well as WGS-84.

**Unit Mode** – This can be set to US-Survey Feet, International Feet, and Metric.





**Transformation** – This is the type of localization transformation to use, it can either be Plane Similarity or Rigid Body. Plane Similarity is the most commonly used transformation.

**One Point Align Azimuth** – This is the type of azimuth to use if you have a single point for localization. Options are grid or geodetic.

**Project Scale Factor** – This is the scale factor that will be applied to the localization. Using 1 as a scale factor is the most common value.


The last menu screen is “Advanced Project Options”, which is shown on the next page. For more information on this screen, refer to Chapter 7, “Manager and Advanced Operator Interface”. This screen is followed by a prompt for project notes, which are optional. Project Notes are displayed when the project is loaded.

**Edit Project:** This option behaves like new project, except that you can only edit an existing project, you cannot create a new one. If you only want to change the files being used, excluding the localization file, it is safer to do this through “Select Files” on the same screen. Just select “Yes” when asked if you want to save the changes that you made to the project.

Advanced Project Options	
Project Desc: Demo Site	
	Localization File: DEMO.DAT
Update Existing Surface For: Cut Only	
	Surface Write Interval: Off
Grading Tolerance: 0.10'	
Vertical Offset: 0.00'	Lock: No
Vertical Offset Increment: 0.10'	
 Cancel	 Next

“Advanced Project Options” screen from New or Edit Project

**Field Design:** This option allows the operator to create a design surface on the fly that will replace the primary surface, until swapped back. The following screen is displayed, where the operator can create a simple slope or a flat pad.

Field Design Method
Last Used
Load Slope From File
New Slope/Ramp
New Flat Pad
 Close

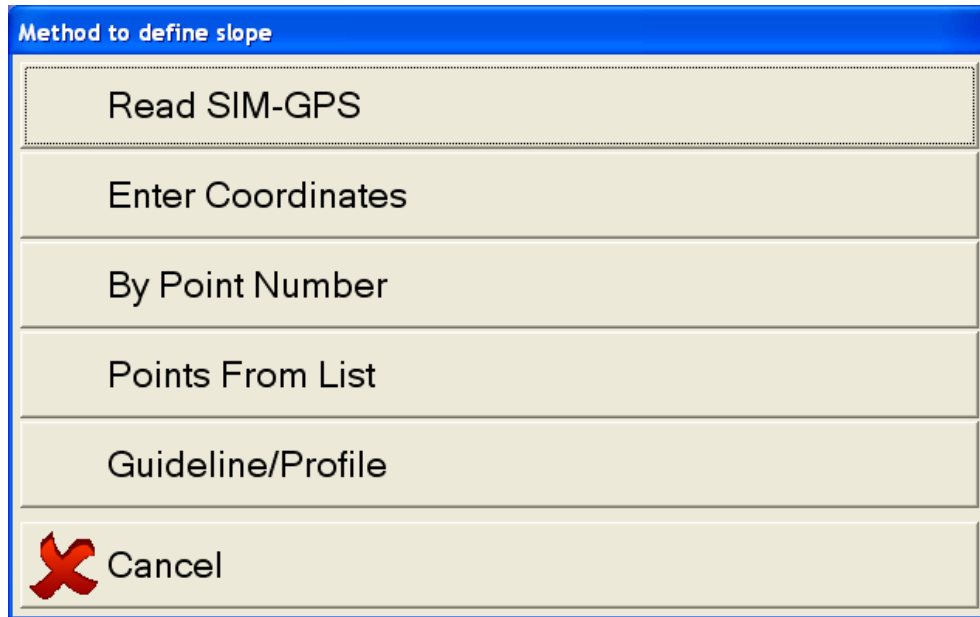
**Last Used** – Loads the last used field design slope.

**Load Slope From File** – Loads a pre-created field design slope file.

**New Slope/Ramp** – Allows operator to create a new field design slope.

**New Flat Pad** – Lets operator select a new flat pad elevation.

The only button needing further explanation here is “New Slope/Ramp”. When you press it the following dialog will be displayed:



The way this works is that Carlson Grade needs two points in order to define the direction of the design. It can get these points in the following ways:

**Read SIM-GPS** – This will read the points using the GPS. In this way the operator can drive between two points to create the slope.

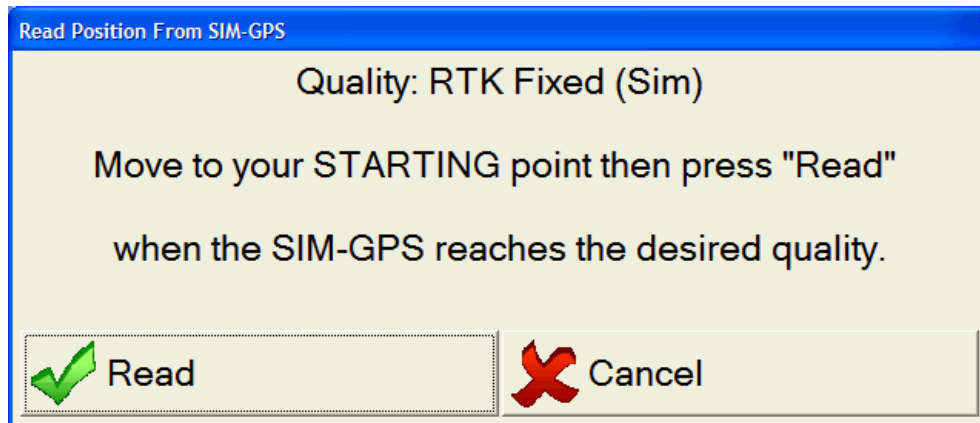
**Enter Coordinates** – This allows the operator to enter the coordinates of two points.

**By Point Number** – This will allow the operator to enter the point number of two points from the loaded coordinate file.

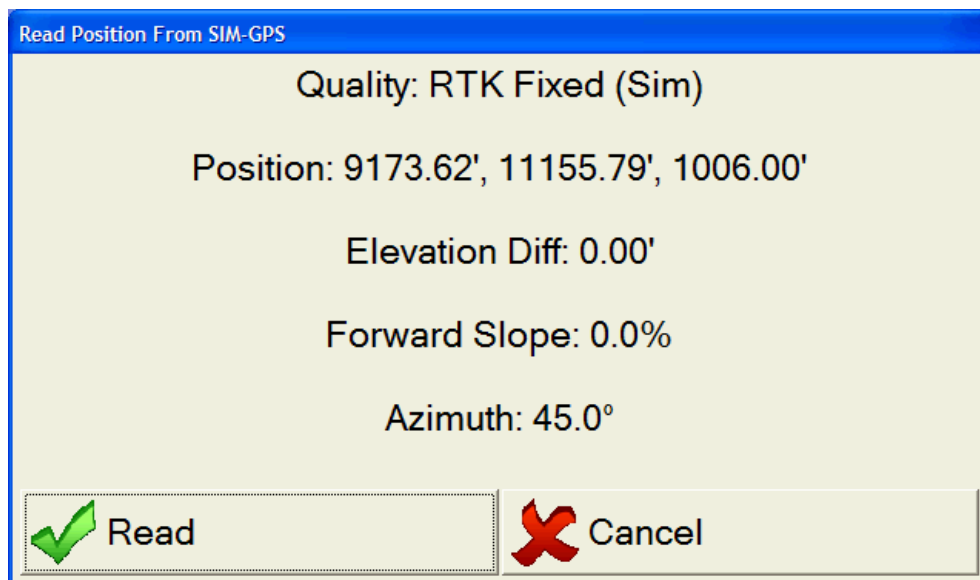
**Points From List** – This will show a list of points from the loaded coordinate file.

**Guideline/Profile** – This allows the operator to select a guideline and profile file to be used for the design.

If you select “Read SIM-GPS” you will be asked to drive to the start point. This will be the first point that is used to calculate the slope.



Press “Read” and start driving towards the second point. As you drive you will see this window:



When you have reached the second point simply press “Read” again. The following items will be asked:

**Forward Slope Percent** – The forward slope of the design surface, in percent. A positive value means going uphill from point 1 to point 2.

**No Cross Slope** – This design surface will be flat from left to right.

**One Cross Slope** – This will create a crown.

**Two Cross Slopes** – This will create a ‘w’ shaped surface.

**Field Design – Drill Pattern Layout:** This is not yet available, but will allow an operator to create a new pattern on-the-fly. Both square and staggered patterns

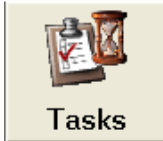
are supported along with variable burden or spacing patterns. The feature steps the user through the process to layout a drill pattern in the field. The operator will indicate the position of the first hole and then enter how many columns (number of holes in row) and rows in the drill pattern. Columns are spacing measurement and rows are burden measurement. Left or right selection is from the row direction. There is an option for square or staggered patterns, with variable rows or columns allowed. The pattern from the prior bench is not taken into account. It was thought that more advanced patterns would be designed in the office for the drill. The user will be prompted to enter a name for the coordinate file or append this new pattern to an existing pattern. The coordinate file in use will be automatically changed to the new file created. Holes that are drilled are marked in a different color and symbol, so the operator knows they are completed (see *Chapter 8, "Typical Operation Scenarios"*).

If variable layout is being used and an exit occurs before all holes are drilled for rows or columns, then the new positions and remaining original holes will be saved. You must work in LOCK status.

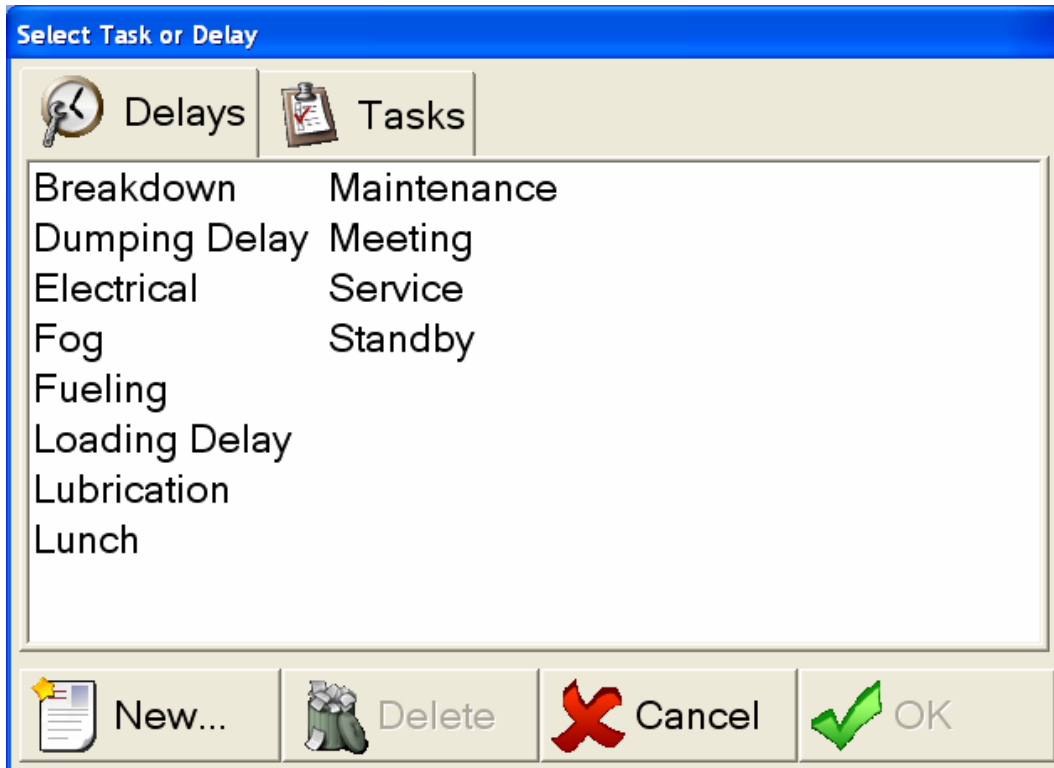
**Switch To:** The next button in the Project dialog is "Switch To". This button allows the operator to quickly switch between a project design surface, a flat pad, or a slope, if they have been created or set accordingly.

**Hold Slope:** This requires a centerline file to be loaded. It will lock the slope calculation at the current distance from the centerline. This is useful when an operator needs to hold a particular slope, even when crossing breaks in the project design surface.

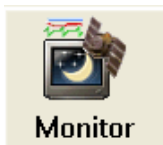
**Select Files:** This brings up a list of files. This is the easiest and safest way to change your project settings if you only want to change a single file. If a project is set, then the user will be prompted to "Save To Project File" when exiting the screen after changes. Answering yes will save the changes to the project and answering no will save your changes, but set the project to None; therefore, not allowing a switch to another project and back to these new changes.



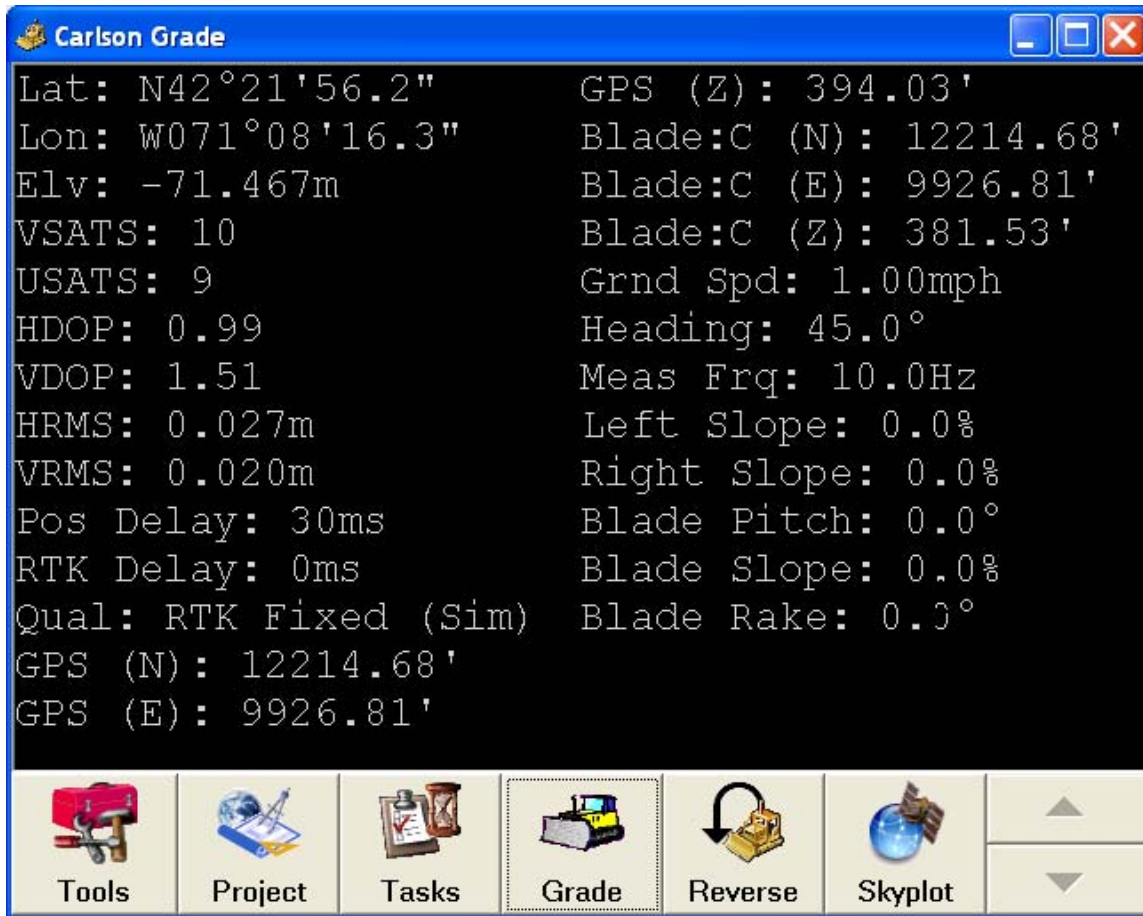
This button allows the operator to log activities and delays so they can be analyzed back in the office. This is only useful if points are being logged (see logging options). When you press this button you will see the following screen:



Here the user can select from delays and tasks. Delays should be used when the machine is experiencing downtime, tasks should be used for different work activities. Pressing the 'New' button will allow the operator to enter in a new task or delay.



The Monitor button allows the operator to check the status of GPS and other hardware. When pressed, something like the following screen shot will be displayed:



This screen shows a lot of information, here is a breakdown:

**Lat/Lon/Elv** – This is the latitude, longitude, and elevation of the GPS antenna.

**VSATS** – The number of satellites visible in the sky.

**USATS** – The number of satellites used in the calculation of the GPS position.

**HDOP/VDOP** – The horizontal and vertical dilution of precision. This is a measure of the quality of the GPS position. A smaller DOP value means a better position.

**HRMS/VRMS** – The horizontal and vertical RMS values of the position. This is another measure of the quality of the GPS position. A smaller RMS value means a better position.

**Pos Delay** – The inherent delay of the GPS position from the GPS receiver.

**RTK Delay** – The time since the last RTK correction from the GPS base station.

**Qual** – The quality of the GPS position. A value of RTK Fixed indicates the highest position quality. This is a value that may be asked of the operator to report to supervisor.

**GPS (N/E/Z)** – The northing, easting, and elevation value of the GPS antenna.

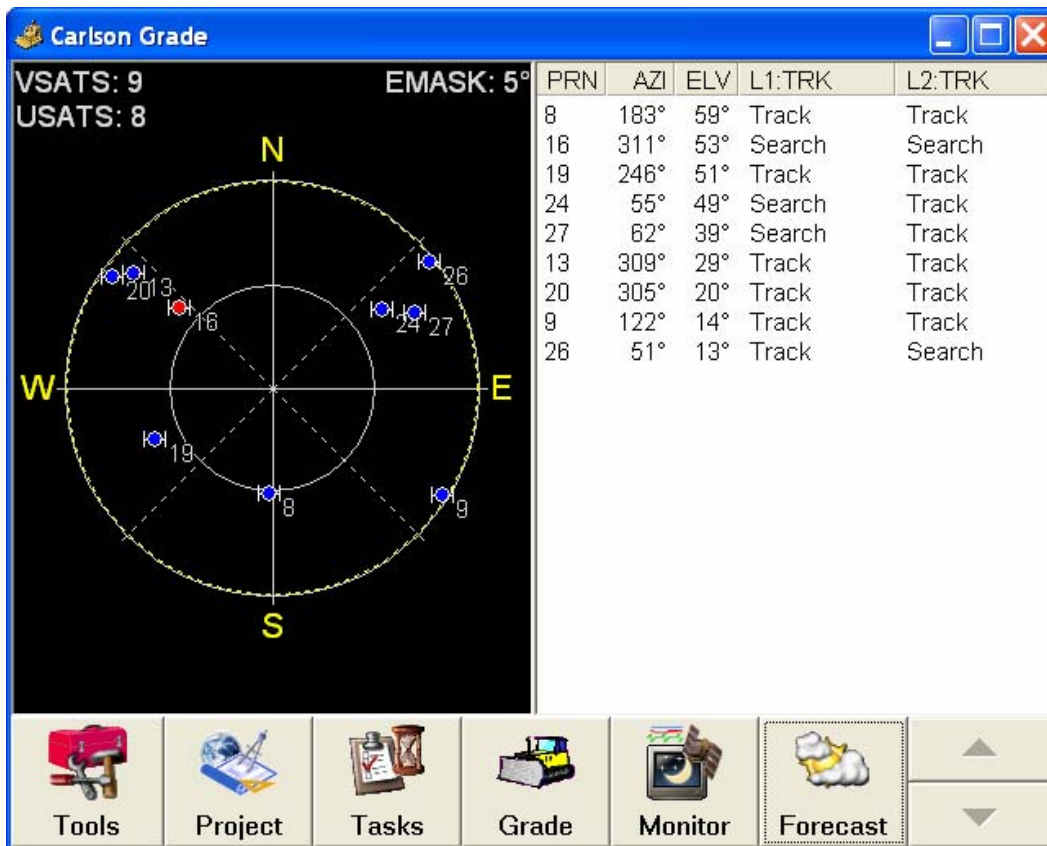
**Blade (N/E/Z)** – The northing, easting, and elevation value of the Dozer Blade.

**Grnd Spd** – The ground speed.

**Meas Frq** – The frequency of the GPS position. A higher number here means a more responsive cut/fill calculation.

The remaining fields are values from the tilt sensor(s).

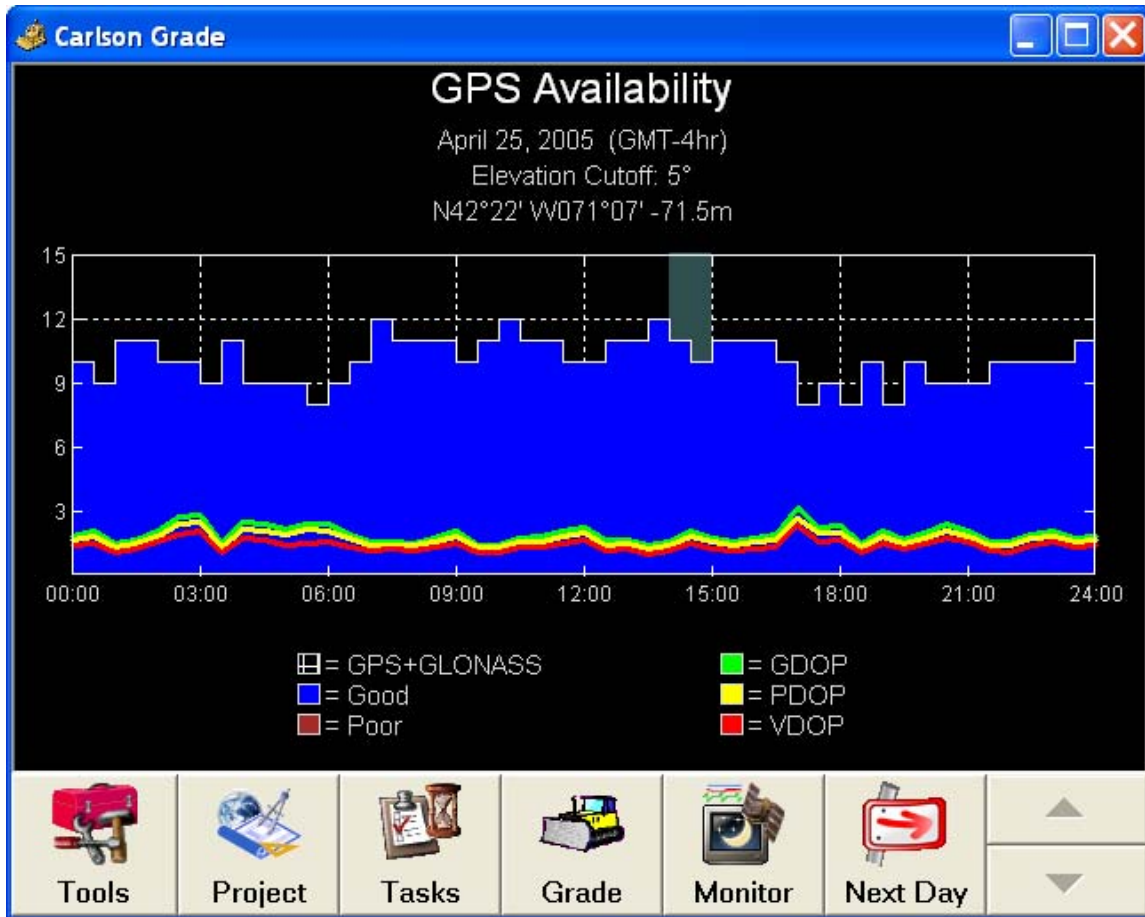
The buttons along the bottom or top of screen that are different from the main grading screen are the “Grade” and “Skyplot” buttons. The “Grade” button takes you back to the main grading screen. The “Skyplot” button shows the current satellite configuration in the sky. Here is an example skyplot screen:



This screen lists all of the visible satellites, along with their PRN (satellite ID number), current azimuth, elevation, and whether or not they are tracking on the L1 or L2 frequency.



The new button on this screen is the Forecast button. Pressing this will show the forecasted number of satellites at certain times in the future. This can help for determining when there will be insufficient satellites to get a lock, thus downtimes can be planned for. An example forecast screen is below:



The “Next Day” button will advance to the next day.



This button is useful if you do not have a reverse sensor and are using the auto-detect reverse feature. When you first start the software, it assumes that the first motion of the machine is forward. If the operator goes in reverse the software can incorrectly determine that machine is moving forward. This button corrects that problem. This button is unnecessary when using a dual-antenna system or a reverse sensor.



This button switches between different views. The drill only uses the plan view right now, but with angle drilling and depth sensor integration, will contain some specialized down-hole and alignment views. For all other equipment, available views include (individual or combined):

**Plan View** – The birds-eye view.

**Section View** – The cross-sectional, back, or blade view.

**Side View** – The side, or profile view.

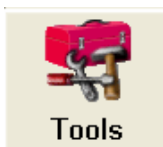
**Cut/Fill View** – A view that just displays the cut/fill value.

Available controls are:

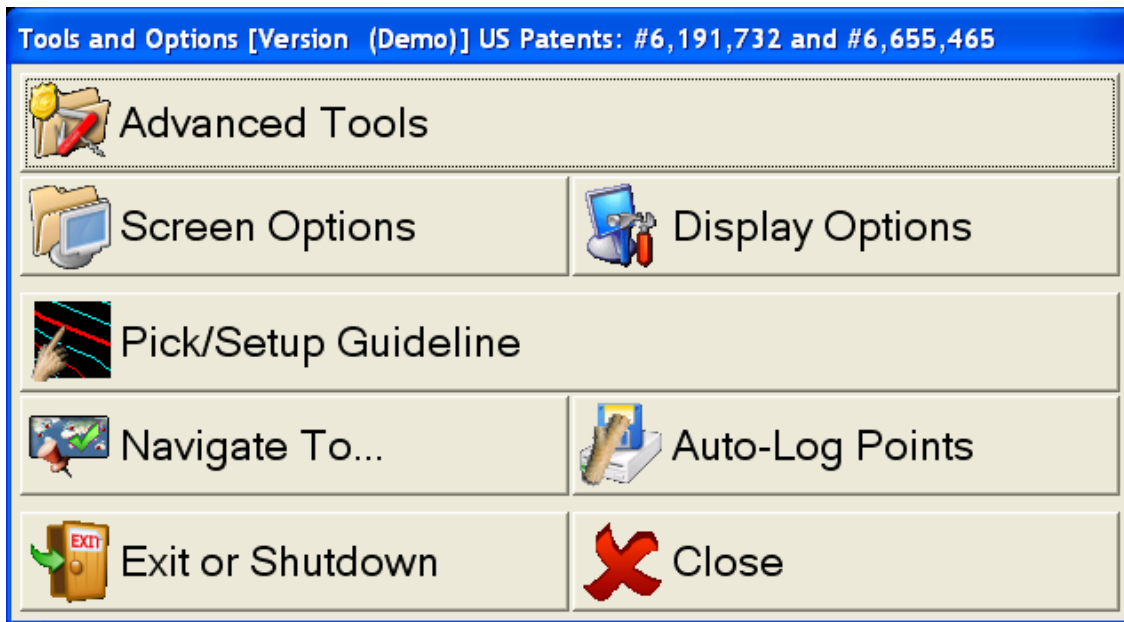
**Magnifying glasses (+/-)** – Zoom in and zoom out respectively for the screen view that they are associated. Double tap the plan view to zoom in or zoom out (depending on current zoom level) and again to return to original zoom level.

**Pan** – This pans the plan view map without resizing. This is accomplished by placing your finger, cursor, etc. on the plan view map then dragging the map until you see what you are after. Reset to the standard operating mode by double tapping.

**Vertical Offsets** – Up-Down Arrows for Subgrades or Grade Offsets that are found on the right side of the main tool bar. This feature will take the surface that is primary and vertically offset it in the direction of your choosing. There are options to control the increment value and if it is locked out to the operator.

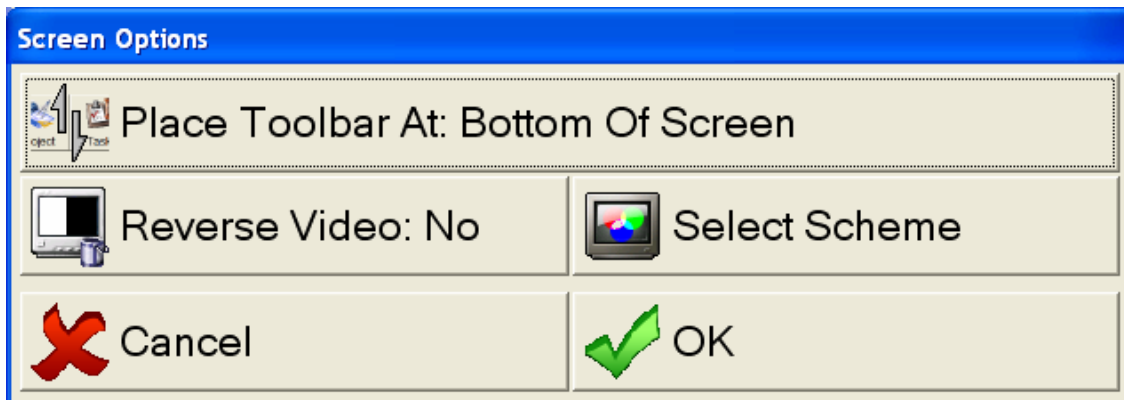


The tools button is where all the basic settings are located. When pressing this button the following dialog is displayed:



**Advanced Tools:** This button goes into advanced tools that are used for system settings and can be password protected. Refer to Chapter 7, “Manager and Advanced Operator Interface” for more details.

**Screen Options:** This button displays the following dialog:

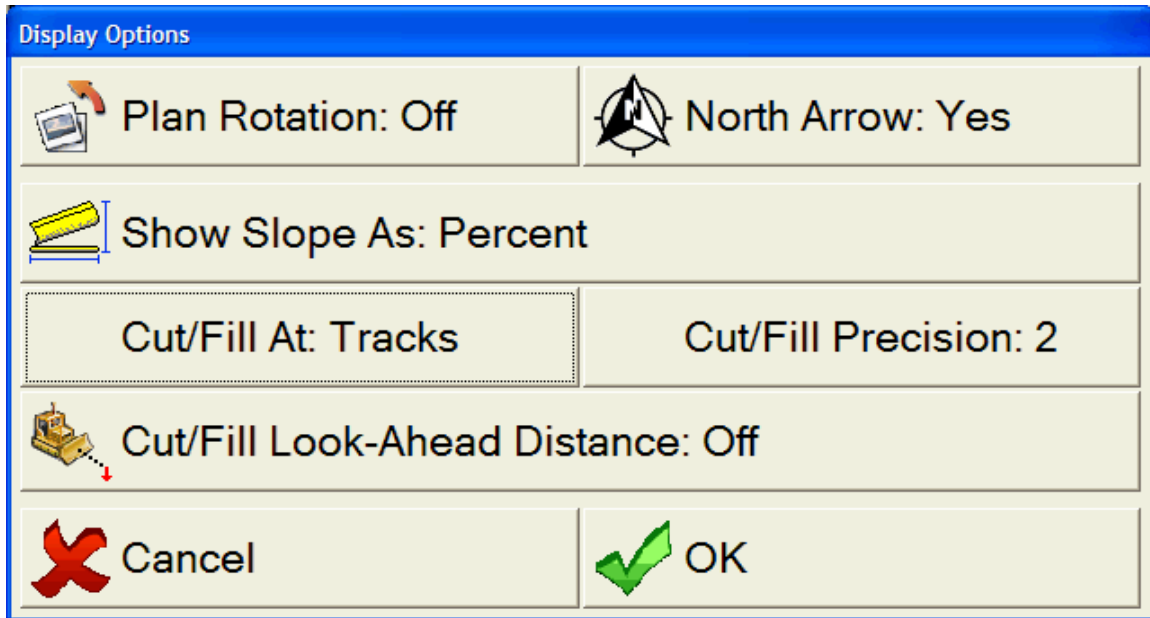








**Place Toolbar At** – This button determines where the toolbar on the grade screen is placed. This can be placed either at the top or the bottom of the screen.

**Reverse Video** – This button causes the color palette to be reversed. When used in conjunction with the color Scheme it can make the screen easier on the eyes in dark environments and easier to see in light environments.

**Select Scheme** – This allows the user to select different color schemes. High Contrast White or Black will enlarge the screen title bars and bold the font to make it easier to read. You can customize with your company colors as well.

**Display Options:** This button brings up the following dialog, which will be slightly different for the drill (refer to *Chapter 8, “Typical Operation Scenarios”*):



 Plan Rotation: Off	 North Arrow: Yes
 Show Slope As: Percent	
Cut/Fill At: Tracks	Cut/Fill Precision: 2
 Cut/Fill Look-Ahead Distance: Off	
 Cancel	 OK

**Plan Rotation** – This controls the rotation of the plan view. Options underneath this menu are Automatic, Fixed, and Move To Set Fixed. Automatic means the plan view will rotate underneath the vehicle, so the vehicle will always move up screen. Fixed allows the user to enter a fixed azimuth. Move To Set Fixed allows the operator to drive to set the plan view rotation. If the plan rotation is fixed and set to 0, this option is said to be Off.

**North Arrow** – Turns on and off a north arrow on the plan view. This can be useful if the plan view rotation is set to automatic or Fixed to a non-zero rotation value.

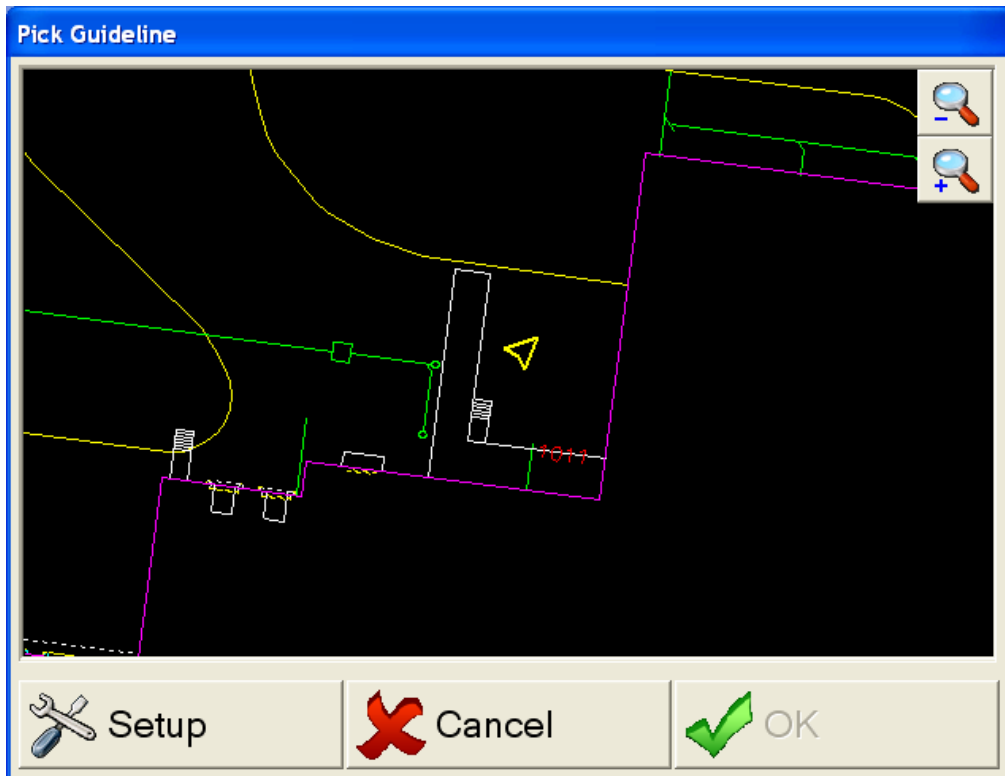
**Show Slope As** – This changes the units that the slope values are reported in. Values are Percent, Rise/Run, and Run/Rise.

**Cut/Fill At** – Where to show cut fill. This will change depending on the vehicle.

**Cut/Fill Precision** – The number of decimal places that will be displayed in the cut/fill window.

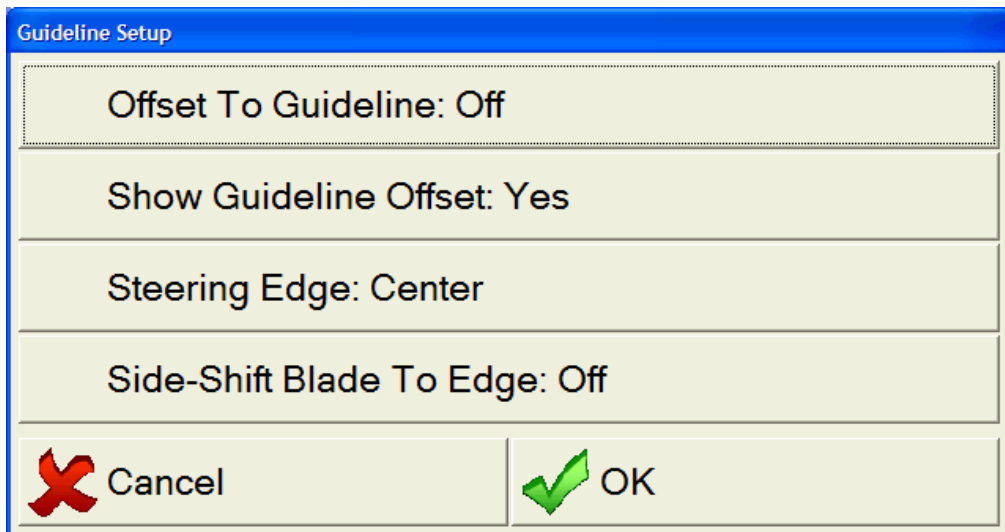
**Cut/Fill Look-Ahead Distance** – This value causes the cut/fill to be displayed at a point in front of the vehicle.

**Pick/Setup Guideline:** This option allows the operator to select a guideline from the plan view. It also allows the operator to select certain guideline options. When this is selected the following screen is shown.



To select a centerline simply touch the line you wish to use. When you do this you will have the option to save it for later use.

The setup screen shows the following dialog:



**Offset To Guideline** – This allows the operator to calculate the offset from the guideline from a distance off the guideline. A positive value means left of the guideline. Unlike the vertical offset which draws an offset line, this will only display the red location circle offset from the guideline.

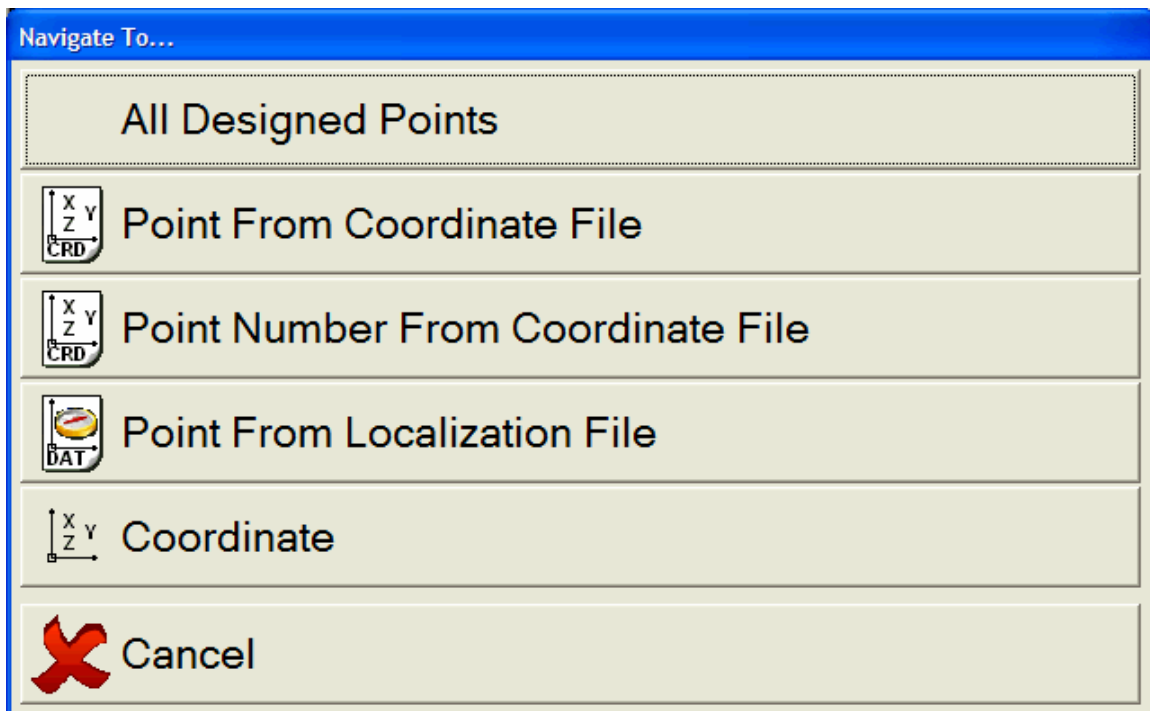
**Show Guideline Offset** – This controls whether or not the offset will be drawn in the plan view. It will show a dashed white line with a red circle at the end from the vehicle to the position of interest, if it is set to “Yes”.

**Steering Edge** – This determines where on the vehicle the station and offset is calculated, including: left, center, right.

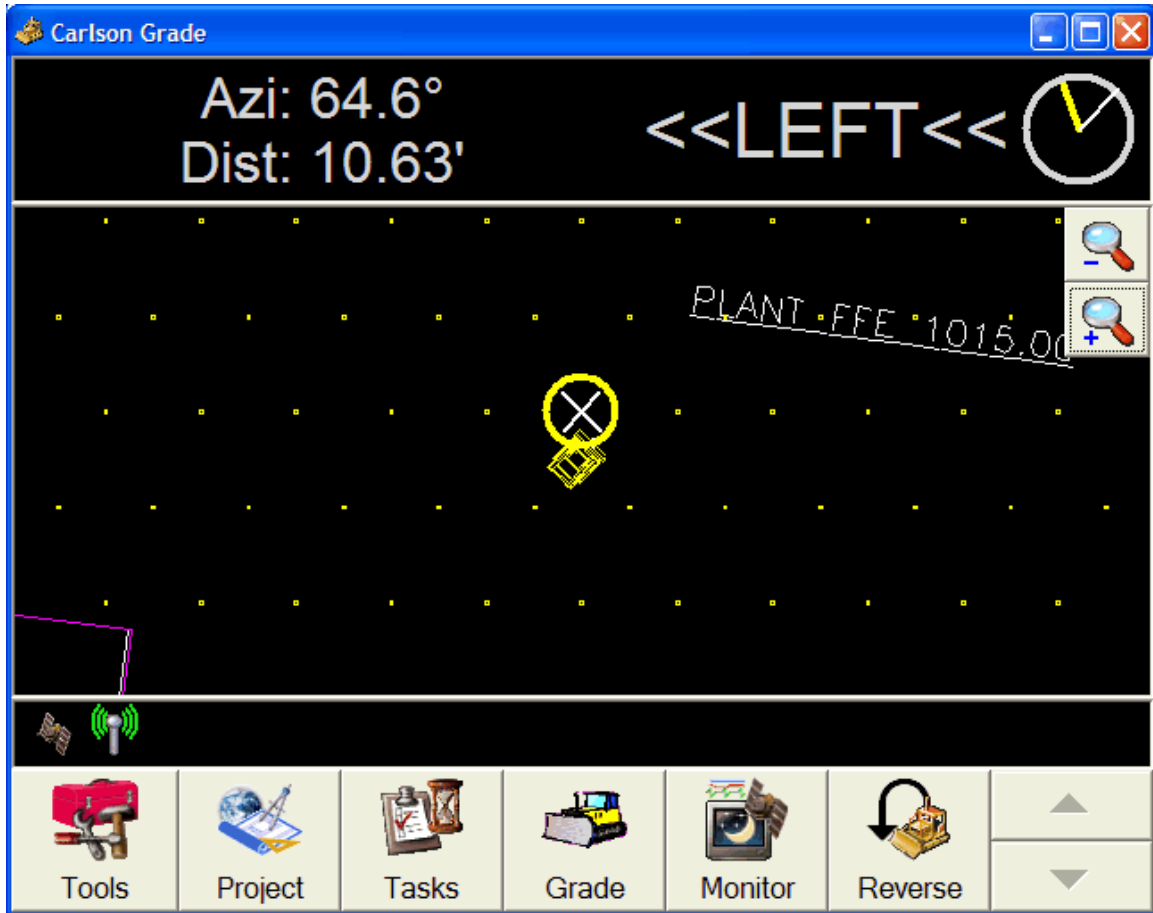
**Side-Shift Blade To Edge** – This is for hydraulic control on a motorgrader blade primarily. It controls the left and right shift of the blade, versus only the vertical shift seen in most dozers.

**Delete Drilled Hole:** This option (not currently available) is used when drilling holes if “Drill” was accidentally selected and it needs to be removed from the records. It works similarly to “Pick Guideline”. To select a hole to delete simply touch the hole you wish to remove. You can select more than one at a time. To deselect a hole, just touch the hole again. When you are satisfied with your selections, press OK to accept. The hole will be deleted from crd file and the drilled hole files.

**Navigate To...:** This allows the operator to navigate to a particular point. The point can be selected from a known coordinate point number, a list of points in a coordinate or localization file, or entered by hand. In the latter, the next available coordinate number will be assigned to the point if it is drilled. If “All Designed Points” is selected, you will be directed to the closest point as you navigate. The selection screen is shown below and again will be slightly different for the drill (refer to *Chapter 8, “Typical Operation Scenarios”*).



Localization points will be displayed with a different symbol. All cases will put a bullseye on the point of interest and it will spin when within the set distance tolerances. The navigate screen for “All Designed Points” is shown below:



The upper display section gives pertinent information about navigating to the desired point. The middle section is the plan view with bullseye target and the lower piece is the normal grading status area. The upper section contains:

**Azi** – Currently the angle difference between the vehicle heading and the direction from the vehicle to the point. May change to be vehicle heading.

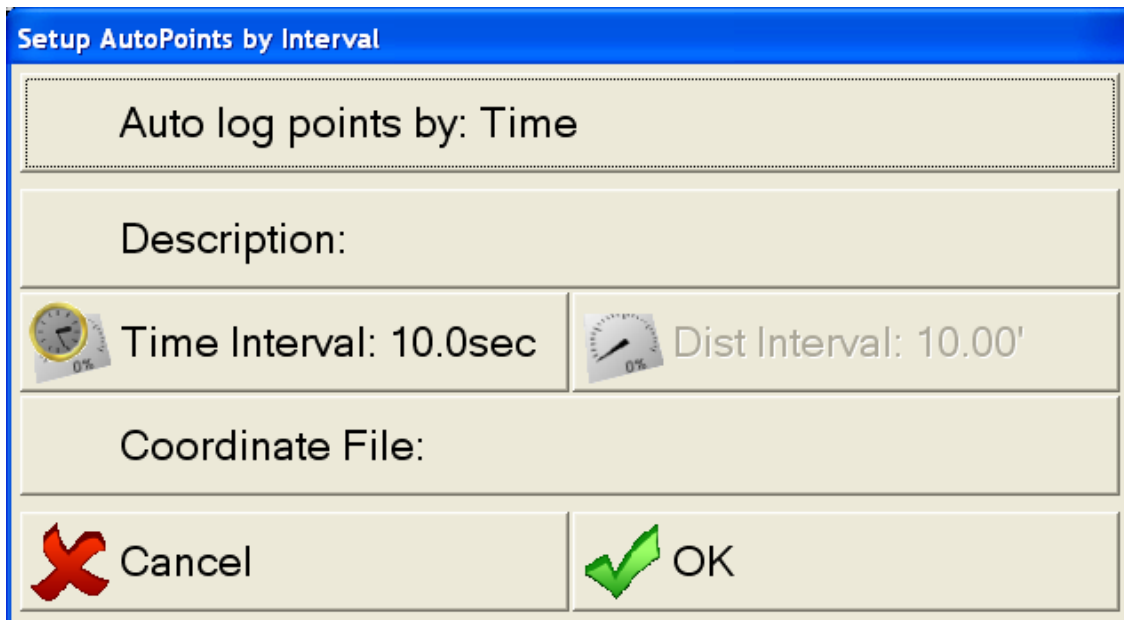
**Dist** – The distance away from the point.

**Direction** – The direction of travel needed to get to the point.

**Compass** – The yellow is the direction from the vehicle to the point and the white is the current heading of the vehicle. Compass North is indicated by a light gray segment to help with orientation when screen is using auto-rotate.

Other items to be added to the upper section include the optional: elevation, cut/fill to primary surface, and project name.

**Auto-Log Points:** This is the auto-points by interval feature. This function will log points to a coordinate file at specified intervals. Intervals can be either time or distance. A description can be added and a Coordinate File needs to be set as to where to save the points. This is a different coordinate file than the one found in the Project File Selection screens. The auto-points by interval dialog looks like:



Setup AutoPoints by Interval

Auto log points by: Time

Description:

Time Interval: 10.0sec Dist Interval: 10.00'

Coordinate File:

Cancel OK

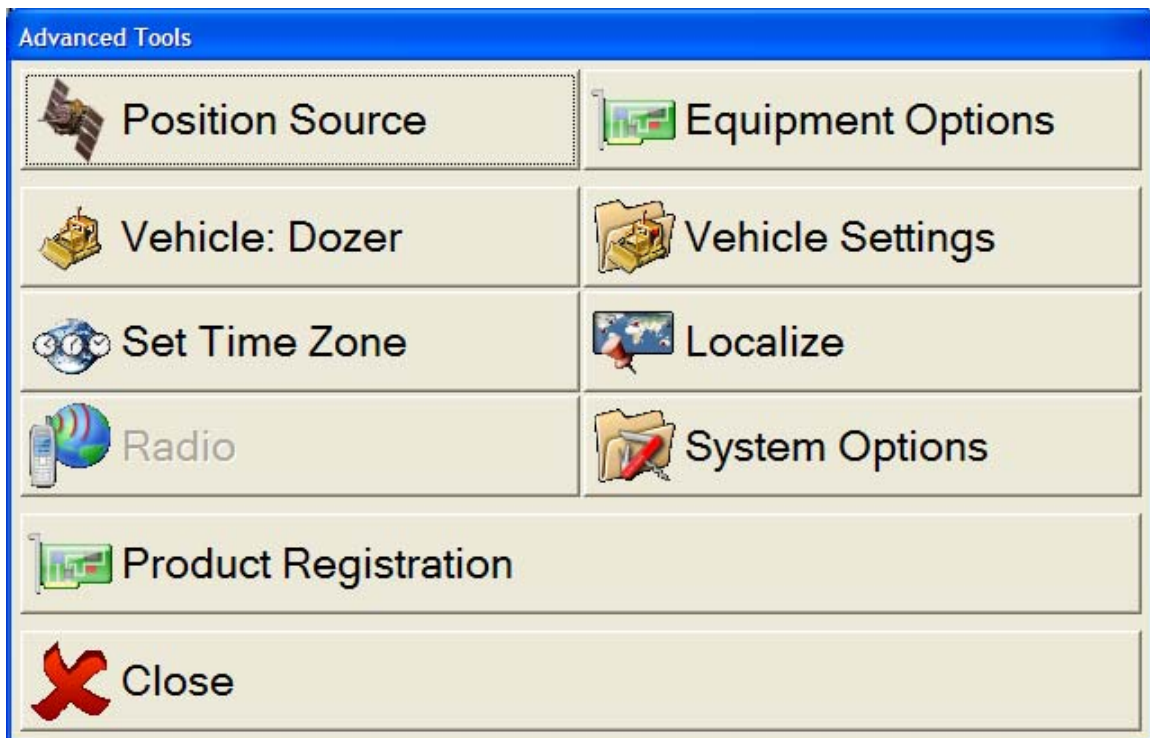
**Warning and Hazard Zones:** For this feature to work, a warning polyline must have been identified in the “PLN” file when it was made by the Carlson office software. If the vehicle strays into this zone, a warning message will flash in the status section of the screen (bottom black area). If it happens to be a warning surface that was entered into, then the description of surface will be displayed with the warning. Currently, “DWG” and “DXF” files do not support this feature.

**Messaging:** Other items that are displayed in the status area (thin black section at screen bottom) include: GPS status, radio strength, equipment control indicators, centerline values if in use, and the vertical offset value if one is set.

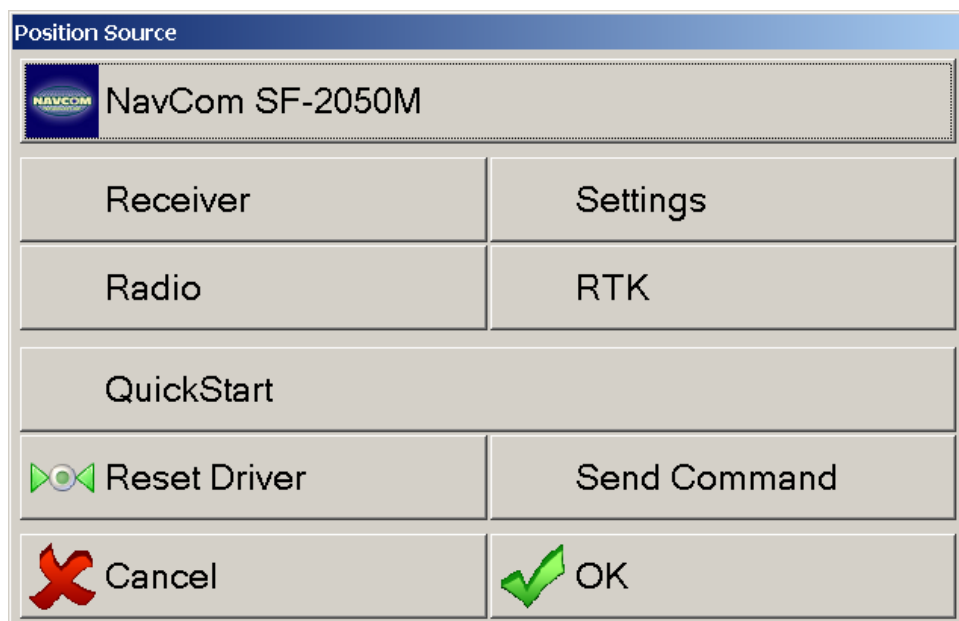
## 7. Manager and Advanced Operator Interface

**Advanced Tools Menu:** Selecting the Advanced Tools button in the Tools menu brings up a confirmation window that warns “This is for authorized personnel only!”. The settings in the Advanced Tools menu are for trained installers and managers. Each of the following sections describes the functionality available in the Advanced Tools menu.

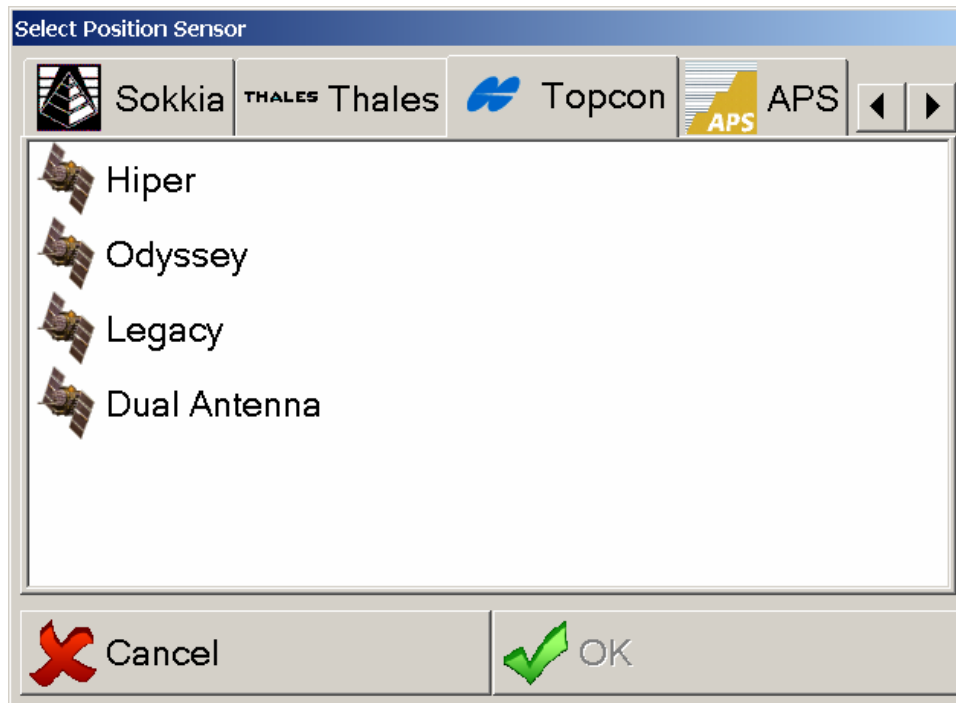




**Position Source or GPS/TPS Setup:** This is used to select the positioning source to be used which can be either GPS or TPS (Total Station). Selecting this button brings up the Position Source screen which includes many settings.



The top button in the Position Source screen shows the current GPS or TPS instrument. Pressing this button allows you to select a different instrument in the Select Position Sensor screen.





You can browse through the different manufacturer tabs by pressing the left and right arrow keys in the upper right corner of the window. Select the desired model by pressing the manufacturer tab and then the model and then press OK.

The Receiver, Settings, Radio, and RTK buttons in the Position Source window can be used to set instrument options after selecting the correct model in the Position Source screen. See Appendix C for “Topcon Dual-Antenna Setup”, also applies to APS Dual.

**Receiver:** The Receiver menu allows you to select the port settings for the port that the receiver is connected to. Typically it will use an RS-232 port; however, Replay is discussed in Appendix B, “Carlson Grade Reporting and Replay”. To see and change the port settings, press the RS-232 button which results in the following screen:

RS-232	
Port: 1	Baud Rate: 57600
Parity: None	Byte Size: 8
Stop Bits: 1	Flow Ctrl: None
Cancel	OK

**Settings:** Some instrument settings are unique to the instrument. The following Settings menu shows settings that all the GPS instruments have in common.

Settings	
Best Quality: Medium	Elev Mask: 5°
Position Rate: 5Hz	Horz Error Limit: 1.0m
Vert Error Limit: 1.0m	HDOP Limit: 10.0
VDOP Limit: 10.0	
 Cancel	 OK

**Best Quality** – Allows setting the minimum quality required for showing elevations and collecting points. Low Quality is for standalone GPS like Garmin. Medium quality is for NavCom StarFire and RTK Float modes. High quality is for RTK fixed and is the default for all receivers except Garmin.

**Elev Mask** – The number of degrees above the horizon a satellite must be above to be used in the GPS solution. It is not advised to go below 5 with this setting.

**Position Rate** – How many times per second the GPS will provide a position. This will depend on what the selected receiver supports.



**Horz Error Limit** – The horizontal distance error allowed before the quality is set to low, which prevents elevations from being displayed. This error estimate is provided by the GPS receiver for every position sent.

**Vert Error Limit** - The vertical distance error allowed before the quality is set to low, which prevents elevations from being displayed. This error estimate is provided by the GPS receiver for every position sent.


**HDOP Limit** – Maximum Horizontal Dilution of Precision before the quality is set to low. A typical value is 2 for high accuracy work.

**VDOP Limit** – Maximum Vertical Dilution of Precision before the quality is set to low. A typical value is 3 for high accuracy work.

**Radio:** The radio screen identifies which receiver port the radio receiving the RTK corrections is connected to. The port identification may be slightly different depending on how the ports on the receiver are labeled.


Radio	
Port: External	Baud Rate: 19200
Parity: None	Byte Size: 8
Stop Bits: 1	Flow Ctrl: None
 Cancel	 OK

**RTK:** The RTK screen may contain additional options depending on the receiver capabilities but it always has a Type button to select among the types of RTK corrections that the current receiver can use.

RTK	
Type: CMR	
 Cancel	 OK

Typical RTK correction types are RTCM, CMR, and Proprietary where Proprietary is a format unique to that particular brand of receiver. For instance Proprietary format for a Leica receiver means the Leica RTK format.






**QuickStart:** The QuickStart window is only available when using a NavCom receiver. See Appendix A, “Special NavCom StarFire Setup”.

QuickStart
Load Last Saved Position
Load Saved Position
Save Current Position
By Point Number
Adjust Localization
 Close

**Reset Driver:** Depending on the receiver type, this will either reset the receiver to the factory defaults or simply just turn it off and back on.

**Send Command:** You can send commands to set items that may not be accessible through Carlson Grade menus or to request additional information from the receiver for instant feedback for troubleshooting for example.

**Equipment Options:** There are numerous options available in this screen. The available equipment types currently include: SonicMaster, ProControl, Tilt Sensors, GPS Tilt Sensors, None, and Simulation. In addition, three other equipment selections on the screen below include: Light Bar, Reverse Sensor, and Second GPS. Future plans include a Depth Sensor selection for the drill and more hydraulic options. From the screen below, the equipment, light bar, and reverse sensor COM ports can be set.

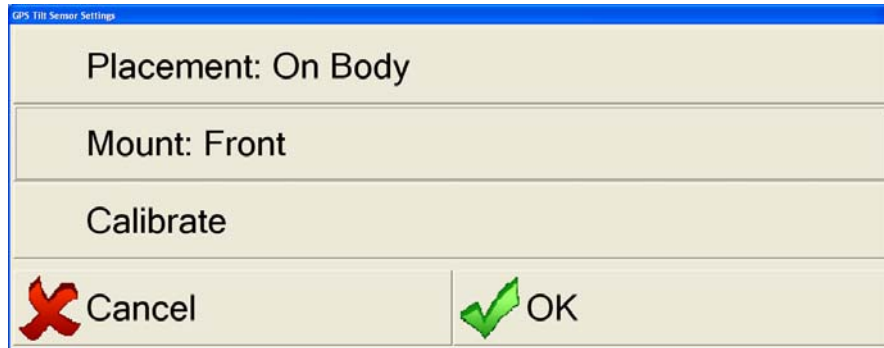
Equipment Options	
Equipment: Tilt Sensors	
Tilt Sensor on: COM2	
Configure Sensors	 Calibrate Sensors
Tune Hydraulics	 Light Bar: COM3
 Reverse Sensor: None	
Second GPS: No Driver	
 Cancel	 OK

**Reverse Sensor:** This keeps the equipment icon always moving in the correct direction. Although Carlson Grade usually detects the direction of equipment movement, it sometimes gets it wrong. To correct the direction, the user can press the “Reverse” button on the main grading screen. Direction is important to Productivity Tools, which distinctly analyzes backing up and forward pushing. Some companies want to avoid ever having operators re-orient the icon with the button press, so they opt for installing a reverse sensor that taps into the back-up “beep” signal on certain equipment. The reverse “beep” sensor must be hooked up to the DSR pin on a serial port.

**Second GPS:** The Second GPS is used if actually using a second GPS to be able to get the heading reading. This feature is not for a dual-antenna system, where the receiver or receivers are configured for such operations, but for two completely separate receivers. By selecting this option, the same screens as

discussed in the “Position Source” section above will be used. Please refer to that section regarding questions with these screens.

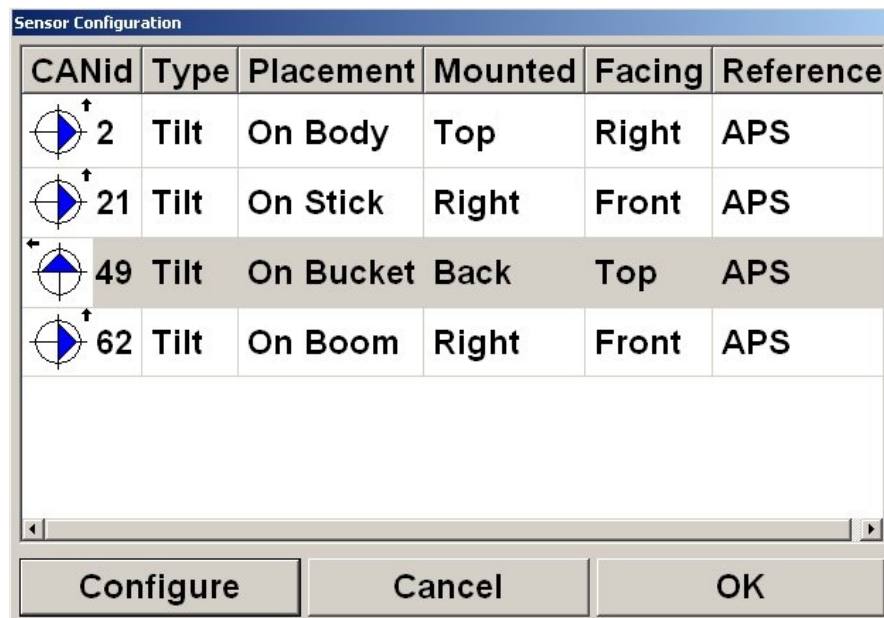
**Configuring and Calibrating Tilt Sensors:** Depending on the equipment selected on the top line, various items will need to be calibrated or tuned. Plug in tilt sensors for all options. For instance, if “GPS Tilt Sensor” (as opposed to “Tilt Sensor”) is selected, clicking Configure Sensors presents the following screen:



The dialog box titled "GPS Tilt Sensor Settings" has a light beige background. It contains three stacked rectangular buttons: "Placement: On Body", "Mount: Front", and "Calibrate". At the bottom, there are two buttons: "Cancel" with a red 'X' icon and "OK" with a green checkmark icon.

Dozer placement options include On Blade, On Body, On Left and On Right or None. Excavator placement options include On Body, On Boom, On Stick, On Bucket or None. Drill supports only On Body or None at this time. See the vehicle operation section in Chapter 8, “Typical Operation Scenarios” for additional discussion. Mounting options are typically Front, Right, Left and Back. Calibrate will perform a simple calibration that involves lining up the machine one direction then turning it 180 degrees around for the second reading.

If “Tilt Sensors” are selected, Configure Sensors leads to the screen shown below:



The "Sensor Configuration" window displays a table with the following data:

CANid	Type	Placement	Mounted	Facing	Reference
2	Tilt	On Body	Top	Right	APS
21	Tilt	On Stick	Right	Front	APS
49	Tilt	On Bucket	Back	Top	APS
62	Tilt	On Boom	Right	Front	APS

Below the table is a horizontal scrollbar. At the bottom of the window are three buttons: "Configure", "Cancel", and "OK".

The APS tilt sensor is a “CAN” device as opposed to a serial device, so is able to work in series and communicate to the computer based on its CANid.

**CANid** - The id number pre-assigned to sensor (found on label). The software will automatically pull in the numbers of the sensors. If installing a multi-sensor system, it is recommended to put the sensors in numeric order from bucket to body for example.

**Type** - This can be either: tilt, rotation, valve, or unknown.

**Placement** - Where is the tilt sensor located, can include: body, blade, blade arm, boom, stick, bucket, dogbone, and other locations depending on heavy equipment.

**Mounted** - Position on the component that the sensor is attached. Options are Top, Bottom, Right, Left, Front, Back. This is always determined from the operator's point-of-view. So, if you were in the operator's seat, left is to your left and back is behind you. Consequently, if the boom sensor was mounted on the right, it would be on the right side of the boom looking towards the bucket from the operator's seat.

**Facing** - The direction the arrow on the APS tilt sensor is facing or rather the direction the sensor is pointing. This is determined by the BIG arrow on the face of the sensor and is considered from the installer's point of view. The values are different for each Placement value. Conveniently, the software will not allow you to set an invalid facing for the mount specified.

**Reference** - Sets the pitch/roll reference frame. This can be APS, SAE, or ARF. For APS sensors these should be set to APS.

**SAE** – Is the standard reference frame.

**APS** – Is the APS reference frame. The pitch and roll are swapped.

**ARF** – Is the Absolute Reference Frame. The pitch and roll will give absolute values around the circle.

Each attached sensor will need to be configured, which is completed by selecting a row and pressing Configure, resulting in the next screen:

Sensor Properties

**CAN Bus ID: 49**
**Sensor Type: Tilt**

**Placement: On Bucket**

**Orientation: Back**

**Facing: Top**

**Reference: APS**

**Terminated: Yes**

**Terminated** - This is either off or on. Only the last tilt sensor on the CAN bus chain should be terminated. If there is only one cable coming out of the sensor, then the terminated value should be set to “Yes”.

When using tilt sensors, the mounting angle must be calibrated. Under the Equipment Options in Advanced Tools, you can Calibrate the Tilt Sensors. Clicking Calibrate (for both Tilt Sensor or GPS Tilt Sensor) presents the following screen:

Sensor Calibration

CANid	Placement	Pitch	Roll	Rake
2	On Body	0.5°	-2.1%	0.0°
21	On Stick	-30.7°	N/A	N/A
49	On Bucket	-20.1°	N/A	N/A
62	On Boom	0.5°	N/A	N/A

Calibrate

Cancel

OK

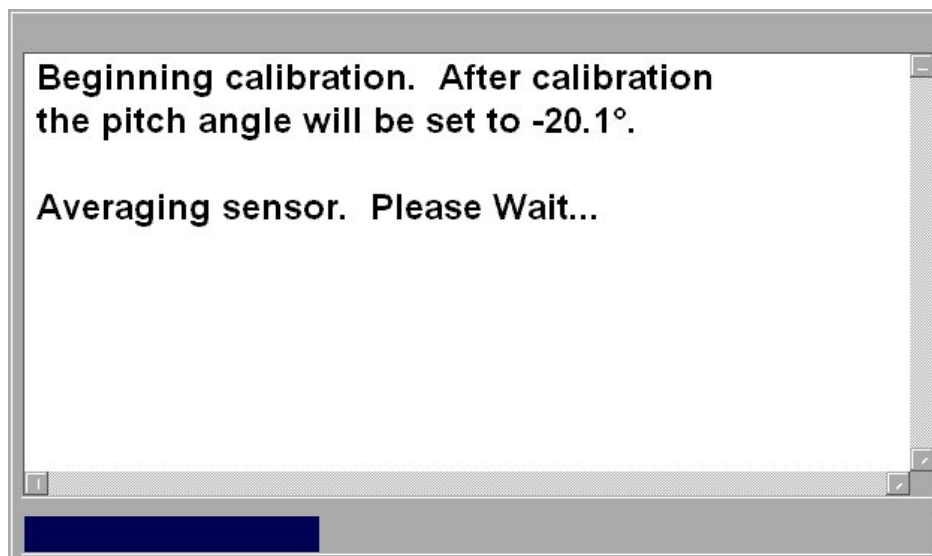
The only items to worry about changing on this screen are the pitch (along sensor) and roll (across sensor) angles. Double-tapping or selecting the sensor and





touching Calibrate will bring up the numeric keypad to enter calibration angles. You can enter a desired reference bucket tilt as shown, using the on-screen keyboard.



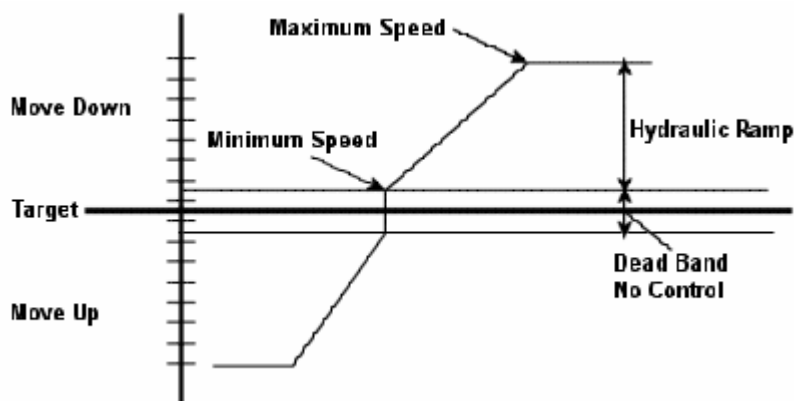
When you select OK, the screen below will appear. In this example, it is for the bucket tilt sensor:



**Tune Hydraulics:** The tuning screen for the Leica SonicMaster and ProControl. Hydraulics Tuning screen is shown below:

Hydraulic Tuning	
Time-out: 125ms	
Ramp: 0.0"	Apply: No
Dead band: 0.0"	
Max Speed: 100.0%	Min Speed: 35.0%
Up/Down Ratio: 80.0%	Apply: Raising
Test Tuning	
 Cancel	 OK

This is one of the most critical parts of the installation where automatic control is involved on motorgraders. The hydraulics must be tuned properly to get the hydraulic response needed to move the blade. Based on cut or fill information from the GPS related to the Primary Surface DTM, Carlson Grade sends a command to the SonicMaster valve controller to either raise or lower the blade. The tuning settings determine the specific movements of the cylinders. This graph illustrates how the movement is determined based on the amount of cut or fill.



**Hydraulic Time-Out** - this is the duration of time in milliseconds that the hydraulics will drive after each given message. Carlson Grade defaults to 125ms.

**Hydraulic Ramp** - This value is the error distance (in inches) it takes to change from minimum speed to maximum speed. Start with 2.

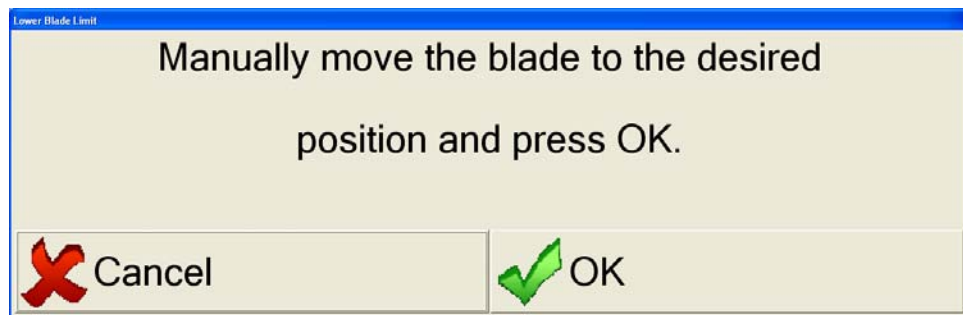
**Dead Band** - This is a distance set for no hydraulic correction. If the cut/fill is less than the dead band, then Carlson Grade will not move the blade. Start with 0.1 inch.

**Maximum Speed** - This is the highest speed the cylinder will travel with out over shooting in the down position. Start with 70 to 100.

**Minimum Speed** - This speed is set for small correction just outside the dead band, without over shooting. Start with 30%

**Up/Down Ratio** - Less fluid is needed to move the cylinder in the up direction. This Ratio is set to even the movement. Start with 75%.

**Test Tuning** - Walks you through the test procedure, beginning with the screen shown here:



Move the blade with the manual levers, then turn the auto manual switch to AUTO and watch movement of the blade. Check to see that the blade comes to grade without overshooting.

**AUTO or MANUAL Display**--To put into AUTO the operator will need to move the SonicMaster auto/manual switch located on the right lift lever to AUTO.

**Auto** - the cut/fill information is sent to the SonicMaster and the blade will be driven automatically.

**Manual** - the cut/fill information is displayed on the screen for the operator to manually control the blade.

**Example** - if the blade is in heavy cut the operator will want to watch the cut/fill numbers and manually move the blade.

**Safety Note** - If the blade position is more than two feet from the line to cut, Carlson Grade won't let this function start.

Once the project and settings have been entered the SonicMaster panel must be set up. Select off/GPS by pushing the mode button on the side that the GPS antenna is located. Select slope on the opposite side. Position the blade near the ground, start forward motion and move the auto/manual switch to auto. This will allow Carlson Grade to drive the blade to the desired elevation and cross slope. The operator can adjust the vertical offset up or down as needed.

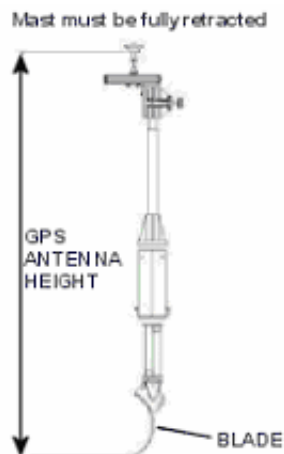
**Note** - The three switches on top of the SonicMaster Panel must be in the AUTO position at all times when using Carlson Grade. Forward motion of the equipment must be started before the MASTER AUTO/MANUAL SWITCH IS SWITCHED TO AUTO.

**Caution** - Check blade to see that all persons are clear of the blade before putting it into AUTOMATIC. When placed in automatic the blade will move and could cause injury.

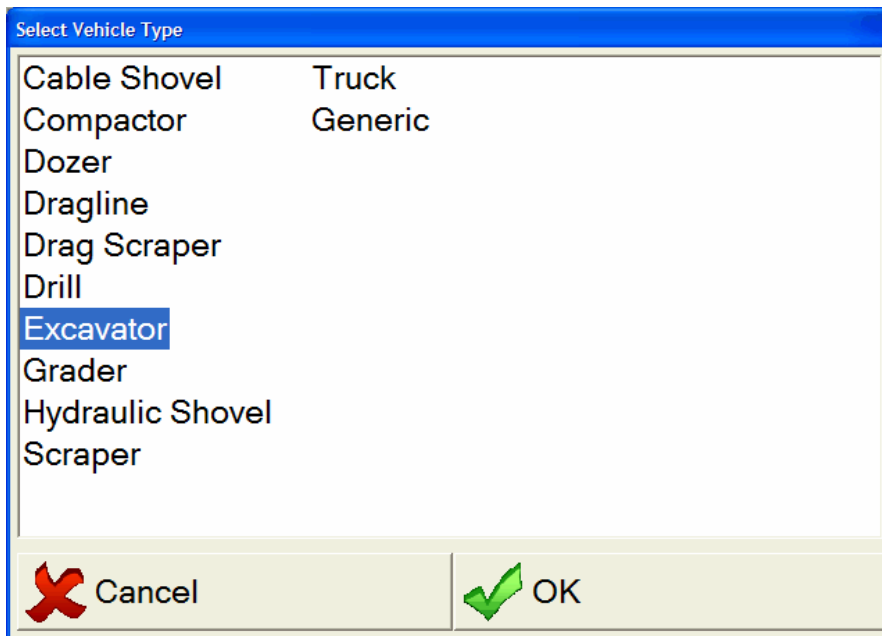
At the end of a pass, backing up or when setting idle be sure to place the auto/manual switch to the MANUAL position.



For the antenna height associated with the SonicMaster, enter the height from the cutting edge of the blade to the bottom of the GPS antenna.

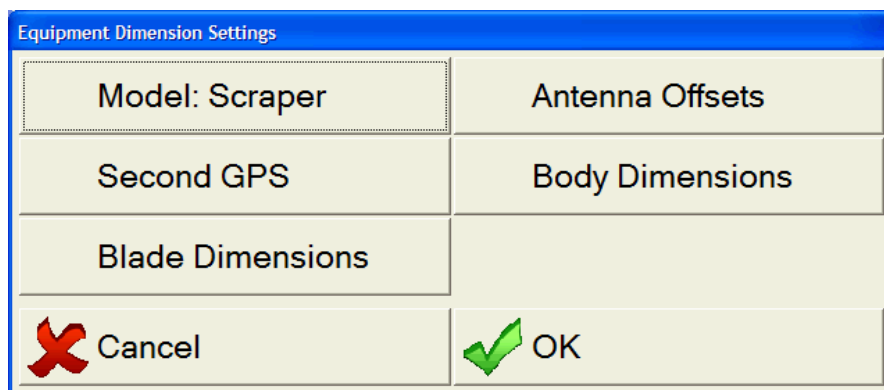


**Vehicle:** The Vehicle button in the Advanced Tools Window shows the current vehicle. Press the button to select a different vehicle, which results in the following screen.





When first installing, there are several important measurements and settings that need to be made, most of which are in Vehicle Settings. Please refer to Chapter 8, “Typical Operation Scenarios”, for detailed instruction on particular vehicle installation.

**Vehicle Settings:** Each vehicle has unique settings. When a vehicle is selected, the options in Vehicle Settings change to match the unique properties of the current vehicle. Settings made in the Vehicle Settings window are saved to a file with the name of the vehicle and a .CFG extension in the C:\Carlson Grade folder. This makes it possible to switch between vehicles without losing the vehicle settings. An example of a scraper is shown below:



**Model** – By default the model name is the vehicle type, but can be any name you give it. Press this button to change the model name.

**Antenna Offsets** – Opens the Antenna Offsets screen where the primary GPS antenna offsets (one used for vehicle position) are entered. The points on the vehicle to which these offsets are measured vary between vehicles. See the installation instructions for the vehicle (*Chapter 8, “Typical Operation Scenarios”*) to know where that point is.

Antenna Offsets	
Mount: Body	Right: 0.00'
Forward: 0.00'	Height: 10.00'
Localize: Ant to Gnd	Ant to Gnd: 6.04'
 Cancel	 OK

**Localize** – If using the heavy machinery to do your site localization, this setting establishes if you will be recording the position at the ground under the antenna or to the blade center.




**Ant to Gnd** – This is the distance from the primary antenna to the ground.

**Second GPS** – Opens the Second GPS antenna location screen. This applies to both dual-antenna and Secondary GPS antennas. It will look like the “Antenna Offsets” screen above without the Localize and Ant to Gnd selections.

**Dimensions** – These are used to set up the drawing and resulting reported position. These vary by vehicle.

Please refer to Chapter 8, “Typical Operation Scenarios” for detailed instruction on particular vehicle installation.

**Set Time Zone:** This allows for changing your time zone. Construction companies contracting near time zone boundaries might change this often. The time is based off GMT and with respect to daylight savings time. The screen is show below:

Change Time Zone	
Difference Between Local Time And GMT	
Eastern Time: -4(summer)/-5(winter)	
Pacific Time: -7(summer)/-8(winter)	
 Carlson Grade now set as GMT -5	
 Cancel	 OK

Before loading or creating a localization file, make sure the correct projection has been selected.

To return to this original Localize section, press Tools, Advanced Tools, and Localize to start this Alignment/Localize screen.


**Create New Localization File** - To create a new localization file, press the Delete button until all old points are removed from the list.

Press the Add button and select whether the local coordinates will be typed in or if the point is in the current coordinate file.

Local Point Coordinates

Enter Coordinates


By Point Number


 Cancel

After entering the coordinates or point number, you will be prompted for whether you want to enter the lat/lon/hgt or read it from the GPS. If you select Read From GPS, you will see a window that shows the current status of the GPS.

Make sure the antenna or vehicle blade is in the correct position over the point and press the Read button to start averaging the positions. When finished, the results are shown for acceptance. The positions are shown in the coordinates of the current projection (State Plane or UTM). The items of importance on this screen, to know if it is a good reading, are the Standard Deviation (SD) values toward the end of each Avg position line. They should be low values like shown.

Carlson Grade

 North Avg: 10021779.74' SD: 0.01'  
 North Min: 10021779.73' Max: 10021779.76'  
 East Avg: 1017891.04' SD: 0.01'  
 East Min: 1017891.03' Max: 1017891.05'  
 Elev Avg: 2824.54' SD: 0.02'  
 Elev Min: 2824.51' Max: 2824.57'



 OK

After pressing OK, you will see the new point in the Alignment window.

Alignment

P/N	Northing	Easting	Elev	HRes	VRes	HV
112	10021687.15'	1018678.15'	2803.96'	848.2*	385.2*	YY

Add Delete View On/Off

Load Save  More  OK



You should collect at least three or four known points in this manner.

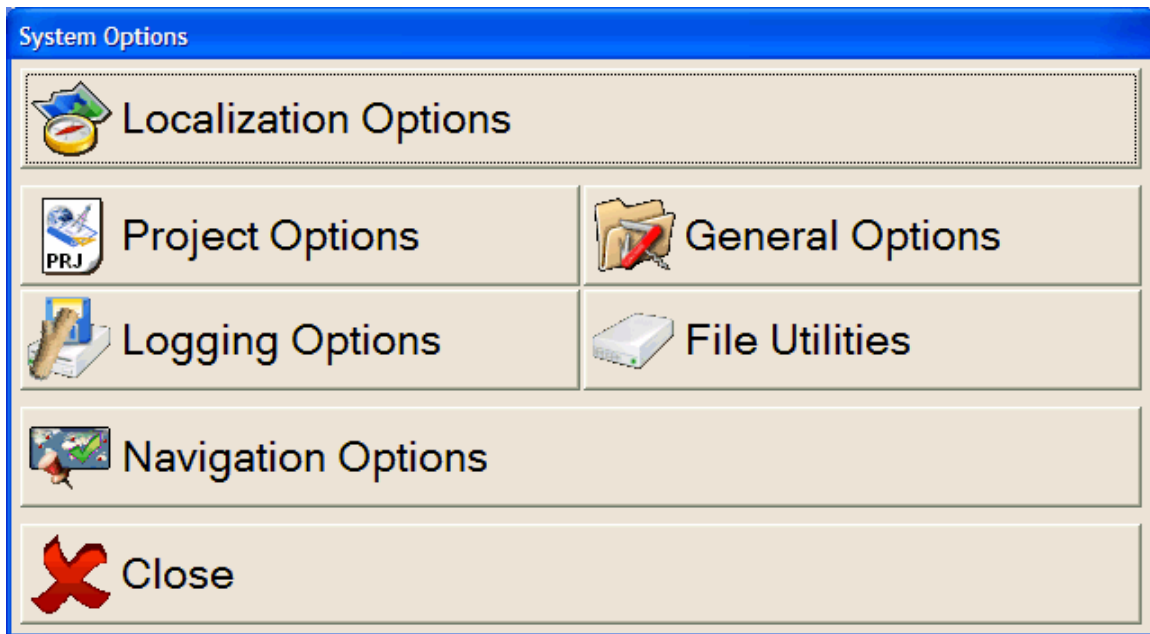
**Edit Point** – Edit a selected point of interest from the list by touching the point in list. It will display the northing, easting and elevation of the localization point, which can be changed.

**On/Off – Vertical/Horizontal Component Control** - Allows you to remove the horizontal or vertical components of your localization points. This is a frequently used feature that enables use of 1 point for vertical control only (turn off its horizontal component) and other points for horizontal control (turn off their vertical, if appropriate).

**Discussion of Localization Techniques** - If you do a base localization by entering Latitude and Longitude or known coordinates on the designated coordinate system, then you do not need to add localization points. A base localization would put you on grid north and grid scale and would work for any new job where you are not trying to “match” existing coordinates. However, any time you are working on a project that has existing coordinates, you will most likely need to do a Localization. Even if that existing job is supposedly on State Plane, UTM or another known coordinate system, the project coordinates often fail to match grid scale and grid north exactly, requiring localization. When localizing, it is advisable to use at least 3 points for horizontal control and 4 points for vertical control, in order to get a measure of “residuals” or accuracy. The program will “best fit” a plane through all activated (H=On and/or V=On) control points. The residuals are how much each activated point is “off” of the plane surface. Because multiple elevation points may create a slightly “tilted” plane, some surveyors will verify that the vertical control has low residuals and is accurate using multiple vertical control points, then turn off all but one (V=Off) and use only the nearest vertical (elevation) as they progress through the job.

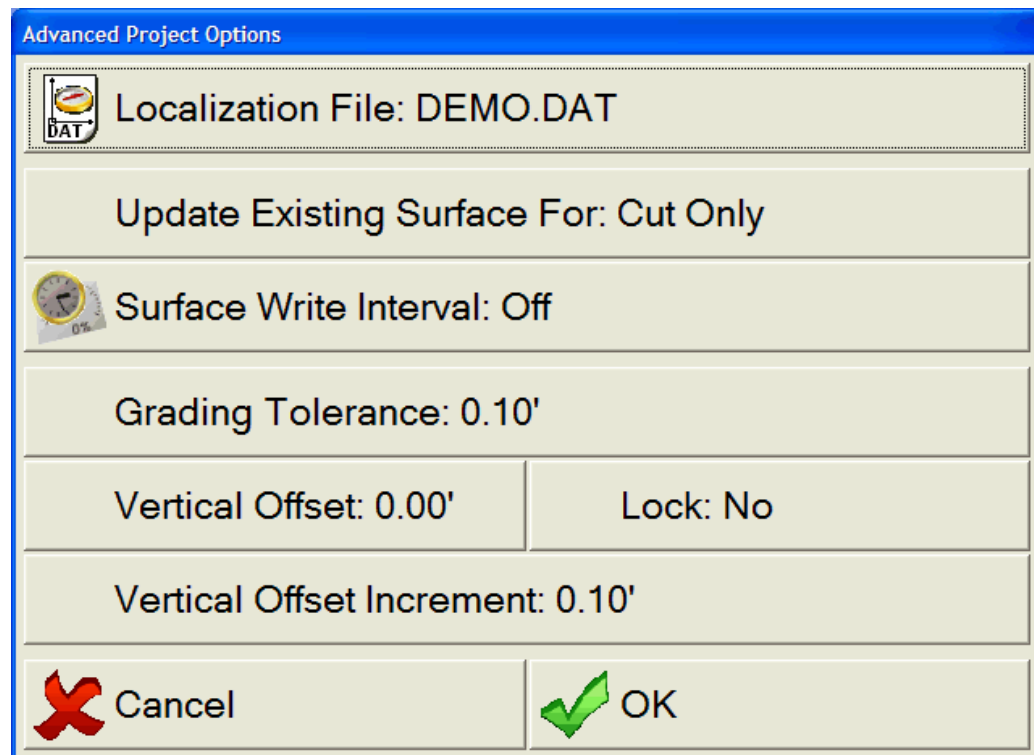
**Radio:** This allows for changing special radio settings, such as:...{Not yet supported}

**System Options:** Below is the screen displayed when selecting System Options. It contains advanced user settings for many different features.



**Localization Options:** These were previously discussed in the “New Project” section in Chapter 6, “Operator Interface”.

**Project Options:** The Advanced Project Options screen, as shown below:



**Localization File** – This can be set here. At mines and landfills, one localization file usually covers the mine site and is never changed. For

construction companies moving from site to site, localization files do change frequently and are entered here after being created by the Localization feature in Carlson Grade or loaded in from SurvCE or Carlson Field.

**Update Existing Surface For** - Cut Only or Cut/Fill. “Cut Only” is used primarily for excavator applications and also for blade-mounted GPS, where the bucket or blade can be raised for dumping and movement, and the resulting x,y,z positions in “fill” should be ignored for updating the actual, existing surface being created. In those cases, all you care about is where you cut to grade.

**Surface Write Interval** - This sets the frequency that the existing surface is written to file. Set this to zero to turn it off.

**Grading Tolerance** - The vertical tolerance level when considered “On Grade”. Whenever the cut or fill is within the tolerance entered (e.g. 0.2), then the green “On Grade” symbol appears as you grade in the main screen, and the cut/fill text becomes black and white, as opposed to red in cut and blue in fill.

**Vertical Offset** - This is the amount the design surface is raised or lowered by default. This option is sometimes used to preset a grading depth for topsoil and subsoil base elevation from design surface. Sometimes it is even used to account for localization and antenna offset measurement discrepancies, where an offset is entered to match a benchmark at a certain point on the site. In that sense, it can be used to “dial in” an accurate grading report on the main screen.


**Lock** - This will lock the up-down arrow keys. They will gray out and not be accessible for applications such as mining. You must re-start the program after setting Lock to Yes in order for the up-down arrow key removal to take effect.

**Vertical Offset Increment** – This will adjust the design grade by the amount shown with each press of the up-down arrow keys. (Enter a positive value here).


**General Options:** These are the general options for Carlson Grade including language and password selection, which are shown in the screen below:



General Options

Auto-Detect Direction: Yes

 Set Time From GPS: No

Language: English (US)

 Password: None

 Cancel  OK

**Auto-Detect Direction** – This will use the GPS positions to analyze which direction the machine is traveling in if no reverse sensor, compass, or dual-antenna system is being used on the vehicle. If set to “No”, only a triangle will be displayed for your vehicle icon.

**Set Time From GPS** – This will synch/set the physical computer time with the GPS receiver time when that information is available (GPS connected and working).

**Language** – This is the language used on display items and menu buttons. Current choices include: English (American, British, Australian, Canadian, New Zealand), German, French (Native, Canadian, Belgian), Italian, Portuguese, and Spanish (Native, Mexican).





**Password** – This is the password that will protect the Manager and Advanced Operator Interface (Advanced Tools) and Project Section File Selection. Leave empty for no password.


**Logging Options:** These are the logging options and tolerance settings for Carlson Grade that allow you to set the frequency and location of the logging. It is not a requirement to do logging with Carlson Grade, but it does provide useful information that can be used by Carlson’s Productivity Tools to help optimize and track your processes. The screen is shown below:



**Logging Options**

Log Method: None

Log Point At: Center

 Time Tol: Off	 Distance Tol: 20.00'
 Elevation Tol: 1.00'	 Azimuth Tol: 30.0°

 Configure Telescope And Stargazer

 Cancel  OK

**Log Method** – None, To File, To Telescope, To Stargazer

**Log Point At** – This sets the position of the logged point. This can be different from the cut/fill position and the steering edge position.

Set any of the Tolerances to zero to turn the individual item “Off”.

**Time Tol** – The time between logged points.

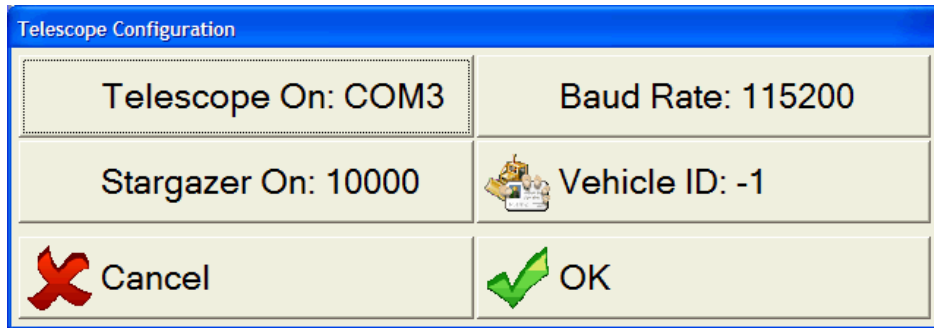
**Distance Tol** – The horizontal vehicle travel between logged points.

**Elevation Tol** – The vertical vehicle travel between logged points.

**Azimuth Tol** – The angle the vehicle turns between logged points.

**Delay Msg Tol** – The time that a vehicle is stationary, before the delay message appears.

**Configure Telescope And Stargazer** – Selecting this brings up the following screen:



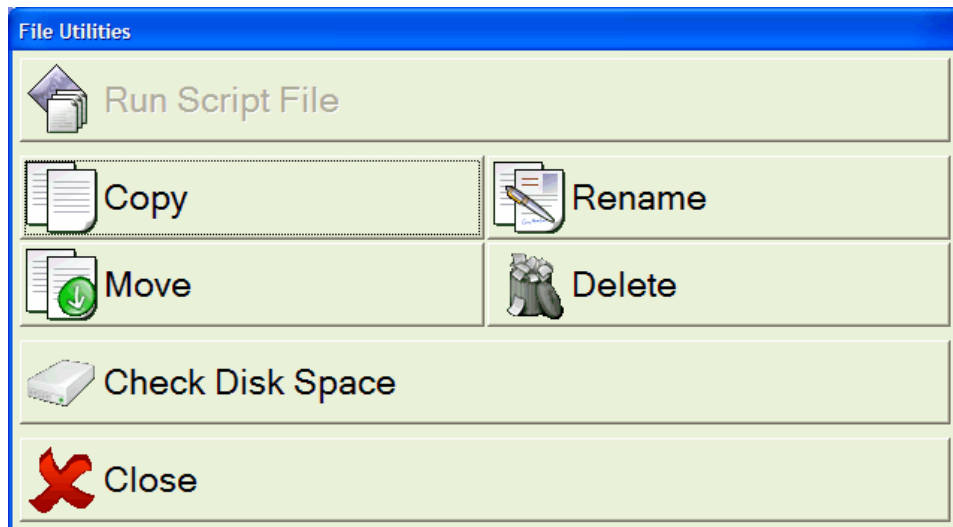
**Telescope On** – This is the COM port setting for Telescope, which defaults to COM3.

**Baud Rate** – This is the baud rate that is used across the Telescope COM port, which defaults to 115200.

**Stargazer On** – This is the internal IP address port used by Stargazer, which defaults to 10000.

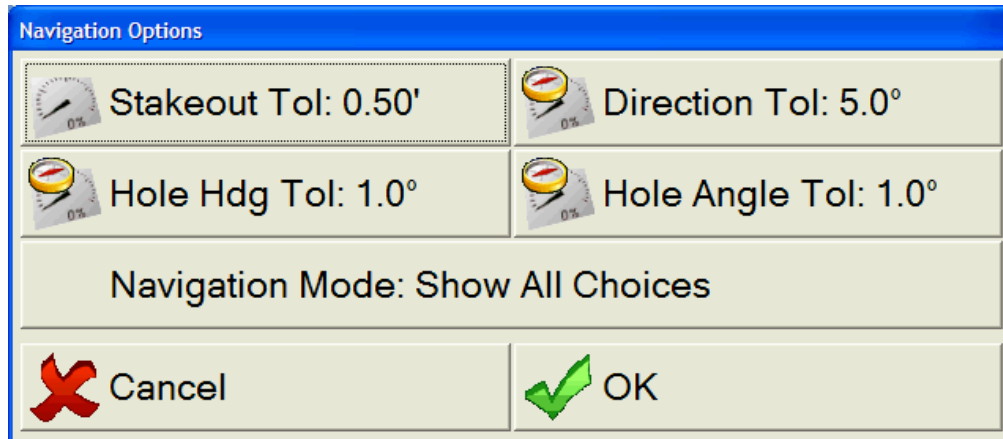
**Vehicle ID** – This is used to identify the vehicle in the database used by Productivity Tools. If Stargazer is being used, this id must match the one entered in Stargazer.







**File Utilities:** The File Utilities screen allows for standard types of file manipulations. If copying a project, all of the files associated with the project will be copied as well. This screen is shown below:



**Check Disk Space** - A useful tool that make checking how much disk space remains on the computer very easy. If using Log Files, these can sometime grow quite large before they are archived or gathered.

**Navigation Options:** These options are shown in the screen below and are slightly different for the drill (refer to *Chapter 8, “Typical Operation Scenarios”*):



Navigation Options	
 Stakeout Tol: 0.50'	 Direction Tol: 5.0°
 Hole Hdg Tol: 1.0°	 Hole Angle Tol: 1.0°
Navigation Mode: Show All Choices	
 Cancel	 OK

Set any of the Tolerances to zero to turn the individual item “Off”.

**Stakeout Tol** – The horizontal distance between the vehicle cut/fill position and the stakeout point. This will enable the bullseye in the plan view to spin once within the desired tolerance.

**Direction Tol** – The angle tolerance of the angle between the vehicle direction of travel (heading) and the direction of the vehicle to the stakeout point. This controls when the point is considered Ahead, Left, Right, or Behind the vehicle.

**Hole Heading Tol** – This is used with angle drilling and is the acceptable angle that the hole heading (orientation/direction) can be different from the design.

**Hole Angle Tol** – This is used with angle drilling and is the acceptable angle that the hole tilt (dip) can be different from the design.

**Navigation Mode** – This will allow a selection of “Navigate To...” in the Operators’ Tool menu, to go straight into a navigation mode, without having to select from the list every time. Selections include: Show All Choices, All Designed Points, Single Point, or Field Marked Points (last one only for drill). For example, if my operation only ever uses “All Designed Points”, I want to go directly into that every time.

**Product Registration:** This was covered in Chapter 4, “Loading and Configuring Carlson Grade”.

## 8. Typical Operation Scenarios



For detailed information on various screen components, please see respectively noted sections, such as: Chapter 7, “Manager and Advanced Operator Interface” for more details on the “Vehicle Settings” menus. The only items discussed here are vehicle and install specific settings. Common items are in their respective sections.

**Dozer, Scraper, Loader Cutting to Grade (Indicate):** This standard operating mode for Carlson Grade applies to most equipment types, including: dozer, scraper, drag scraper, compactor, loader, and truck.

**GPS Antenna Placement:** For these applications, you can place the rover GPS antenna on a blade mast or on the roof of the cab.

**GPS Antenna Measurements:** In both cases, you measure and enter the antenna height to the top of the blade. A separate measurement of blade height, which allows for blade wear, can be entered in Vehicle Settings. In the case of a roof mounted GPS, the antenna height is measured from the vehicle roof to the top of blade. In addition, the vehicle height, measured from vehicle roof to bottom of tracks, can be entered in Vehicle Settings. These separate measurements allow for calculating elevation and reporting cut/fill at both the base of blade and base of tracks. Consequently, it is very important to calculate and enter accurate measurements in Vehicle Settings.

**Vehicle Settings:** For detailed information on this see Chapter 7, “Manager and Advanced Operator Interface” under this same subheading. The only items discussed here are vehicle and install specific settings. Select Tools from the main grading screen, followed by Advanced Tools. Once you have chosen the appropriate vehicle type on left, select Vehicle Settings for the following screen:

Equipment Dimension Settings	
Model: Dozer	Antenna Offsets
Second GPS	Body Dimensions
Blade Dimensions	Slope Board: None
 Cancel	 OK



**Slope Board** – Dozer specific. Set to None, Left, Right, or Both.

All other buttons exist for dozer, grader, compactor, scraper, and drag scraper. The truck has all of these too, except for the blade button.



**Model** – Just a name assigned to the vehicle, which defaults to type.

**Antenna Offsets** – This is where the rover/primary position antenna entries are made. Defaults are different for the different vehicle types and those of dozer are shown below. Selection results in the following screen:

Antenna Offsets	
Mount: Center	Right: 0.00'
Forward: -0.75'	Height: 6.54'
Localize: Blade Center	Ant to Gnd: 6.54'
 Cancel	 OK

**Mount** – Options include: Body and Blade Left, Right, and Center.

**Right** - Indicates the distance right from the center of the vehicle to the GPS antenna. In the event the GPS antenna is located to the left of the center, a negative distance should be entered in this field.

**Forward** - The distance measured from the center of the blade to the GPS antenna. In the case of a body mount or in any circumstance where the GPS antenna is mounted behind the blade, a negative distance should be entered in this field.

**Height** - Blade mounted: height from the top of the blade to the GPS antenna. Body mounted: height from the top of the blade to the GPS antenna on the roof of the cab.



**Localize** – If using Carlson Grade to localize, then can select Blade Center or Ant to Gnd, which represents taking the antenna off the equipment and performing localization with it mounted on a rod or the like.

**Ant to Gnd** – Height of the GPS antenna to the ground, so either rod height or mounted position on vehicle to the ground.

**Second GPS** - The typical “indicate” install includes one GPS antenna; however, if a dual-antenna or two receiver system is being used, please see

Dragline setup below in this section or Appendix C, “Topcon Dual-Antenna Setup”, or Appendix [?](#), “Two Receiver Setup”.

**Body Dimensions** – For entry of the measured vehicle dimensions, which vary by type. The resulting screen is shown below is shown for dozer:

Body Dimensions	
Length: 12.50'	Width: 6.50'
Height: 9.00'	
 Cancel	 OK

**Length** - The measured length...

**Dozer** - from blade to rearmost part of dozer.

**Grader** - from front of grader to rearmost part of grader.

**Scraper** - center of front wheel to center of back wheel.

**Drag Scraper** - center of front wheel to center of back wheel.

**Compactor** - from front of compactor to rearmost part of compactor.

**Truck** - from front bumper to rearmost part of truck.

**Width** - The outermost dimensions of your vehicle from side to side.

**Height** - The measured height...

**Dozer** - from bottom of tracks to roof of cab.

**Grader** - from bottom of tires to roof of cab.

**Scraper** - from bottom of tires to top of bed.

**Drag Scraper** - from bottom of tires to top of bed.

**Compactor** - from bottom of roller to roof of cab.

**Truck** - from bottom of tires to roof of cab.

**Blade Dimensions** - Must be entered for proper calculation of elevations if you are using either a blade mounted or a body mounted GPS antenna. An antenna height measurement that is broken into the separate components of Blade Height and Antenna Height allows for quick and easy compensation for blade wear. This setting does not exist for a truck. The screen below appears if selected:

The image shows a software dialog box titled "Blade Dimensions". It contains two input fields: "Width: 8.50'" and "Height: 3.50'". Below these fields are two buttons: "Cancel" with a red 'X' icon and "OK" with a green checkmark icon.

**Width** - The measured width of the blade, pan opening, or roller respectively.

**Height** - The measured height of the blade or roller respectively. Needed for blade or cab mounted calculations. This can be routinely adjusted for blade wear. The scraper blade height is zero.




**Tilt Sensor:** (Optional) If one is used, such as the APS dual-axis tilt sensor, then the grade along the entire length of a fixed, rigid blade is known, and the icons can be displayed on the screen moving along the ground at the correct pitch and roll. The tilt sensors can be body or blade mounted, corresponding with the GPS antenna mounting position. If mounting on the blade, make sure to place in a protected location, either horizontally or vertically.

For detailed information on how to configure and calibrate the sensors, please refer to Chapter 7, “Manager and Advanced Operator Interface” under “Equipment Options - Configuring and Calibrating Sensors”.

The APS dual-axis tilt sensors have two valid facings per mount position for a dozer “indicate” type of install. The valid mounting options are:

Placement	Facing	Direction arrow pointing on face of sensor
TOP	UP	FRONT & RIGHT
BOTTOM	DOWN	FRONT & RIGHT
RIGHT	RIGHT	FRONT & TOP
LEFT	LEFT	FRONT & TOP
FRONT	FORWARD	TOP & RIGHT
BACK	BACKWARD	TOP & RIGHT

Selecting Configure Sensors from the Advanced Tools, Equipment Options panel when the equipment type is Tilt Sensor, not GPS Tilt Sensor, results in the screen below:

Sensor Properties	
CAN Bus ID: 21	Sensor Type: Tilt
Placement: On Blade	
 Mount: Top	Facing: Front
Reference: APS	
Terminated: Yes	
 Cancel	 OK

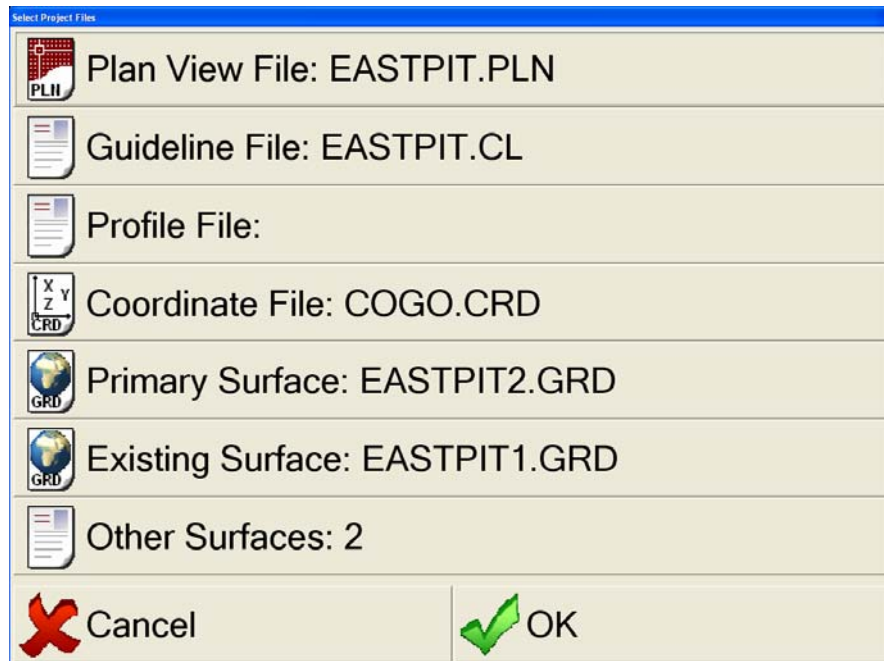
The above configuration would be correct for a sensor mounted on the top side of a protective bracket welded behind the blade and under the mast, as in the installation shown below:



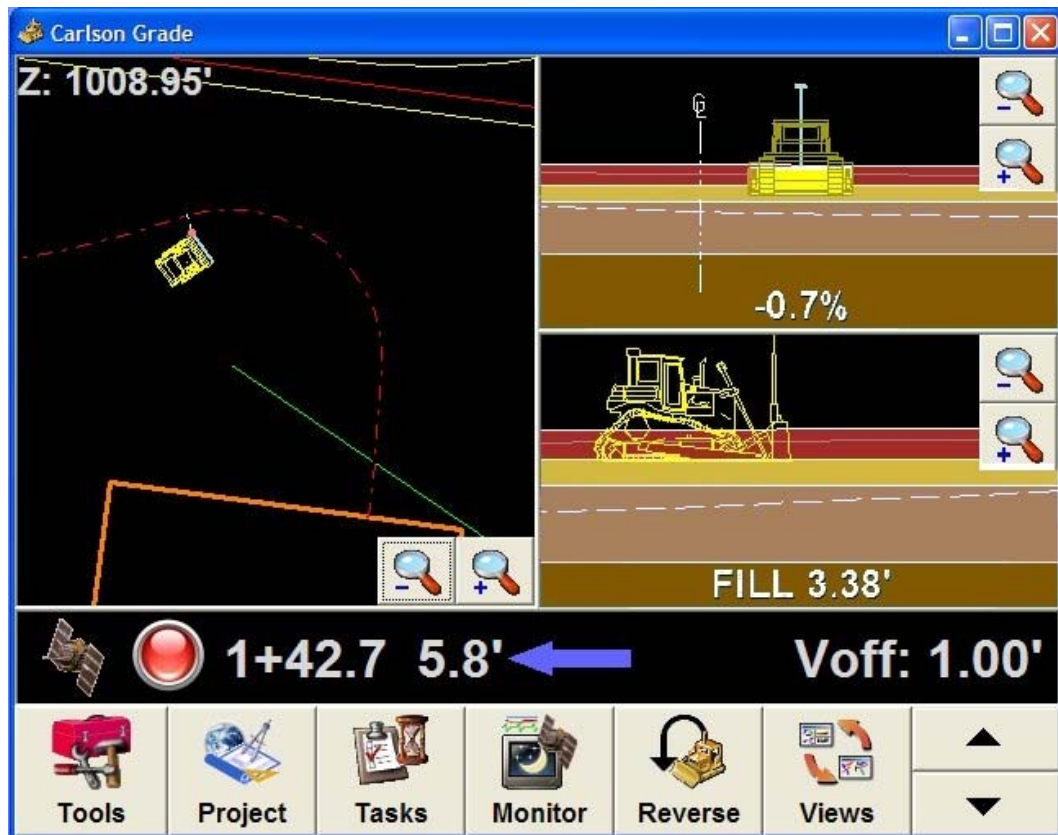
Note that the arrow on the APS dual-axis tilt sensor is pointed forward or “facing” the front end of the dozer.



**Design Files and Vertical Offsets:** You must have some design files selected to see where you are and to know what to cut or fill. The design files are accessed under the Project Button on the main grading screen (shown two images below) and by selecting: “Select Files” or “Edit Project” from the Project menu screen. The most common files to use in “indicate” type of installs are: Plan View, Guideline (Centerline), Primary Surface, Existing Surface, and Other Surfaces. For further discussion, please refer to Chapter 5, “Files and Formats Used in Carlson Grade” and Chapter 6, “Operator Interface - Selecting Projects and Job Files”.



The Main Grading screen is shown below, where the Primary Surface is the maroon red color in both section and profile views. The ability to lower the Primary Surface with the up-down arrow keys is popular for construction applications, where operators can lower the design grade by, say, 2 feet or 0.5 meters to obtain a desired and parallel sub-grade. In that case, the maroon red surface would drop lower on the screen with each press of the down arrow, and a grey line would remain on the screen representing the original design grade. This offset is referred to as a vertical offset and can be “locked in” under the Advanced Project Options area. The increment used for each button press can also be set in this same area found in Advanced Tools, System Options, Project Options.



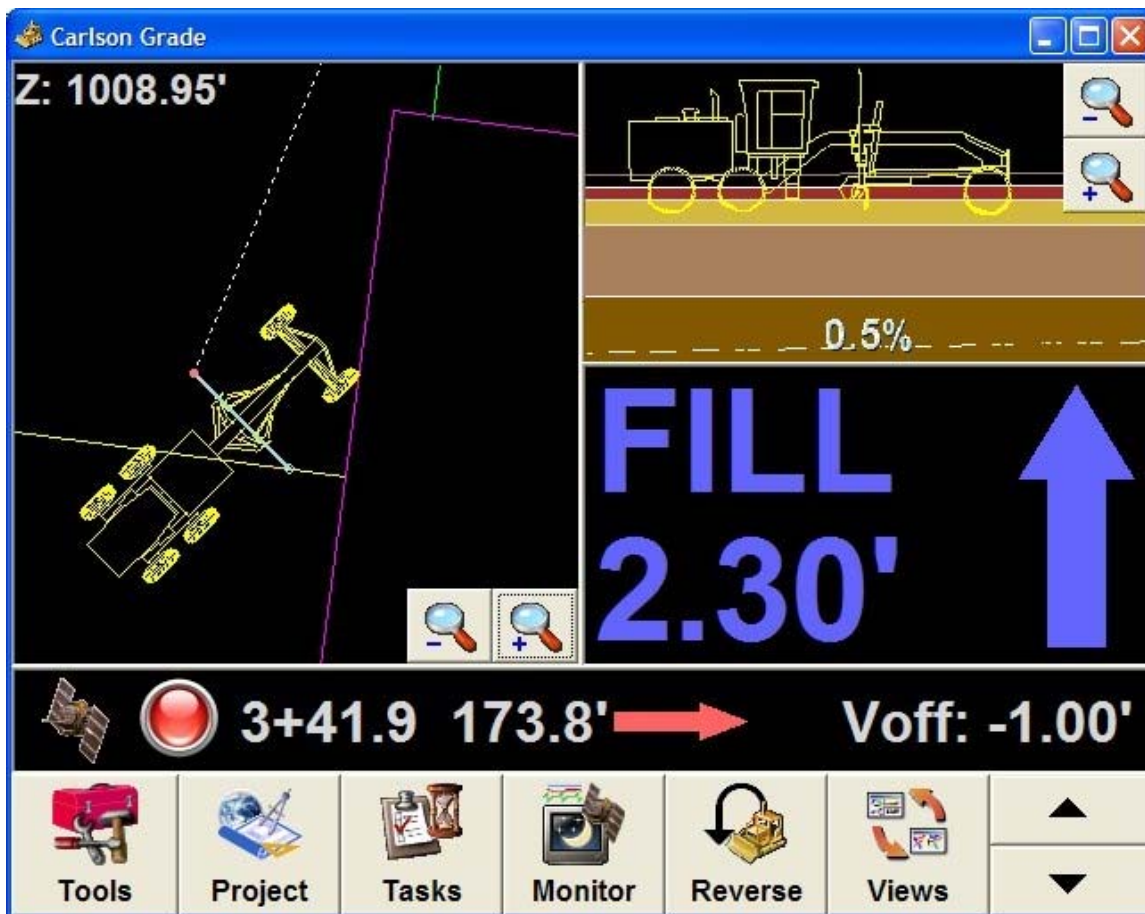
The Existing Surface is shown as a dashed white line above and keeps track of the current surface. This needs to be set to a small grid size (e.g. 2 feet) to update properly and can also be set to only change on Cut and not Cut and Fill. The latter is most commonly used on active dumping sites. As shown in the “File Selection” screen two above, there is a Primary Surface, an Existing Surface, and 2 Other Surfaces specified, for a total of 4 displayed surfaces. In the above example, there appear to be 5 surfaces including existing grade, plus a faint parallel line representing original design surface (caused by the Voff of 1.00).

**Cost Savings for Scrapers:** Scrapers using 10cm accuracy single-GPS Navcom with Starfire offer an interesting fit of lower cost where lower accuracy is tolerable.





**Dozer and Motor Grader Hydraulic Control:** This mode of operation assumes that blade control is active. Currently, only the Leica SonicMaster (for motor graders) and Leica ProControl (for dozers) are supported for automatic blade control. Plans are to add drivers for the Moba equipment and for direct valve control from the on-board computer. For hydraulic control, all positions on the blade are absolutely critical, so an elaborate process of configuration and entering dimensions for the mast position and for the hydraulic devices must be followed. The steps are described above in Chapter 7, “Manager and Advanced Operator Interface” under “Equipment Options – Tune Hydraulics”. See the above example for other general configuration information. The Main Grading is shown below for a motor grader:



Note that a motor grader can be run in “indicate” (non-automatic) mode but is ideally suited for automatics, given its stable design with a central blade position between front and back wheels.

**Dozer Applications in Mining and Landfills:** For nearly all mine installs, the GPS antenna is mounted on the cab. The antenna height and vehicle height components (as discussed above in the “Indicate” section) will be entered. The antenna height was from antenna on top of cab to top of blade and the vehicle height was from antenna on top of cab to bottom of tracks. This leads to cut/fill computation to the track position, which provides sufficient accuracy needed for mining. In fact, most mines do not install tilt

sensors, keeping costs to a minimum. Mines, unlike construction operations, make significant use of the logging features of Carlson Grade. This enables monitoring and recording productivity. By providing cut/fill to the track, the cab-mounted antenna approach provides both accurate cut/fill and accurate logging data, all sufficient for mine applications. Adding tilt sensors increases accuracy of logging, since an existing grid will be updated along the tilting planes indicated by the tilt sensors. This helps compute accurate volume per hour production rates, especially on steeply sloping terrain like that found at many mines and landfills.

**Excavator Operation:** The excavator solution in Carlson Grade can be used in construction or mining environments. It calculates grade accurately at the bucket teeth, usually to 2 to 10 centimeters depending on the size of the excavator (and on the quality of the calibration).

**GPS Antenna Placement:** For an excavator application, Carlson Grade requires two antennas. You can place the rover and second (moving base/heading) GPS antennae on the body of the machine. The preferred location is at the back of the machine away from the cab and boom.





**Excavator Measurements:** See Appendix E for “Excavator Measurement Procedure”.

**Dual Antenna Setup:** Refer to Appendix C, “Topcon Dual-Antenna Setup” and Appendix 2, “Two Receiver Setup” for further information on configuring for a two antenna system.







**Vehicle Settings:** For detailed information on this see Chapter 7, “Manager and Advanced Operator Interface” under this same subheading. The only items discussed here are vehicle and install specific settings. Select Tools from the main grading screen, followed by Advanced Tools. Once you have chosen the excavator vehicle type on left, select Vehicle Settings for the following screen:

Equipment Dimension Settings	
Model: Excavator	Antenna Offsets
Second GPS	Body Dimensions
Offset To Boom	Boom Length: 18.90'
Stick Length: 8.10'	Bucket Settings
 Cancel	 OK

**Model** – A name given to the excavator, which defaults to excavator.

**Antenna Offsets** – This is where the rover/primary position antenna entries are made. Selection results in the following screen for excavator:

Antenna Offsets	
Mount: Body	Left of RP: 4.00'
Behind RP: 10.00'	Above Body: 3.00'
Localize: Ant to Gnd	Ant to Gnd: 3.00'
 Cancel	 OK

**Mount** – Can only be Body for the excavator.

**Left of RP** - Indicates the distance left from the center of rotation to the GPS antenna. In the event the GPS antenna is located to the right of the rotation point, a negative distance should be entered in this field.



**Behind RP** – Indicates the distance behind from the center of rotation to the GPS antenna. In the case of a GPS mount in front of the rotation point, a negative distance should be entered in this field.

**Above Body** - height from the top of the body to the GPS antenna (essentially a GPS mast height).

**Localize** – If using Carlson Grade to localize, then can select Bucket Center or Ant to Gnd, which represents taking the antenna off the equipment and performing localization with it mounted on a rod or the like.

**Ant to Gnd** – Height of the GPS antenna to the ground, so either rod height or mounted position on vehicle to the ground.

**Second GPS** – See image below for screen settings, but refer to Appendix C, “Topcon Dual-Antenna Setup” and Appendix 2, “Two Receiver Setup” for further information on configuring for a two antenna system.



Second GPS	
Right of RP: 4.00'	Forward of RP: -10.00'
Height: 3.00'	
 Cancel	 OK

**Right of RP** - Indicates the distance right from the center of rotation to the GPS antenna. In the event the GPS antenna is located to the left of the rotation point, a negative distance should be entered in this field.

**Forward of RP** – Indicates the distance in front of the center of rotation to the GPS antenna. In the case of a GPS mount in back of the rotation point, a negative distance should be entered in this field. This will likely always be negative for excavator install.

**Height** - height from the top of the body to the GPS antenna (essentially a GPS mast height). If different height than found in Antenna Offsets, the tilt bias will be compensated for in the calculations; therefore, separate height measurements of the antennas will be used.

**Body Dimensions** – For entry of the measured excavator dimensions. The resulting screen is shown below:



Body Dimensions	
Length: 16.00'	Width: 14.00'
Height: 9.00'	
 Cancel	 OK

**Length** - The measured length from the body front to rearmost part of excavator.

**Width** - The outermost dimensions of excavator from side to side.

**Height** - The height from bottom of tracks to top of body.

**Offset To Boom** – Offsets from the center of rotation to the boom pivot point. The resulting screen is shown below:

Offset To Boom	
Right of RP: 1.00'	Forward of RP: 2.00'
Below Antenna Base: 3.	
 Cancel	 OK

**Right of RP** - Indicates the distance right from the center of rotation to the boom pivot point. In the event the boom pivot is located to the left of the rotation point, a negative distance should be entered in this field.



**Forward of RP** - Indicates the distance in front of the center of rotation to the boom pivot point.

**Below Ant Base** - The measured height from antenna base to boom pivot point.

**Boom Length** – Distance between boom/body pivot point and boom/stick pivot point. This is the “y” distance only and should not include the “x” component, meaning do not just use a straight line distance between them without removing the distance that the pins stick out. This inaccuracy will exponentially increase as you progress to the bucket, resulting in position errors, especially on large equipment.

**Stick Length** – Distance between boom/stick pivot point and stick/bucket pivot point. The same applies to this measurement as the one above.

**Bucket Settings** – This button is brings up the following screen:



Bucket Settings	
Bucket Length: 4.60'	Bucket Width: 5.00'
Style: Excavator	
 Cancel	 OK

**Bucket Length** - Distance between stick/bucket pivot point and center tip of bucket teeth.

**Bucket Width** - The outermost dimensions of your bucket from side to side.

**Style** – Can be Excavator or Shovel style bucket.

**Dogbone Settings** –If sensors are mounted on the dogbone connector instead of the bucket the following entries will be needed:

Dogbone Settings	
Dogbone Length: 1.22'	Back Pin Dist: 0.65'
Front Pin Dist: 0.31'	Bucket Pin Dist: 0.97'
Max Angle: 120.0°	
 Cancel	 OK

The angle calculated between L3 and L4 ( $L3/L4$ ) has a linear relationship with the bucket angle. However, the relationship between angle A1 and  $L3/L4$  is nonlinear because the sides are all different lengths.

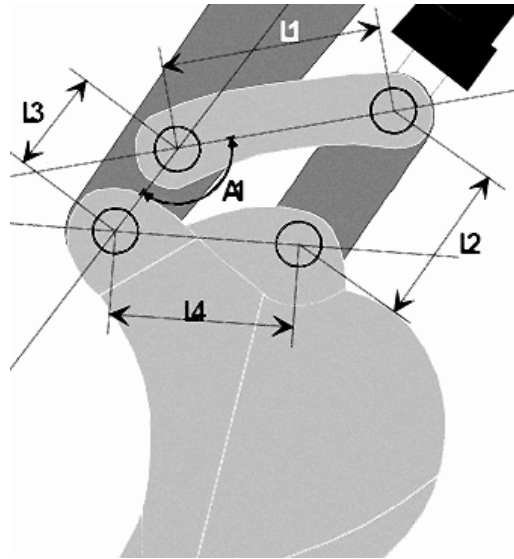
**Dogbone Length** - Distance between the two dogbone pins. (L1)

**Back Pin Dist** – Distance between dogbone and bucket back pins. (L2)

**Front Pin Dist** - Distance between dogbone and bucket front pins. (L3)

**Bucket Pin Dist** - Distance between the two bucket pins. (L4)

**Max Angle** – Angle made between dogbone connector and the front pins. (A1)



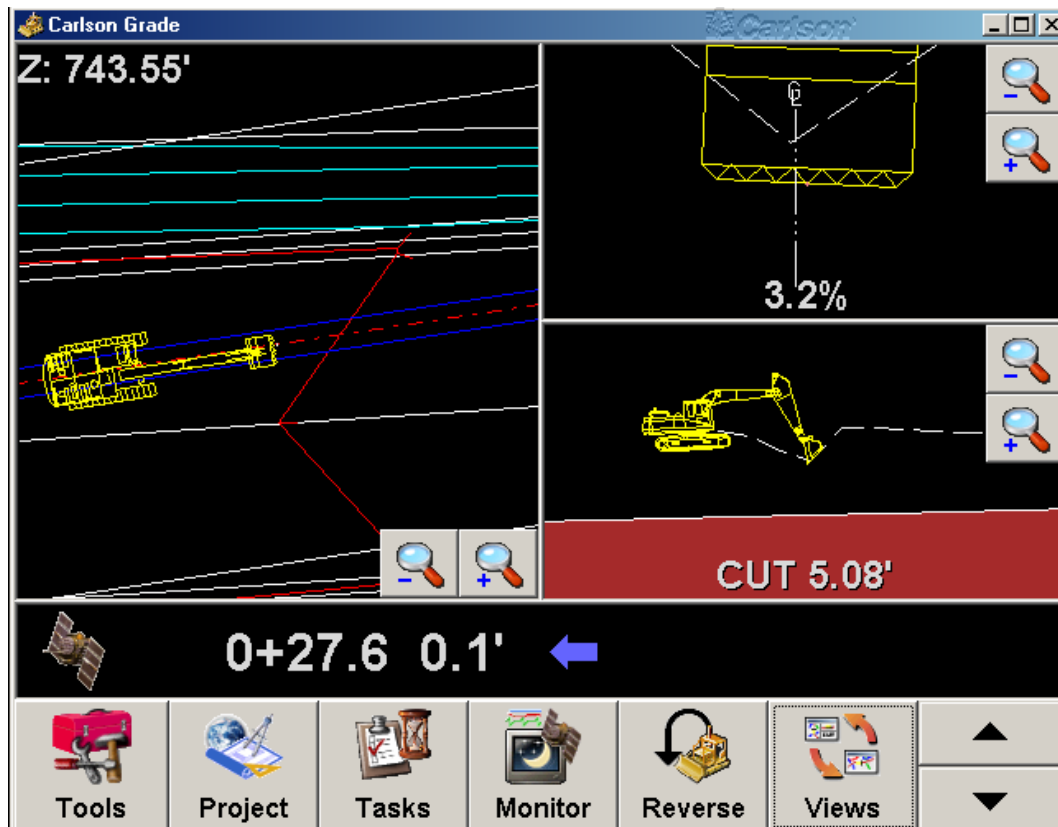
**Tilt Sensors:** Carlson Grade requires at least 3 tilt sensors for an excavator installation, but a fourth can be used on the body of the excavator as well for a more accurate measurement. For detailed information on how to configure and calibrate the sensors, please refer to Chapter 7, “Manager and Advanced Operator Interface” under “Equipment Options - Configuring and Calibrating Sensors” which uses the excavator for an example. When mounting the sensors, make sure to place them in protected locations. For the bucket sensor, the sensor and cabling are better protected if mounted on the dogbone connection.



Close-up of Mikrofyn Tilt Sensor on Boom

**Change and Work-To Guideline/Centerline:** If digging a trench, a useful feature is picking a polyline from the plan view map to create a new centerline. Simply tap the "Tools" button on the far left side of the toolbar and select

"Pick/Select Guideline" from the menu. Select the polyline or centerline file that represents your ditch line or footing. The plan view displays your position on the job, while the cross sectional view shows your bucket relative to the guideline you selected. The profile view will mark your progress if you have designated an existing surface and have chosen to update the existing surface for CUT only in the Project settings. (Go to Tools, then Advanced Tools, System Options, then Project Options, and turn on "Update Existing Surface for Cut Only").



**Existing Surface Update:** The red surface in the profile view above (lower right) represents the target or design surface. The dashed line represents existing grade. For effective updating of the existing surface as you dig, it is important to make a design grid and actual surface grid with a small grid cell size (recommend 2 feet or 0.5 meters or less). Grid cell size should ideally be less than the bucket width. The best way to see this is if you used a grid cell size of 10', and dug a 2' trench up the middle of such a large grid, the grid corner points would not update at all, and the existing surface would remain unchanged on the graphic.

**Boom, Stick, and Bucket Movements:** As the operator digs, the track position of the excavator remains centered in profile view and the boom, stick and bucket move precisely as determined by the tilt sensors.

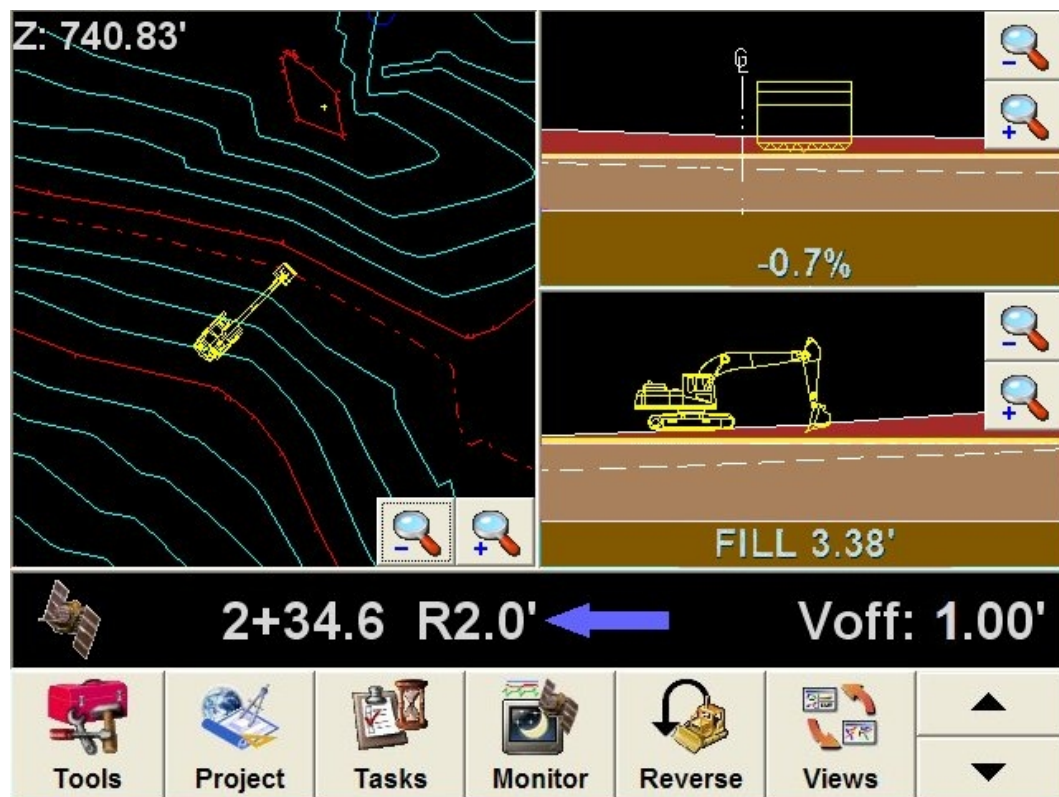
**New Guideline, Flat Pad, or Slope:** If you get to the site and need to design your own trench, it's easily done using the Field Design command. Tap the



"Project" button and then select "Field Design" from the menu. The various options are explained in detail in Chapter 6, "Operator Interface". The excavator configuration works very well for most front-end loaders, and can be applied to overburden and coal/ore removal in mining.

**Log Point:** For mining applications, one particularly useful option is to use the Log button in the lower right (the log option will replace the up/down arrow keys when configured for mining or when set by the operator). When a point is logged, the description "AndersonTop" indicating top of Anderson seam or whatever applies can be entered, and then imported to the office software and interpreted (by Carlson's mining software) as a pit sample for improved geologic modeling.

Note that multiple surfaces, when specified, are displayed to assist in digging towards defined surfaces:





The excavator can be run in simulation mode on a PC using the controls identified in Appendix F, Simulation Mode Key Strokes.

**Drill Operation:** The drill configuration, like the excavator configuration, requires a two antenna GPS setup on the body of the drill for accurate heading calculation. See picture below, where the antennae are mounted on the back of the drill on antenna masts to elevate them above the drill mast when it is laid flat for longer trams.







**Vehicle Settings:** For detailed information on this see Chapter 7, “Manager and Advanced Operator Interface” under this same subheading. The only items discussed here are vehicle and install specific settings. Select Tools from the main grading screen, followed by Advanced Tools. Once you have chosen the drill vehicle type on left, select Vehicle Settings for the following screen:

Equipment Dimension Settings	
Model: Drill	Antenna Offsets
Second GPS	Body Dimensions
Veh-Mast	Veh-Steel
 Cancel	 OK

**Model** – A name given to the drill, which defaults to drill.

**Antenna Offsets** – This is where the rover/primary position antenna entries are made. Selection results in the following screen for drill:

Antenna Offsets	
Mount: Body	Right: -6.10'
Forward: -20.40'	Height: 9.80'
Localize: Ant to Gnd	Ant to Gnd: 12.40'
 Cancel	 OK

**Mount** – Can only be Body for the drill now.

**Right** – The distance measured from the GPS antenna to the drill mast pivot point. In the event the GPS antenna is located to the right of the drill mast pivot, a negative distance should be entered in this field.



**Forward** – The distance measured from the GPS antenna to the drill mast pivot. In the case of a GPS mount in front of the drill mast pivot point, a negative distance should be entered in this field.

**Height** – The height measured from the location where the antenna mast joins the drill body to the GPS antenna. If the “drill body plane” is not flat such that the junction of the primary and secondary antennae are both to the same plane, then find a common plane to measure to.

**Localize** – If using Carlson Grade to localize, then can select Drill Point or Ant to Gnd, which represents taking the antenna off the equipment and performing localization with it mounted on a rod or the like.

**Ant to Gnd** – Height of the GPS antenna to the ground, so either rod height or mounted position on vehicle to the ground (Ant Height + VehMast Height + Veh Height (negative)).

**Second GPS** – See image below for screen settings, but refer to Appendix C, “Topcon Dual-Antenna Setup” and Appendix [?](#), “Two Receiver Setup” for further information on configuring for a two antenna system.



Second GPS	
Right: 6.30'	Forward: -20.40'
Height: 9.80'	
 Cancel	 OK

**Right** – The distance measured from the Heading/Moving Base GPS antenna to the drill mast pivot point. In the event the GPS antenna is located to the right of the drill mast pivot, a negative distance should be entered in this field.

**Forward** – The distance measured from the Heading/Moving Base GPS antenna to the drill mast pivot. In the case of a GPS mount in front of the drill mast pivot point, a negative distance should be entered in this field.

**Height** – The height measured from the location where the antenna mast joins the drill body to the Heading/Moving Base GPS antenna. If the “drill body plane” is not flat such that the junction of the primary and secondary antennae are both to the same plane, then find a common plane to measure to. If this is a different height than found in Antenna Offsets, the tilt bias will be compensated for in the calculations; therefore, separate height measurements of the antennas will be used.

**Body Dimensions** – For entry of the measured drill dimensions. The resulting screen is shown below:



Body Dimensions	
Length: 30.00'	Width: 12.40'
Height: -3.00'	
 Cancel	 OK

**Length** - The measured length from the body front to rearmost part of drill.

**Width** - The outermost dimensions of drill from side to side.

**Height** - The height from drill mast pivot point to the location where the antenna mast joins the drill body. This will be negative if the antenna mast junction is below the drill mast pivot point.

**Veh-Mast**– For entry of the drill mast dimensions. The resulting screen is shown below:



Veh-Mast	
VMast Length: 3.00'	VMast Width: 6.00'
VMast Height: 5.60'	
 Cancel	 OK

**VMast Length** - The distance from drill mast pivot point to center of drill steel (drill point).

**VMast Width** - The outermost dimensions of drill mast from side to side.

**VMast Height** - The height from drill mast pivot point to drill point. This is always a positive value.

**Veh-Steel** – For entry of the drill steel dimensions. The resulting screen is shown below, but set to all zeros for now:

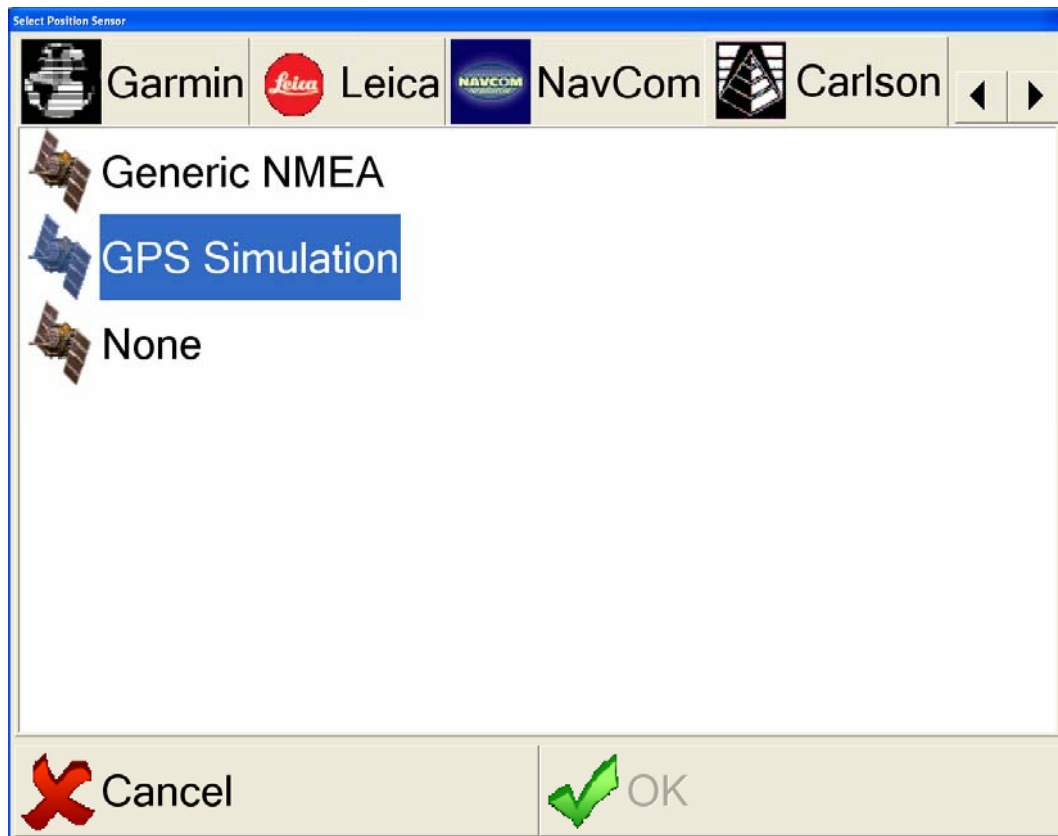
Veh-Steel	
Steel Length: 0.00'	Steel Width: 0.00'
Steel Height: 0.00'	
 Cancel	 OK

**Steel Length** - The distance from outer edge of drill steel to center of drill steel.

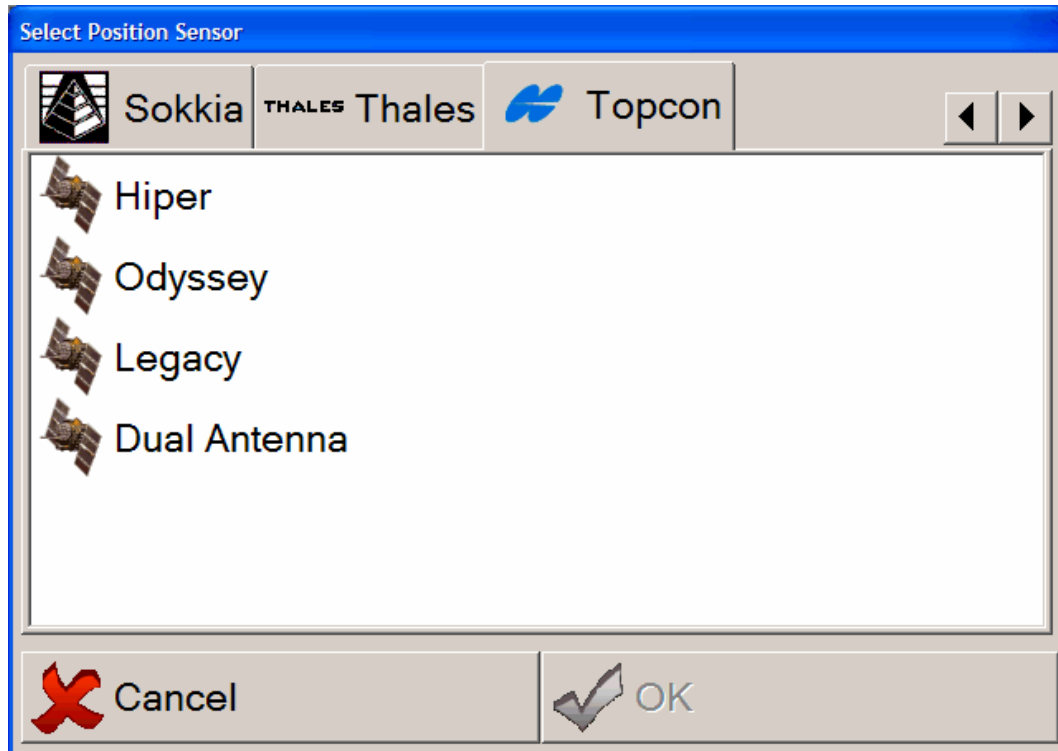
**Steel Width** - The distance from outer edge of drill steel to center of drill steel. Same as length.

**Steel Height** - The distance from collar point to current drill point (so current distance of steel below the surface).

**Dual- Antenna GPS Setup:** First make sure the receiver is connected to the computer running Carlson Grade and has power. Select Advanced Tools, and first button: Position Source, which is explained in detail in Chapter 7, “Manager and Advanced Operator Interface”. This is where you select your GPS type, from among the available options across the top line of the screen. The left and right arrow buttons at the top right of the screen allow you to move through the choices. When you select from that list, you get a “short list” of options to choose from below:



For drill work, choose Topcon and then select option “Dual Antenna” and choose OK.

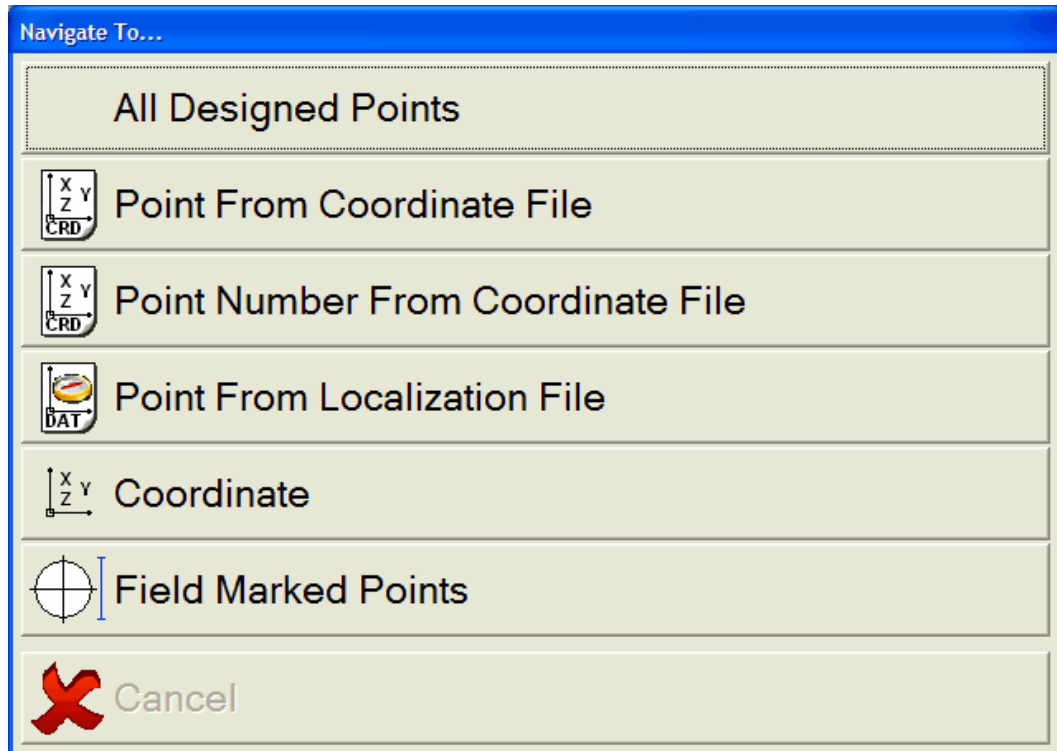


Refer to Appendix C, “Topcon Dual-Antenna Setup” for further information on configuring for a dual-antenna system.

**Navigation Choices and Files:** The drill functionality is based on the “Navigate To...” principle. When the program is started, the user is prompted to select from one of the following items seen below. In all cases, a Coordinate file (“CRD”) must be selected. If one is not set, the user will be prompted to set one and whether it should be saved to the active project. Answering no will set your project to “None”.

The drill only has a plan view. If a downhole sensor is being used, then a geologic column will be displayed on one side to indicate the penetration through the strata or various surfaces and lenses. Angle drilling mode will bring up an additional side view screen that will be a profile along the heading of the drill mast. This will allow for getting the hole angle correct. In addition, the hole heading will be indicated on the plan view to allow for correct orientation.

An extra file found only for the drill is the Lower Coordinate file (“CRD”) that contains the bottom-of-hole drillhole information, which accommodates angle drilling. If no file is used, then the holes are considered vertical.



**All Designed Points** - This is the recommended approach, because the hole positions can be designed in the office where geologic structures and patterns from surfaces above can be taken into consideration. A bulls-eye target will move to the hole closest to the drill.







**Single Points (Including: Point from Coordinate (“CRD”) File, Point Number from “CRD” File, Point from Localization (“DAT”) File, and Coordinate Entry)** - This allows the user to choose a point number from a list or enter either the coordinates or point number. A bulls-eye target will be displayed in the plan view to direct the user where to go.

**Field Marked Points** - This allows the user to work without a design on the computer and just navigate over holes laid-out in the field and collect the position. If selected and Pattern Guides have been enabled, two circles, at most, will be displayed. They are red, tan, and light purple for spacing, burden, and staggered design type. This used to be red, white, and blue (but had a conflict with white and black backgrounds).

**Change Navigation Mode** - If “All Choices” is the default navigation mode, then the drill navigation mode that you have entered can be changed to a different mode by going to Tools and selecting “Navigate To...”. This will bring up the “Navigate To...” screen shown above.

**Default Navigation Mode:** If a specific mode is selected all the time, to prevent the navigation mode screen (shown above) from coming up every time, go to the

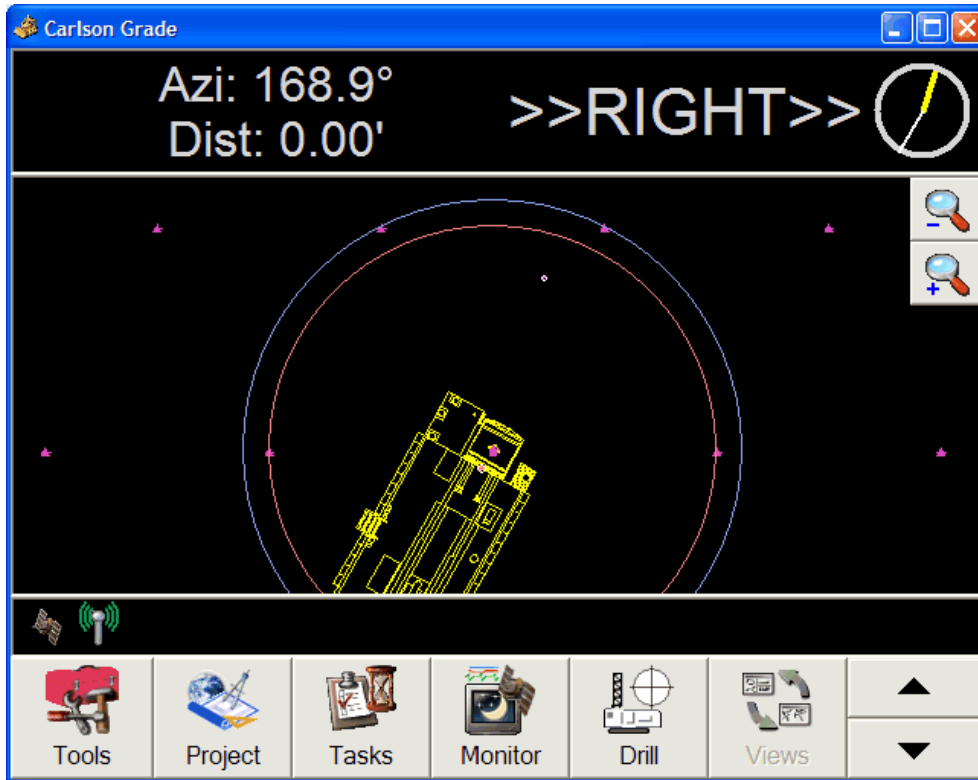
option under Tools/Advanced Tools/System Options/Navigation Options called Navigation Mode. The default is All Choices as show in the screen above, but All Points, Specific Point, or Field Marked Points are also options. This screen was partially discussed in Chapter 7, “Manager and Advanced Operator Interface” under “System Options – Navigation Options” and is shown below:

Navigation Options	
 Stakeout Tol: 0.50'	 Direction Tol: 5.0°
 Hole Hdg Tol: 1.0°	 Hole Angle Tol: 1.0°
Navigation Mode: Show All Choices	
Save Field Points To: Project File	
Enable Pattern Layout Guides: Yes	
 Cancel	 OK

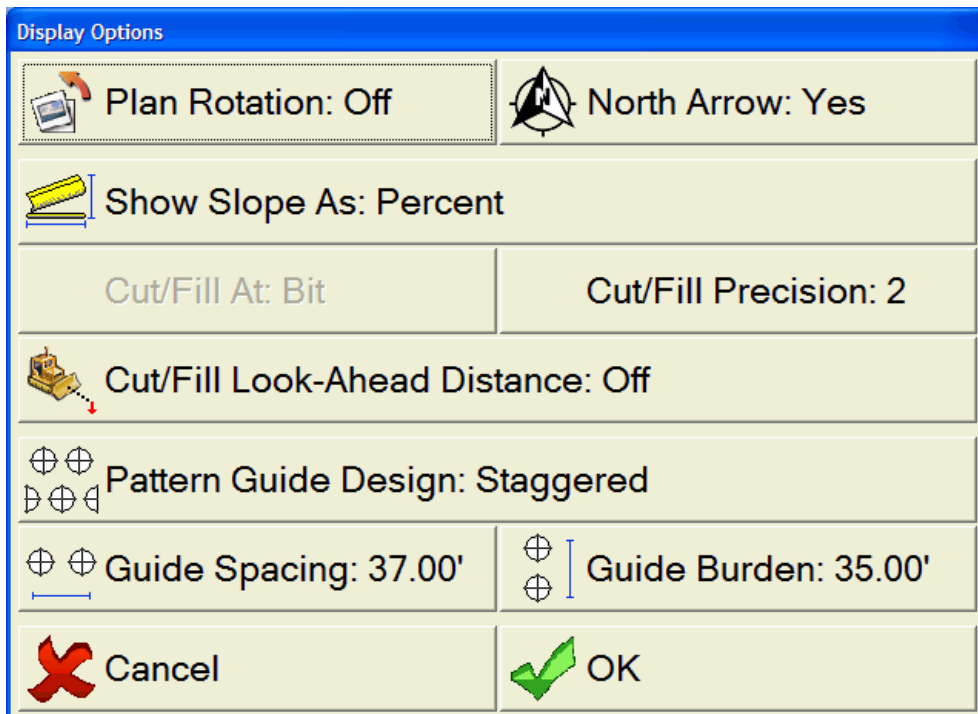
**Save Field Points To** - This can be set to project file or choose file. This will either use the active project coordinate file or force the user to choose a file each time they enter the Navigate To Field Points screen. This only happens when changing modes or starting a new session, not after each hole that is drilled. The coordinate file is used to record the drill holes and set names of other files that record information about the drilled holes.

**Enable Pattern Layout Guides** - Using field points allows for pattern layout guides, which are enabled by default. These guides are simply circles that follow the drill around and can be used to visually gauge the proper placement of the next drill hole. It allows the user to design a pattern on-the-fly, one hole at a time which is ideal if just trying to drill as much as you can before blasting. The example below shows the settings for a staggered pattern. If one hole is drilled, you can drill the next one in the row by using the red circle (spacing circle) to gauge distance. Notice that the red circle intersects the hole in the same row indicating that the drill is at the proper distance from that hole. Once two holes are drilled in a row, the outer circle in the view (medium purple), representing the staggered distance in this case, can be aligned to intersect two holes from the row above or below the current row. This gives the proper drill placement. Two circles will also be displayed if it is a square pattern and the spacing and burden is different. In that case you would use the red circle for spacing distance and the tan circle for burden distance with both inline respectively.





**Pattern Layout Guides:** The spacing, burden, and pattern type settings can be changed in the Display Options menu found under Tools where the operator can change the pattern sizes. This screen was discussed in Chapter 6, “Operator Interface” under “Display Options”, but is shown below:



The only differences in this screen from the one previously described in Chapter 6 are setting the distance and design type for pattern layout guides. This refers to “on-the-fly” drilling, where circles or user-set radius emanate from the drill point on the drill rig, and when they intersect two or more existing drilled holes (or possibly drill layout holes), it indicates that the drill is correctly positioned for another hole on the same pattern, even if a formal hole layout has not been designed.

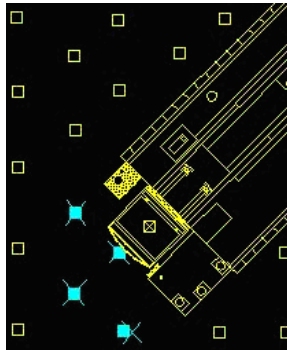
**Pattern Guide Design** – This is the pattern type being designed, which can be Square or Staggered.

**Guide Spacing** – This is the pattern spacing (distance between holes in the row) to be used for the pattern layout guides.

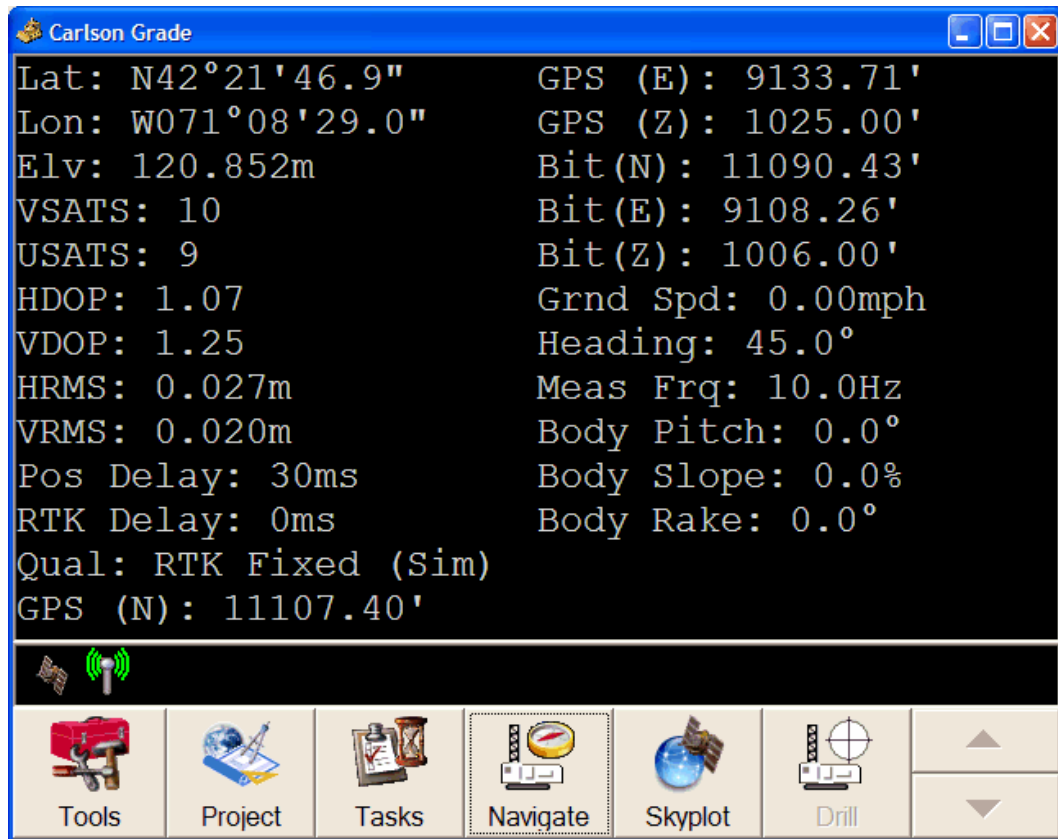
**Guide Burden** – This is the pattern burden (distance between rows) to be used for the pattern layout guides.

**Cut/Fill At** – The position the cut/fill will be reported to. This is the bit position for the drill (actually the collar position).

**All Designed Points:** In the plan view, the designed holes are yellow squares and solid cyan if already drilled. A cyan ‘X’ indicates the actual position the hole was drilled.



**Monitor Screen:** The monitor screen for the drill shows the GPS Position and the Bit position (N, E, Z). The GPS status or quality is shown in the example as RTK Fixed (Sim) indicates that the GPS type being used is Simulation. The newer monitor screen actually has tabs, one of which shows the GPS type selected.



**Pattern Layout:** This allows the user to create a full drill pattern on-the-fly. See Chapter 6, “Operator Interface” under the Project - Field Design: Drill Pattern Layout”.

**Hole Deletion:** This allows the user to delete a hole that was not meant to be drilled. See Chapter 6, “Operator Interface” under “Tools – Delete Hole”.

**Drill:** This is the item that is selected when a hole is to be drilled. The button for this is at the bottom of the main navigation screen. A series of screens will be displayed that guides the user through the process.

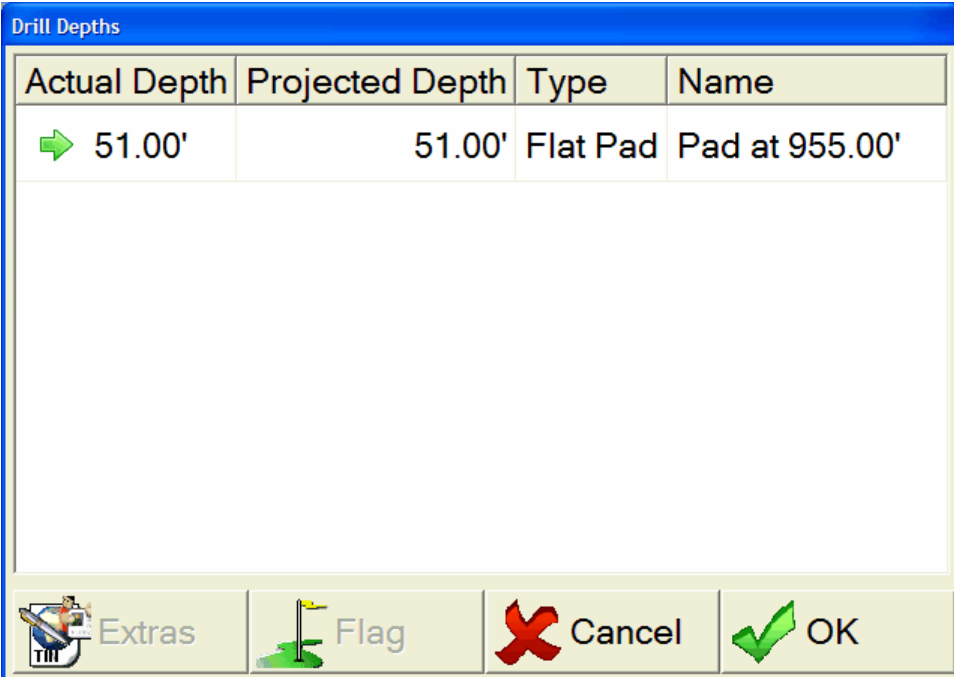
**Pre-Level** - If pre-level option has been enabled, the driller should navigate to hole, press drill, physically level the drill, then press OK to continue with drilling process. This captures the GPS position and related pitch/roll, and then calculates the height difference once leveled. This gives a fairly accurate representation of the height difference and is included in the displayed depth calculations when "Drill" is selected. So, if the drill operator zeroes the on-board depth monitor at ground level (actual collar position), the Drill Depth screen will show an accurate projected depth to surface.

**Warning** – If this option has been enabled, the user will be warned if the measurements are not within certain defined tolerances.

**Down-Hole Depth Information (Geologic Modeling)** - Currently, Carlson Grade does not automatically track the downhole information. The current configuration requires the operator to enter in the depth they've actually drilled. However, the projected depth to one or many surfaces is supplied to the operator. As for future development....the downhole depth sensor integration is scheduled which will provide better geologic modeling to the end user.

One of the principle benefits of the drill program, besides navigation to and drilling of blast holes, is the ability to log the holes according to the material or strata hit at a certain depth. In this way, tops and bottoms of coal or other ore, as well as major marker seams such as a particularly hard or soft rock, can be logged, sent to the engineering office by PC card or radio link, used for re-modeling of the strata or ore, with new DTM geologic models sent back out to the drills for more precise work.

If target surface grids are being used, the user will be instructed to drill a specified distance. Entries are allowed for all of the surfaces used/being captured. The primary surface is typically the bottom of hole target depth, such as: "Top of Coal" or "10ft Offset from Coal". This is the depth screen the operator will see.



Actual Depth	Projected Depth	Type	Name
➔ 51.00'	51.00'	Flat Pad	Pad at 955.00'

Extras Flag Cancel OK

**Actual Depth** – This is the actual depth that was drilled. This will default to the projected depth, but it can be changed to indicate the real depth which can sometimes differ. Double-tap the item of interest to change the value.

**Projected Depth** – This is the projected or targeted depth to drill. This is based off of the available data from the surfaces that have been loaded which are built from exploration, in-pit, and production drilling. However, what is seen in the field is sometimes different, which is why the Actual Depth is allowed to be changed.

**Type** – The type of surface this is. The primary surface is often times the bottom of hole target depth.

**Name** – This is the surface name, which lets the operator know what surface this really is especially if there is more than one.

**Flag** – To flag a specific surface as special, use this button once you have highlighted (single-tapped) the item of interest. A depth entry screen will appear. Once you have entered your value successfully, and have completed drilling the hole, then select OK from the screen. This flagged hole will be exported to a separate file, so the engineer or geologist can review this in comparison to their current geologic model and alter it if needed.

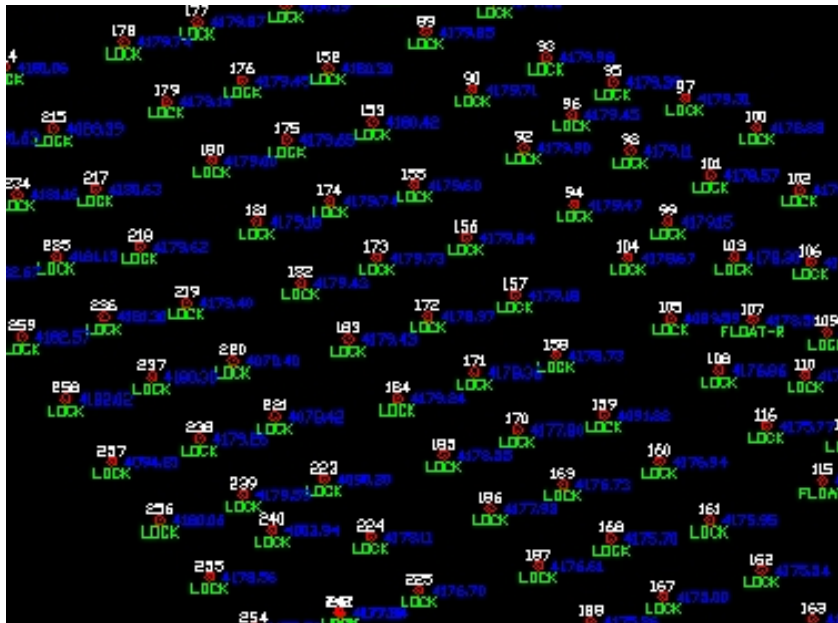
**Extras** – This is where the general parameters are accessible when “actively show” is not selected. In addition, abandon hole and enter unexpected items are found under this button.

**Abandon Hole** - If something goes wrong during drilling, creating the need for a “twin” hole, the user is instructed to select Cancel & Save. This is also termed Abandon Hole. A no-load reason will be requested, such as: broken steel or hole blowout.

**Extra/Unexpected Items** - The user can log extra/unexpected items, such as rocks. The list can be added to, deleted from, and revisited until complete. The user will be asked to enter a depth for every item added here.

**General Parameters** – The user will be prompted to enter in some general parameters for the hole. This currently includes the operator, drillability, the depth actually drilled (if target surfaces equal 0), hole action (load/no-load), no load reason, description, and any custom list items. Drillability is to aid in identifying the material type being drilled. Future plans include automating depth and geologic parameter collection. This hole log will be written to the data folder as the coordinate file name in a .txt file, for example blast1.txt. This screen will only display here if Actively Show General Params is selected; otherwise, it will be under Extras.

**Post-Processing:** Drillholes that are logged from “Field Marked Points” are stored as points in a coordinate file that can be loaded into any of the Carlson office products for viewing and record-keeping. However, the import of the “TXT” file is more helpful and is what you want to use when drilling “All Designed Points”, because the crdf file contains the designed position, not the actual drilled position. This will also allow the modeling of other items in plan view, such as GPS status as shown below. The benefit of plotting the GPS status will color flag any holes that were not in LOCK/FIXED status when drilled. This can give a clearer indication if a repeater needs to be moved in the pit to get better coverage or the like. The operator that drilled the hole can also be tracked. So if one operator is doing better than another, “Best Practices” can be used.



The above image shows three distinct blast lines as well as a few holes that were not drilled with uniform burden and spacing. Tools like these can help pinpoint the areas for improvement in the blasting practice.

**Angle Drilling:** Angle drilling requires the collar hole position and bottom of hole position in separate coordinate files. This will give the strike/heading/bearing and dip/tilt of the hole. We have plans to have some indicators/screens to easily guide the driller to the proper hole alignment.

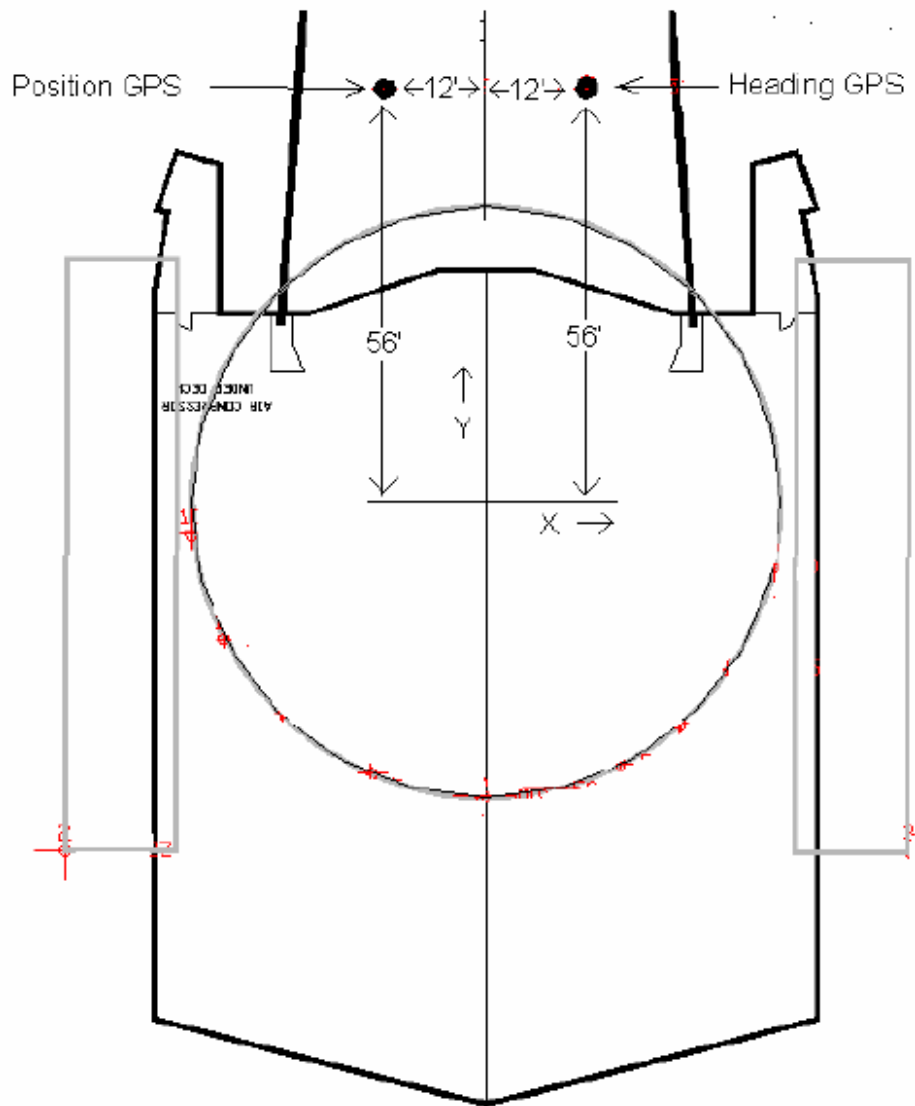


Carlson Grade installed on a 10" JLT touch-screen computer inside of a drill cab.

**Dragline Operation:** For draglines, a low-accuracy, inexpensive GPS is used such as the Garmin 18. Two receivers are placed on the dragline (no base is needed) to obtain the approximate heading of the boom. Multi-antenna GPS such as Novariant or Septentrio could be used for the position and heading calculations for greater accuracy, running RTK in conjunction with a base GPS receiver. The program tracks and displays the swing of the dragline boom and can count swings per hour and transmit the precise dragline position by radio link to the office. If logging is turned on, the dragline movement can be played back and studied after-the-fact, to review operation efficiency, since dragline production can be so critical to overall mine productivity. If a wireless radio link is established at the mine, the dragline can be monitored real-time back at the office. A single dual-axis tilt sensor such as the APS sensor is used with the dragline configuration to know, for example, if the tub is more than 1% off of flat.



Phase II for the dragline configuration is to get rope information from the PLC equipment and display the bucket position on the operator's screen at the main office through wireless radio linkage.

**GPS Antenna Placement:** For a dragline application, Carlson Grade requires two antennas or two receivers. You can place the rover and second (moving base/heading) GPS antennae on the body of the machine. The typical placements of the two GPS antennae are shown in the following diagram:





**Vehicle Settings:** For detailed information on this see Chapter 7, “Manager and Advanced Operator Interface” under this same subheading. The only items discussed here are vehicle and install specific settings. Select Tools from the main grading screen, followed by Advanced Tools. Once you have chosen the dragline vehicle type on left, select Vehicle Settings for the following screen:



Equipment Dimension Settings	
Model: Dragline	Antenna Offsets
Second GPS	Body Dimensions
 Cancel	 OK

**Model** – A name given to the dragline, which defaults to dragline.

**Antenna Offsets** – This is where the rover/primary position antenna entries are made. Selection results in the following screen for dragline:

Antenna Offsets	
Mount: Left	Right: 12.80'
Forward: -56.00'	Height: 160.00'
Localize: Ant to Gnd	Ant to Gnd: 160.00'
 Cancel	 OK

**Mount** – Can only be Left for the dragline.

**Right** – (X-Offset) The distance measured from the GPS antenna to the center of the tub. In the event the GPS antenna is located to the right of the tub center, a negative distance should be entered in this field.

**Forward** – (Y-Offset) The distance measured from the GPS antenna to the center of the tub. In the case of a GPS mount in front of the center of the tub, a negative distance should be entered in this field.



**Height** – The height measured at the tub center from the ground to the GPS antenna.

In the example dragline drawing, the X-Offset is 12 feet, Y-Offset is -56 feet and although not shown on the drawing, the height is 160 feet.

**Localize** – It is not advised to localize using the dragline. If localization is required, then use the Ant to Gnd options or do it using one of Carlson’s other products such as SurvCE. Ant to Gnd represents taking the antenna off the equipment and performing localization with it mounted on a rod or the like.

**Ant to Gnd** – Height of the GPS antenna to the ground using a rod or the like.

**Second GPS** – See image below for screen settings, but refer to Appendix C, “Topcon Dual-Antenna Setup” and Appendix 2, “Two Receiver Setup” for further information on configuring for a two antenna system.

Second GPS	
Right: -12.80'	Forward: -56.00'
Height: 160.00'	
 Cancel	 OK



**Right** – (X-Offset) The distance measured from the GPS heading antenna to the center of the tub. In the event the GPS antenna is located to the left of the tub center, a negative distance should be entered in this field.

**Forward** – (Y-Offset) The distance measured from the GPS heading antenna to the center of the tub. In the case of a GPS mount in front of the center of the tub, a negative distance should be entered in this field.

**Height** – The height measured at the tub center from the ground to the GPS heading antenna. If this is a different height than found in Antenna Offsets, the tilt bias will be compensated for in the calculations; therefore, separate height measurements of the antennas will be used.

In the example dragline drawing, the X-Offset is -12 feet, the Y-Offset is -56 feet and the height is 160 feet (not shown in drawing).

**Body Dimensions** – For entry of the measured dragline dimensions. The resulting screen is shown below:












Body Dimensions	
Length: 150.00'	Width: 80.00'
Height: 100.00'	
 Cancel	 OK

**Length** - The measured length from the body front to rearmost part of dragline.

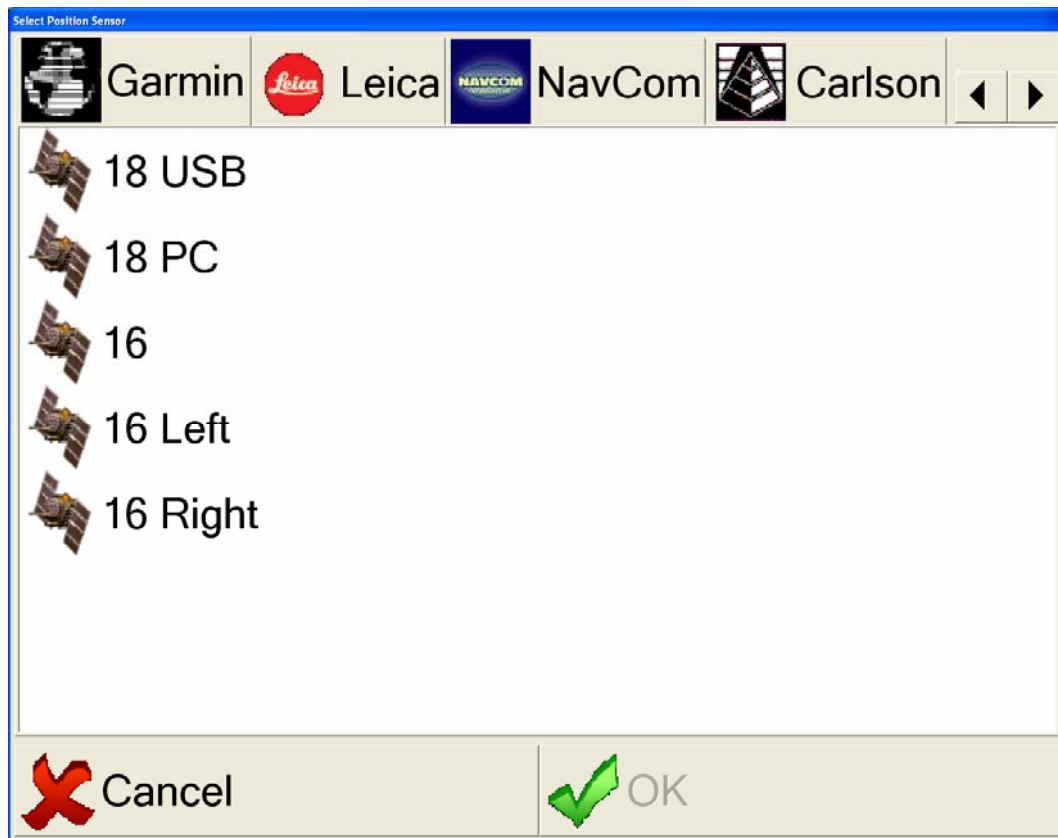
**Width** - The outermost dimensions of dragline from side to side.

**Height** - The height from bottom of pads to top of body.

**Position GPS Antenna Setup:** First make sure the antenna is connected to the computer running Carlson Grade and has power. Select Advanced Tools, and first button: Position Source, which is explained in detail in Chapter 7, “Manager and Advanced Operator Interface”. This is where you select your GPS type, from among the available options across the top line of the screen. The left and right arrow buttons at the top right of the screen allow you to move through the choices. When you select from that list, you get a “short list” of options to choose from below:

Select Position Sensor	
 Garmin	 Leica
 NavCom	 Carlson
<div>   </div>	
<div>  Generic NMEA         </div>	
<div>  GPS Simulation         </div>	
<div>  None         </div>	
 Cancel	 OK

For dragline work, choose Garmin and then select option “16 Left” and choose OK.



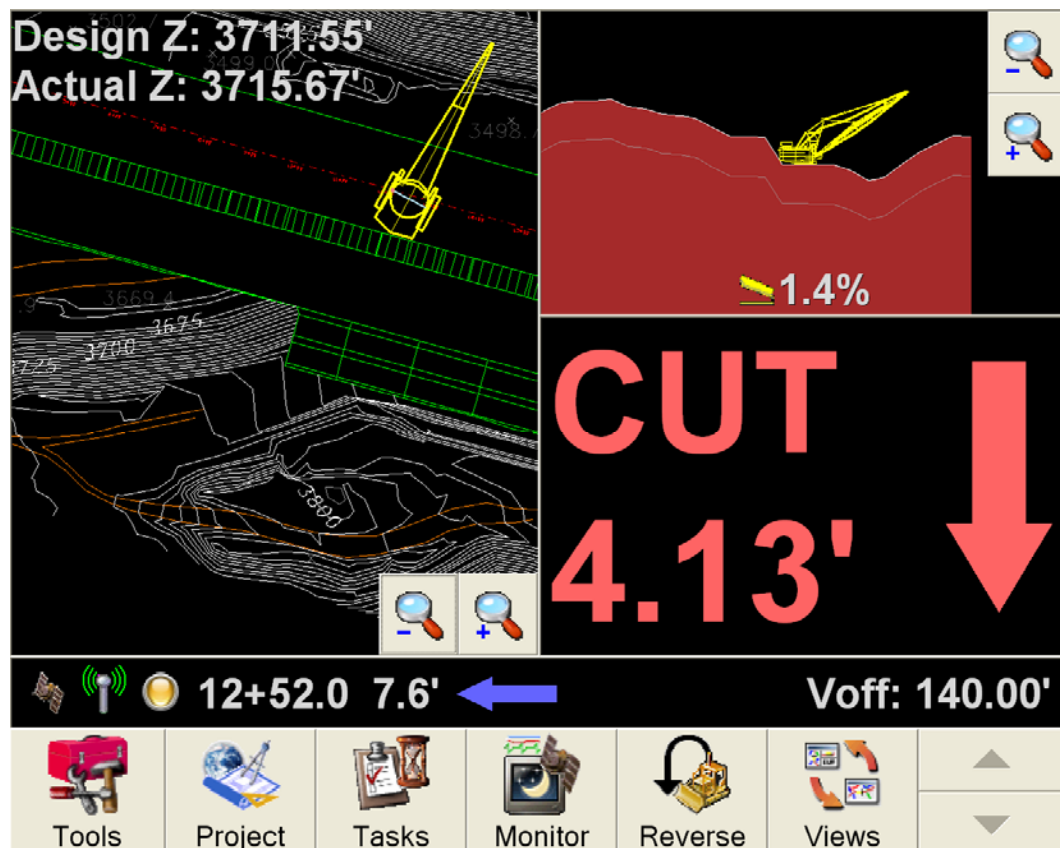
Press the Receiver button in the Position Source dialog. Then press the Receiver RS-232 button in the Receiver dialog. Press the Port button until the correct Com Port for the position receiver is presented, which selects it. If using a higher Port number than 4, see Chapter 9, “Troubleshooting, Serial Ports”. Similarly, press the Baud Rate button and select the correct Baud Rate. Press OK and exit back to the main screen and look for positions from the GPS receiver by going to the Monitor screen.

**Heading GPS Antenna Setup:** First make sure the heading GPS antenna is connected to the computer running Carlson Grade and has power. Select Equipment Options under Advanced Tools. The current Heading source GPS is shown on the Heading “Second GPS” button. Press the button to bring up the Heading Source dialog. The current Heading Source is shown on the first button. Press the button to select the model of GPS used for the Heading Source antenna. For this example, select “16 Right” under the Garmin tab and press OK.

Press the Receiver button in the Heading Source dialog. Then press the Receiver RS-232 button in the Receiver dialog that comes up. Select the correct Port and Baud Rates.

**Verify Heading Working:** To verify that the heading is being calculated based on the heading antenna, press the Monitor icon on the main screen. If the heading value has “GPS” after it, the heading antenna is being used for heading. If “GPS” is not shown, heading is being calculated based on the direction of travel of the position antenna.

**Warnings:** The dragline included in the Carlson Grade vehicle list is drawn in feet. A different vehicle file should be created for draglines in meters. The same instrument model should not be selected for both the position antenna and heading antenna. If that happens, they will both use the same config file which means they will try to use the same port. In an upcoming release of Carlson Grade it will be possible to name driver configurations to solve this limitation.



The dragline is shown on the plan view and also the profile view, if displayed.

## 9. Troubleshooting

**Hardware Configuration Issues:** Some common issues...

**Hardware Selection Issues:** What type of vehicle is Carlson Grade being installed on and what sort of accuracy will suffice for your task?

**Localization Problems:** Sometimes you may be far from the desired location. If your position seems off, check the following few items to resolve the issue.

**Check Settings:** Verify that you have a Localization File set and that you have selected either a State Plane or UTM Projection to use. Ensure that the correct GPS receiver type is in use and the correct vehicle type is entered.

**Review Files:** Once you have verified that you have a Localization File set, verify that the file looks normal. Open the file in a standard text editor, like Notepad, to see that it has the expected number of points and that it is not garbled looking (corrupt).

**Verify Position GPS Antenna Location:** If the values you are getting seem to be off, then check the antenna positions with a GPS backpack to verify that you have the positions of offsets entered correctly versus it being a localization problem. When comparing the GPS values from the backpack and the vehicle Position GPS, look at the GPS position in the Carlson Grade Monitor screen. Note that there is the cut/fill position reporting in addition to the GPS position, so make note of the one you are looking at.

**GPS Radio and Signal Problems:** What to check? Cabling, power level (battery level).

**Dozers with 6-Way Blades:** Unless the blade is perfectly square to the body of the machine or unless you add a rotation sensor to adjust calculations accordingly you will have some error in the elevation calculation on dozers with 6-way blades.

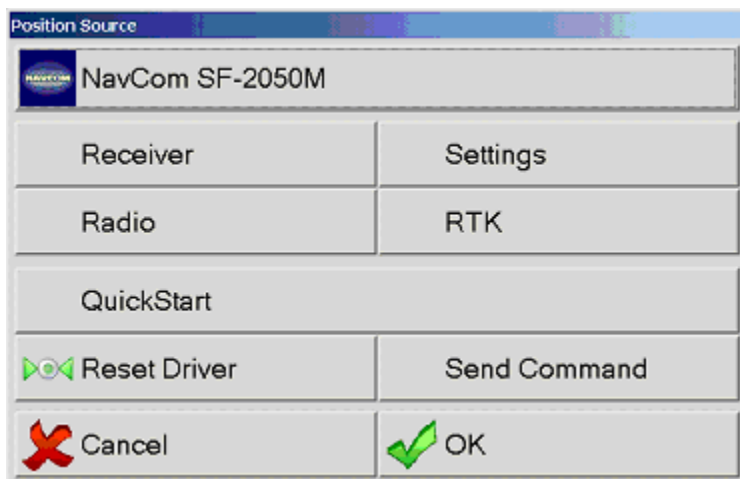
**Adding Serial Port Options (eg. Com5, Com6):** If a port higher than 4 is used, the receiver configuration file can be edited to show more port numbers. The configuration files are in “c:\carlson grade\drivers” and are named after the receiver model with a “.cfg” extension. Open a configuration file in notepad and search for the line that has “1,2,3,4”. If adding port 5, change it to “1,2,3,4,5”. If you somehow damage the configuration file, just delete and Carlson Grade will create a new one

## Appendix A — Navcom Starfire Setup

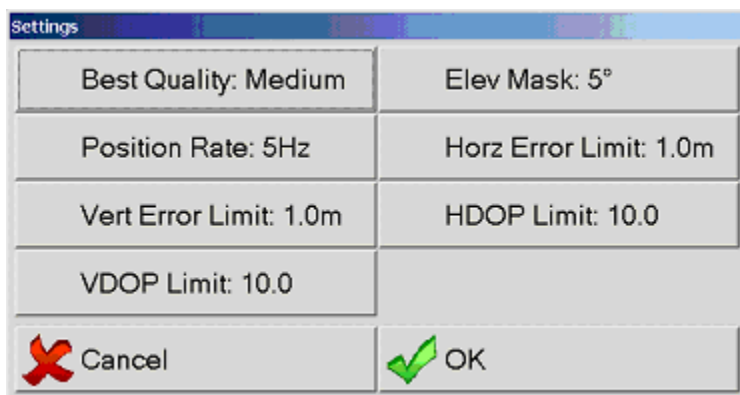
NavCom's Starfire capable receivers are able to get 10 cm accuracy without a base station. Because Starfire receivers are getting corrections from a Starfire satellite instead of a local RTK base station, there are a few differences in setting up the receiver and localizing to the project's coordinate system. This section describes how to select the NavCom Starfire receiver, establish the localization and how to perform Quickstarts.

### Select the Receiver Type

In Carlson Grade, select Tools, Advanced Tools, and Position Source to start the Position Source Window. The first button shows the current receiver type. Press this button, select the NavCom tab and then the matching receiver model. Notice that all receiver models that start with SF are capable of using Starfire. Press OK to return to the Position Source window where various options can be set such as port number, baud rate, and tolerances.



Press the Settings button to bring up the Settings window.

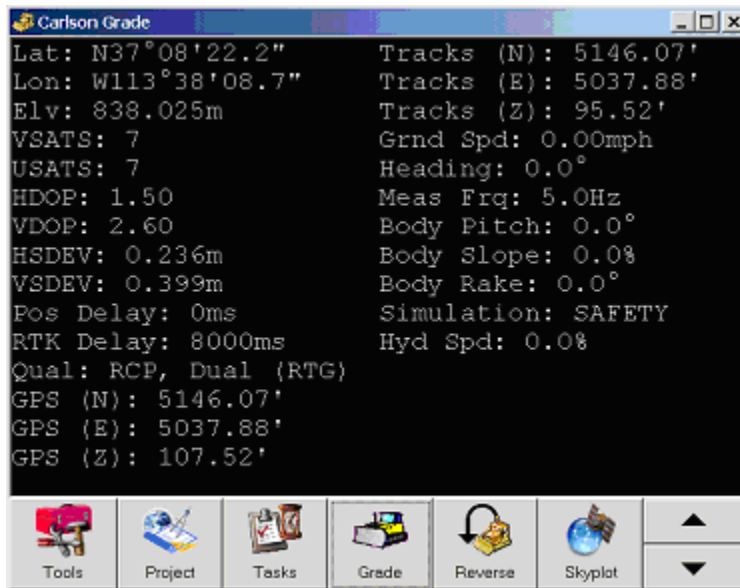


Toggle the Best Quality button until the Medium setting is current. If using the receiver in RTK mode, switch the Best Quality to High. Standalone and WAAS positions are

considered low quality, StarFire and RTK float are medium quality, and RTK fixed is high quality. When the quality of a position is below the “Best Quality” setting or if the other limit values are exceeded, elevations and cut/fill values are not shown to indicate that the position is not good enough.

When using Starfire without an RTK base, the RTK and Radio settings in the Position Source window are ignored. The QuickStart button is grayed out until the OK button is pressed and the driver is loaded. Press OK in the Position Source window to load the driver.

## Monitor Screen



This monitor screen example shows the status of a NavCom StarFire receiver. Notice that the “Qual:” field shows “RCP, Dual (RTG)”. This is the best mode when in StarFire mode. It is also normal to see 8000ms or 9000ms in the “RTK Delay” field. HSDEV and VSDEV are about double the actual error.

## Localization

A localization file (extension .DAT) contains the projection coordinates and matching local coordinates for control points in the project. A localization file can be created in Carlson Grade, SurvCE, or Carlson Field.



Before loading or creating a localization file, make sure the correct projection has been selected by pressing Tools, Advanced Tools, System Options, and Localization Options. The first button in the Localization Options window should show the State Plane or UTM zone for your area. If it is not correct, select the button to change the projection. The projection type can also be changed using the “Edit Project” button in the Project Configuration window.



## Setting the Vehicle Localization Point

When collecting points for a localization file or when saving or loading a Quickstart point, Carlson Grade needs to know where to locate the point being surveyed on the ground relative to the position of the antenna.

Go to the vehicle Antenna Offsets window by pressing Tools, Advanced Tools, Vehicle Settings and Antenna Offsets. The Localize button in that window toggles between “Ant to Gnd” (Antenna to Ground) and “Blade Center”. This determines how the position is calculated from the point being surveyed to the antenna. If the Localize option is set to “Ant to Gnd” then the point being surveyed should be directly below the antenna and the distance from the antenna to the ground entered in the “Ant to Gnd” field. This is also the option to use if the antenna is taken off the vehicle and put on a pole. If the Localize option is set to “Blade Center” then the blade of the vehicle should be centered on the survey point.



Antenna Offsets	
Mount: Center	Right: 0.00'
Forward: 0.00'	Height: 10.00'
Localize: Ant to Gnd	Ant to Gnd: 7.50'
 Cancel	 OK

## Load Existing Localization


To select an existing localization file, press Tools, Advanced Tools, and Localize to start the Alignment window. Press the Load button to select the file and then the OK button to close the window.

## Create New Localization



If an RTK localization has not already been created, the NavCom StarFire system can be used to create a localization file. Since StarFire is not as accurate as RTK, it is better to use RTK. These instructions apply to using RTK or StarFire. To create a new localization file using StarFire, start the NavCom Starfire unit and give it an hour or more to get to 10 cm accuracy. Start the Alignment window by pressing Tools, Advanced Tools, and then Localize. Press the Delete button until all old points (like the one shown below) are removed from the list:

Alignment			
P/N	Northing	Easting	Elev HRes VRes HV
--	413588.00'	2674544.00'	3581.00' 0.00 0.00 YY
Add	Delete	View	On/Off
Load	Save	 More	 OK

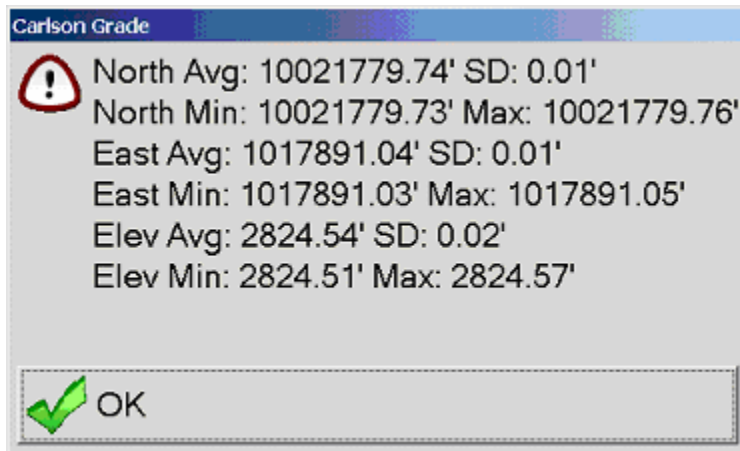
Press the Add button and select whether the local coordinates will be typed in or if the point is in the current coordinate file.

Local Point Coordinates	
Enter Coordinates	
By Point Number	
	Cancel

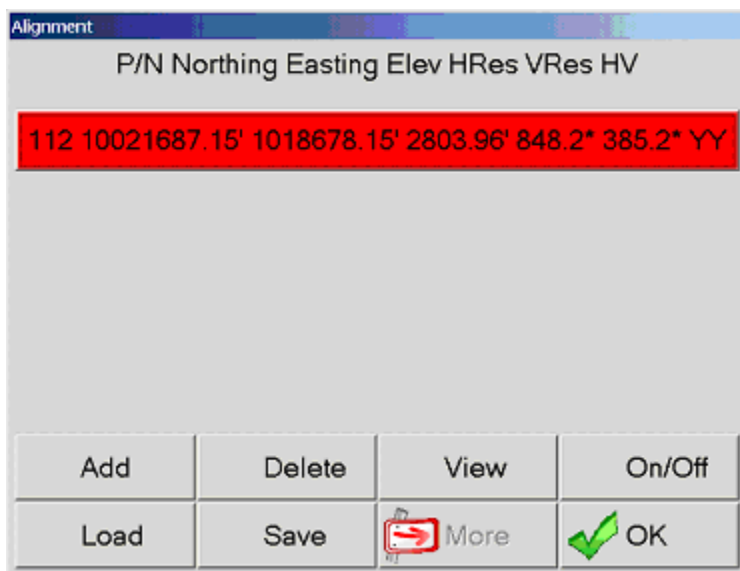
After entering the coordinates or point number, you will be prompted for whether you want to enter the lat/lon/hgt or read it from the GPS. If you select Read From GPS, you will see a window that shows the current status of the GPS. If you are getting StarFire corrections, you will see the following status.

GPS Position Status	
GPS Status: RCP, Dual (RTG)	
	 Read

Make sure the antenna or vehicle blade (See “Setting the Vehicle Localization Point” above) is in the correct position over the point and press the Read button to start averaging the positions. When finished, the results are shown for acceptance. The positions are shown in the coordinates of the current projection (State Plane or UTM). The main items to look for in this window are the Standard Deviation (SD) values.



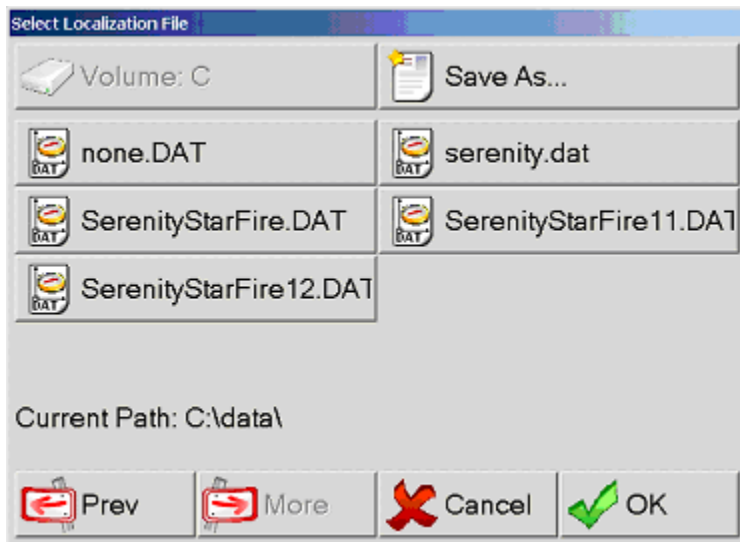
After pressing OK, you will see the new point in the Alignment window.



You should collect at least three or four known points in this manner.

### Adjust localization for StarFire

A GPS base station is not needed when using StarFire. When a localization file has been created by using RTK GPS, Carlson Grade needs to know how much to adjust the StarFire positions to match the RTK positions. To adjust the current localization file to match StarFire, position the GPS (or the blade center if selected in Antenna Offsets) over a known point and press Tools, Advanced Tools, Position Source, StarFire, and then the "Adjust Localization" button. Type in the point number of the point the GPS is over and then the GPS Position Status window will come up. Press the Read button when ready and several measurements will be averaged over about 5 seconds. Press OK after reviewing the results. The next window will show the localization files.

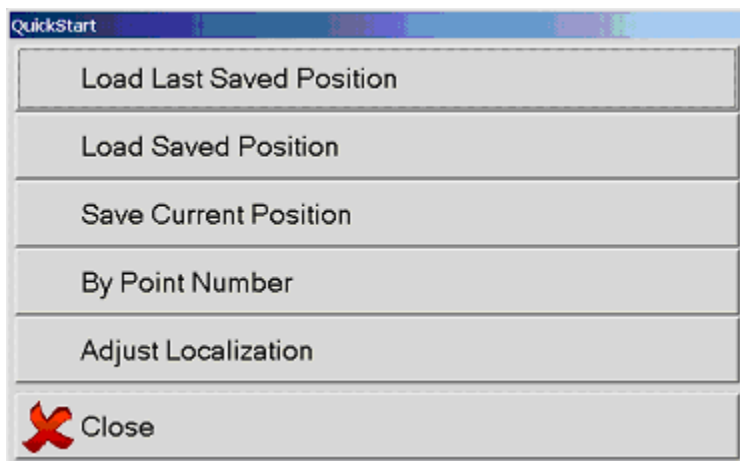


Press the “Save As” button so you can give the modified localization file a new name. It is important not to replace the original RTK localization file because if you want to adjust again or to a different point you should use the original RTK localization file.

### Perform Quickstart

When a Starfire receiver first turns on or when it loses sight of satellites in the sky, it must find the satellites and start processing the Starfire corrections to get an accurate position. This can take up to an hour. Quickstart is a command that can be sent to the receiver to tell it exactly where it is so that the initialization is shortened to 50 seconds. A Quickstart can be done using a saved position or, if the localization is correct, by using a point number in the coordinate file.

Position the antenna (or blade if selected in Antenna Offsets) over the point to be saved or loaded. Make sure the receiver has had enough time to find the satellites by looking for just the green LED to be flashing above the GPS label on the receiver. In Carlson Grade, Press Tools, Advanced Tools, Position Source, and Quickstart to start the QuickStart window.



If positioned over a point in the coordinate file, press By Point Number to enter the point number and start the Quickstart operation. If the point is not correct or the localization does not match, you will see the error message “Position is not close enough to use”.

A convenient way to do Quickstarts is to park the vehicle at the end of the shift and press “Save Current Position”. The operator at the beginning of the next shift can press “Load Last Saved Position” before moving the vehicle to perform a Quickstart without having to maneuver into position over a known point.

## Appendix B — Carlson Grade Recording and Replay

Recording GPS data and replaying the data in Carlson Grade is advanced functionality useful for testing, diagnostics, and demonstration. It provides the ability to record the data coming from the port to the driver and then later replay that data to the driver.

**Preparation:** In the regular mode of Carlson Grade, only the default replay file can be replayed. It is necessary to start Carlson Grade in debug mode to record or select the replay file. To start Carlson Grade in debug mode, close Carlson Grade, right click on the Carlson Grade shortcut and select Properties. Add –debug to the end of the text in the “Target” field. From now on, Carlson Grade will start in debug mode. To go back to regular mode, remove –debug from the Target field.

**Recording:** Start Carlson Grade in debug mode. Select the driver that you want to record (Tools | Advanced Tools | Position Source). Select the Receiver button in the Position Source window. Make sure the Port option is set to USB or RS-232. Select the RS-232 or USB button to open a new window. Set the Recording button to On. If you want to save the port data in a file different than the default port.log, select the Save In button to change it.

Press OK on all windows until back to the main screen. The port data is now being saved into the log file. Logging to that file will stop when the record option is turned off, a different driver is selected, or Carlson Grade is closed. If Carlson Grade was closed while logging, logging will resume with the new data replacing the old file.

Each driver can have a different log file specified. Each driver will record or not record based on its own record setting.

**Replay:** Start Carlson Grade in debug mode. Select the driver that you want to use to replay a port log file (Tools | Advanced Tools | Position Source). The port log file must contain data created from an instrument that is compatible with the driver used to replay it. Select the Receiver button in the Position Source window. Make sure the Port option is set to Replay. Select the Replay button to open a new window. Select the Play From button to type in the name of the file to replay.

Press OK on all windows until back to the main screen. The driver is now using the data from the log file. The positions are replayed as quickly as the file is read. This will usually result in the replay happening faster than it was recorded. The measurement frequency in the monitor screen (shown as Meas Frq) will show the rate at which the positions were recorded. The Satellite View screen will not work unless that information was transmitted while recording.

Replay of the file will start over when end of the log file is reached, the driver is selected again or Carlson Grade is restarted.

## Appendix C — Topcon Dual Antenna Setup

Dual antenna systems provide Carlson Grade with the position of the rover antenna and the heading based on the position of the moving base antenna relative to the rover antenna. This section applies to configuration of the Topcon dual antenna (dual GPS) system, either in the form of Topcon receivers (standard) or APS Astrum ruggedized housings which use Topcon GPS receivers. Dual antenna setups apply to excavator and drill installations as well as potentially to dozer installs where logging might be to track and grading to the blade (managed to 2 antenna, one on blade and one on cab). These instructions explain the procedures of connecting two Topcon receivers to get heading.

Diagram 1 shows an example of a two-antenna setup. The port numbers, baud rates and antenna separation values shown in this diagram are just examples of possible values.

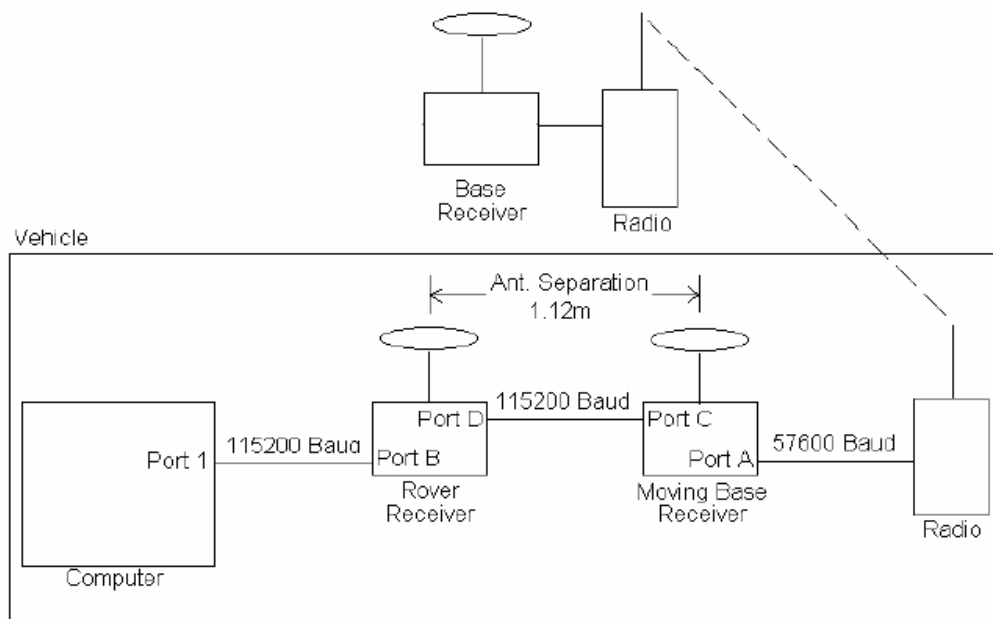


Diagram 1

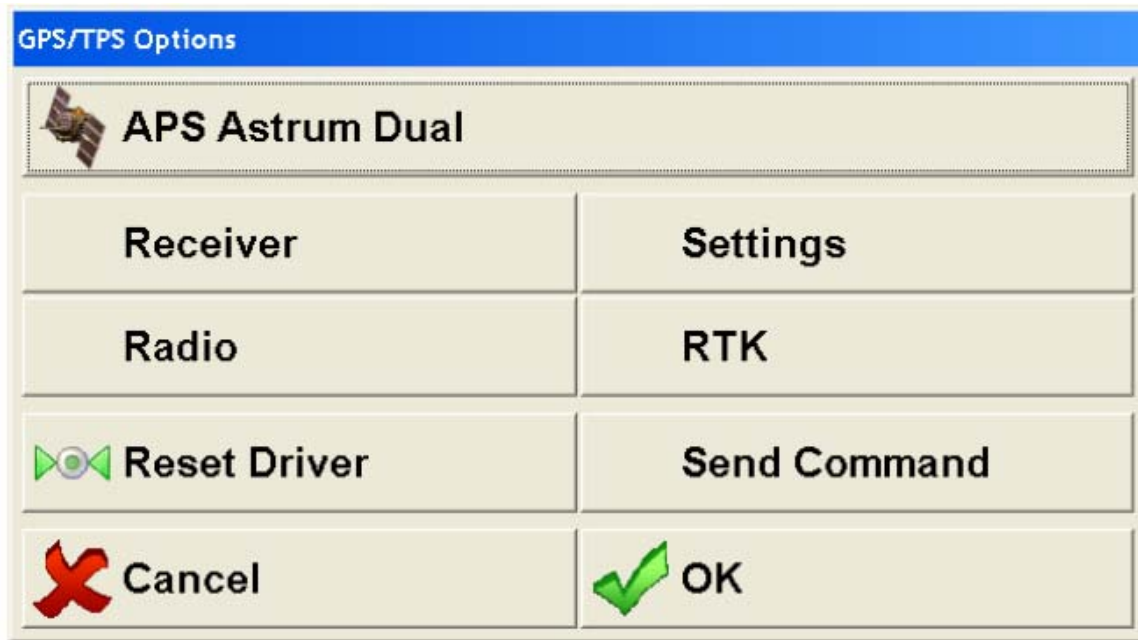
**Equipment**—The base receiver may be any brand or model of receiver that can transmit RTCM, CMR, CMR+ or Topcon Proprietary corrections. It is connected to a radio that will transmit the corrections to the radio on the vehicle. Carlson Grade does not configure the base. The Base Receiver should be configured by a different program such as SurvCE to transmit one of the supported corrections through the radio.

Any model of Topcon or APS receiver may be used as the moving receiver as long as it supports the desired RTK Rover position update frequency. The Topcon or APS receiver used as the rover receiver must support heading calculations. Carlson Grade checks for this option and will report “Heading not supported by this receiver” if it is not supported by the rover receiver. This option can be also checked in the Topcon PC-CDU program

by looking for ADU in the Receiver Options window found in the Tools menu. If the ADU option is not active in the receiver, it may be purchased from Topcon or APS.



Driver Setup for Dual Antenna—The following screens show how Carlson Grade should be configured to match the example shown in Diagram 1. The settings for Topcon Dual Antenna and APS Astrum Dual are identical and these instructions may be used for either model.

1. In Carlson Grade, press the Tools icon, Advanced Tools button, Yes button, and choose Position Source (GPS/TPS options). If APS Astrum Dual or Topcon Dual Antenna is not shown on the first button, press the first button to select the correct driver.





1. Press the receiver button to bring up the Receiver Communications dialog. Select the port number of the computer that the Rover Receiver is connected to (Port 1 in Diagram 1 example). If the baud rate selected does not match the baud rate of the rover receiver, the driver will automatically change the baud rate of the rover receiver to match the selected baud rate. Leave the other options in the Receiver Communications window the same as they are shown below. Press OK to save the entered settings and return to the GPS/TPS Options dialog (Position Source). Carlson Grade does not need to be told that the computer is connected to Port B of the rover receiver. Any port on the rover receiver will work.





Receiver	
Port: 1	Baud Rate: 115200
Parity: None	Byte Size: 8
Stop Bits: 1	Flow Ctrl: None
 Cancel	 OK

2. Press the Settings button in the GPS/TPS options to start the Settings dialog window. Use the Antenna Separation button (sometimes found under Dual Antenna) to enter distance between the centers of the Rover Receiver and the Moving Base antenna (1.12 meters in Diagram1 example). Press OK to save the new value and return to the GPS/TPS Options screen.



Settings	
Elev Mask: 10°	Position Rate: 10Hz
Horz Error Limit: 1m	Vert Error Limit: 1m
HDOP Limit: 10	VDOP Limit: 10
Ant. Separation: 1.12m	
 Cancel	 OK

3. Press the RTK button in the GPS/TPS options screen and then press the Moving Base button to start the Moving Base dialog window. Enter the port letter on the rover receiver that is connected to the moving base (Port D in Diagram 1 example). Enter the baud rate of the port on the moving base receiver that the rover receiver is connected to (115200 in Diagram 1 example). Press OK to return to the RTK window. If the baud rate of the moving base receiver port is unknown, perform the following steps:
  - a. Connect the computer directly to the Moving Base receiver

- b. Select the driver for that receiver
- c. Start the Receiver Communications window by pressing the Receiver button and set the computer port and desired baud rate
- d. Press OK in the Receiver Communications window and OK in the GPS/TPS Options window. Carlson Grade will establish a connection with the receiver and change the baud rate to the selected baud rate
- e. Reconnect the computer to the rover receiver
- f. Follow the Driver Setup for Dual Antenna instructions from the beginning.

Moving Base	
Port: D	Baud Rate: 115200
Parity: None	Byte Size: 8
Stop Bits: 1	Flow Ctrl: None
 Cancel	 OK

4. If not already in the RTK screen, press the RTK button in the GPS/TPS Options dialog (Position Source). Select the Type button to choose the type of corrections being sent from the base receiver (CMR in Diagram 1 example). Press OK to return to the GPS/TPS Options screen.

RTK	
Type: CMR	Moving Base
 Cancel	 OK

5. Press the Radio button in the GPS/TPS Options screen to start the Radio window. Select the port number on the moving base receiver that is connected to the radio (Port A in Diagram 1 example). Select the baud rate (57600 in Diagram 1 example) and other settings of the radio that the moving base is connected to. Press OK to return to the GPS/TPS options window.

Radio	
Port: A	Baud Rate: 57600
Parity: None	Byte Size: 8
Stop Bits: 1	Flow Ctrl: None
 Cancel	 OK

6. Press the OK button in the GPS/TPS screen to save the options and establish the connection to the Rover receiver.

Status of Carlson Grade
<p><b>Connecting to Astrum Dual (this may take up to 30 s</b></p> <div style="border: 1px solid black; height: 200px; width: 100%;"></div>
<div>Cancel</div>

7. Press OK in the Advanced Options dialog and OK back out to the main Carlson Grade screen. Driver setup is complete.

# Appendix D — Hardware Monitors for Install Diagnostics

## Serial Port Monitor

Portmon is a serial port monitor program. Start Portmon before starting the application to see the interaction of the program and the serial port. You will be able to see when the port is opened and closed, what settings are used and the actual data that is passed back and forth. The output can be saved to a log file for later analysis.

There are several useful options that can be read about in the help file but the main thing to know when getting started is to select the ports to be monitored by selecting Ports in the Capture menu.

## Can232 Monitor

The Can232 program in the Can232 folder is a utility to detect the presence and status of the Can232 adapter. Start CAN232 and set the baud rate to 57600 and the bit rate to 20 Kbs. Press 4 to connect.

If the CAN232 adapter is not connected or does not have power, you will get status=109 Cannot open CAN. You can check connections and retry again by pressing 4 again.

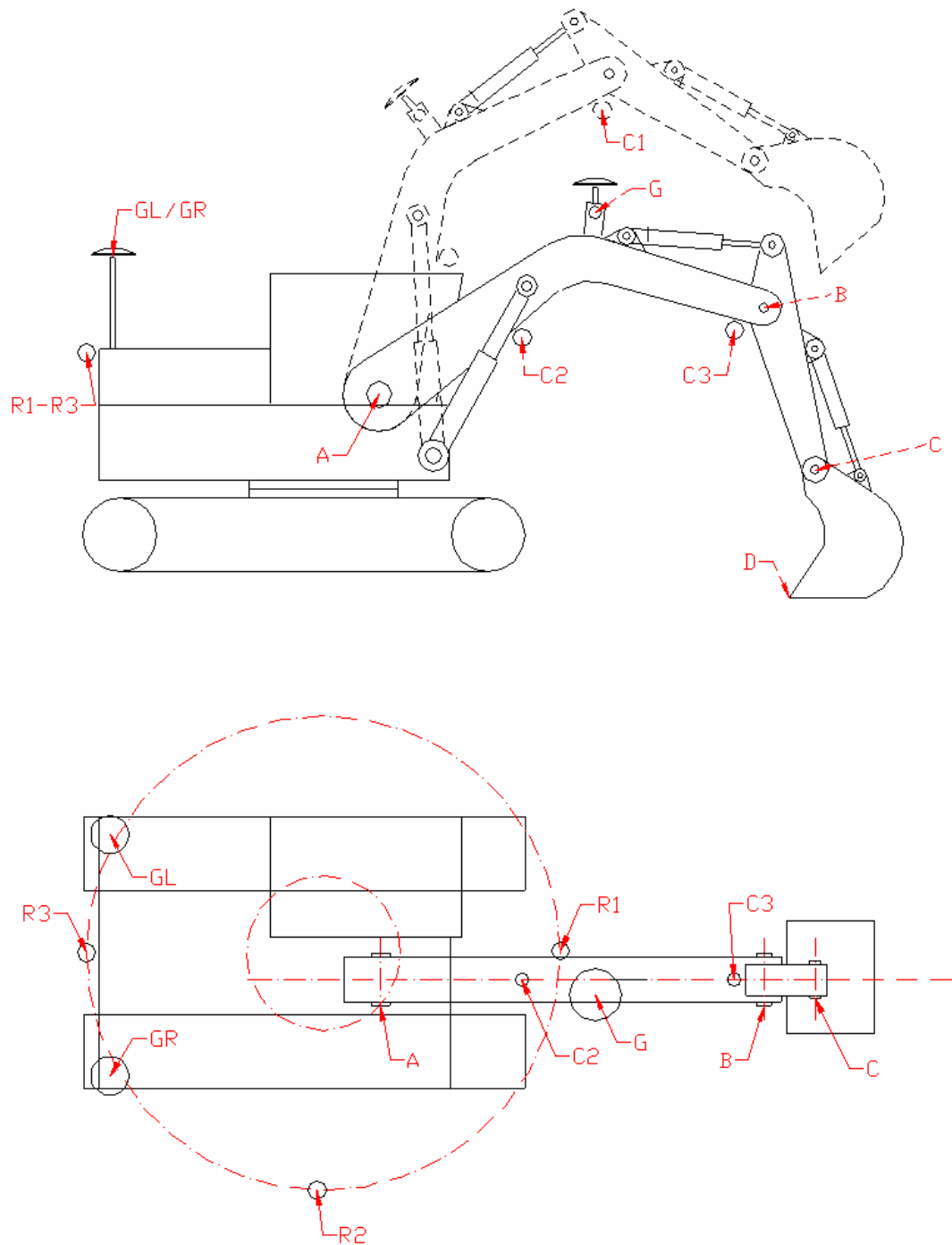
If the CAN232 adapter is working but it does not see any devices, you will see the Can232 status information appear in the upper right corner of the window, but the lower half of the window will still be empty. As soon as a device is connected, it's id will appear automatically.

## Debug Messages Monitor

The DbgView program in the DebugView folder is only useful if you have been sent a debug version of the program to analyze a problem. This requires a fair amount of effort and should be done only as a last resort. It will display streaming messages from the program about what the program is doing.

## Appendix E — Excavator Measurement Procedure

The following diagram can be used as a reference for the excavator configuration:



Points R1, R2, R3 are the all the same target, measured at different rotation positions of the excavator. These points are used to define a plane perpendicular to the rotation axis of the excavator.

Target C1 and C2 are used to define a centre line for the boom. They should be centered with good precision (measure them and punch mark them), at both ends of the boom. C1, C2, C3 are used to define a plane through movement direction of the boom, perpendicular to R1-R3 plane.

Targets A, B, C must be centered with good precision at the end of each bolt at the link for the boom, stick, bucket respectively. It is a good idea to stick on reflective tape and mark the centre positions. It is most convenient to use a reflectorless Total Station (careful with prism constants and target heights).

Target D is the tip of the bucket (take care with target height). Points A-D are used to define length and angles for the boom, stick and the bucket.

The offset from boom center line for A-D will be taken in consideration in the calculation, and dimensions in the result are all projected to the center line (slope distance).

#### **Measurement Procedure:**

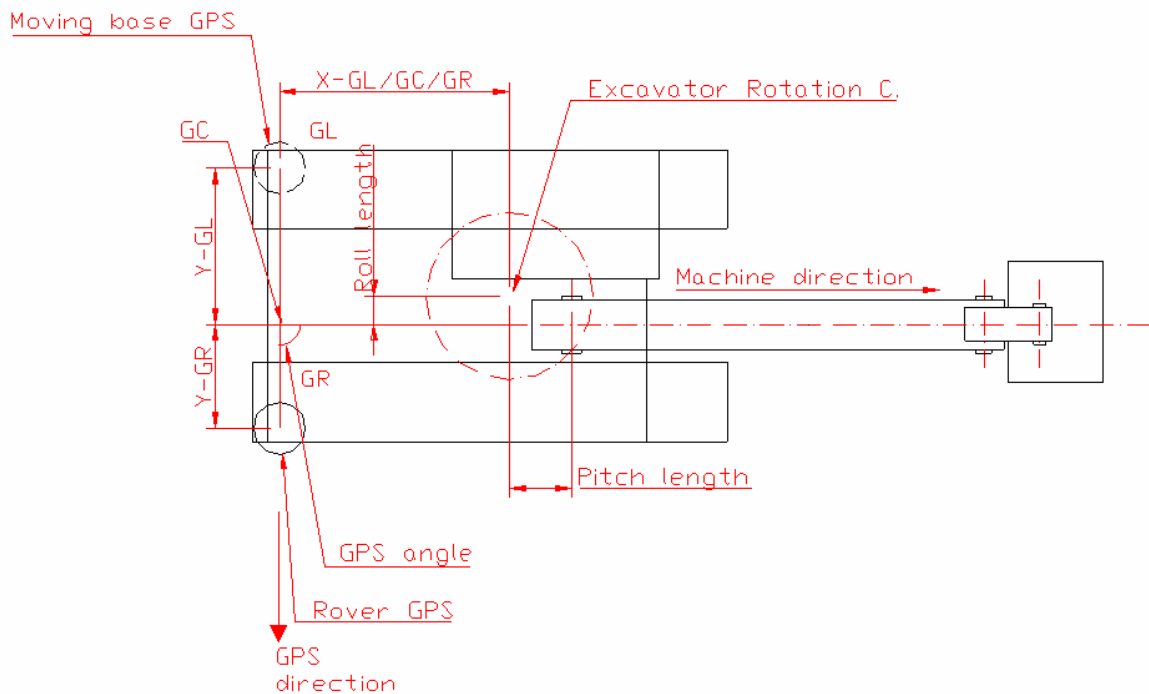
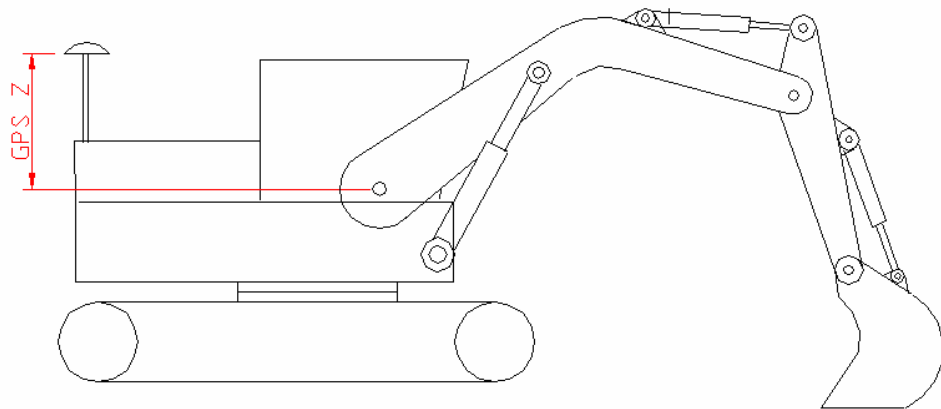
1. Place the excavator on a flat surface in a stable position, as close to horizontal as possible. (A 3D transformation needs to be computed to compensate for pitch and roll).
2. Stick on the reflective tapes to positions A-C and mark the centre positions.
3. Attach the prism/reflectorless target to a magnetic adaptor and mount it carefully at C1 (for later measurements when the boom is high).
4. Mount a 360 degree prism (or rotating reflectorless target) somewhere on the body of the excavator (the further from the central rotation point the better). You could use either GL or GR.
5. Check that all points are visible from the instrument position.
6. Check that the point C2 is visible with the boom in high position as well as in low position.
7. Raise the boom to a high position (to minimize the weight of the boom causing body pitch/roll).
8. Rotate the machine 180 degrees. Measure point R1.
9. Turn back 90 degrees so the rear end of the machine point towards the instrument and measure R2.
10. Rotate back to the original position (where you checked that you could see everything) and measure R3.
11. Measure the point C1 (while the boom is still high).
12. Lower the boom and set the bucket carefully down in a flat position. Avoid any rotation of the machine and take care not to introduce body pitch/roll by pushing the bucket into the ground. Measure C2 and C3 (same magnetic target as C1).

13. Measure points A-D (reflectorless recommended). Determine if the operator will be using the cutting edge of the bucket, or the end of the bucket teeth and measure D accordingly.
14. Measure points GL and GR (set the target height to measure the antenna center).
15. Calculate

Excavator Dimensions

Excavator Dimensions

GPS placed on the Body (single/multiple antenna)



# Appendix F — Making Vehicle Icons from Drawing (DWG) Files

The following procedures can be followed in Carlson office products like Carlson Survey, Carlson Roads, SurvCADD, and Takeoff. Carlson Grade does not currently offer the ability to edit dwg files.

- 1) Load the dwg file.
- 2) Remove (or hide) any unnecessary data from the dwg file. This could include any text in the drawing.
- 3) Rotate the drawing so that the vehicle is facing directly north.
- 4) Relocate the drawing so that following points (the point at which cut/fills are calculated) is located at (0,0).

## **Dragline**

- a. Top view icons - centered on the center of the tub.
- b. Side view icons - centered on the ground at the center of the tub.
- c. Back view icons - centered on the ground at the center of the tub.

## **Grader, Dozer, & Scraper**

- a. Top view icons - centered on the center of the blade.
- b. Side view icons - centered on the tip of the blade.
- c. Back view icons - centered on the ground at the center of the machine.

## **Truck**

- a. Top view icons - centered at the center of the front bumper.
- b. Side view icons – centered on the ground at the center of the cab.
- c. Back view icons - centered on the ground (between the wheels) at the center of the truck.

## **Excavator**

- a. Side and top view of the excavator body icon - centered at the pivot point of the body and the boom.
- b. Side and top view of the boom icon – centered at the hinge point of the body and boom.
- c. Side and top view of the stick icon - centered at the hinge point of the boom and stick.
- d. Side and top view of the bucket icon - centered at the hinge point of the stick and bucket.
- e. Bucket (Back) view icons – centered at the center of the bucket teeth.



**Drill**

- a. Side and top view of the drill body icon - centered at the pivot point of the body and the mast or similar connection.
  - b. Side and top view of the hydraulic arm components - centered at the hinge point closest to the body, like the excavator.
  - c. Side, and back view of the mast icon - centered at the hinge point of the body (or hydraulic arm) and mast.
  - d. Top view of the mast centered at the drill point.
- 5) For all vehicles except for Draglines, the icon must be scaled to be 1000 units. The scale is different for different machines.

**Dragline**

- a. All views – Scaled in same units as project – usually feet or meters.

**Grader, Dozer, & Scraper**

- a. Top, side, and back views – blade/pan width must be scaled to 1000 units.

**Truck**

- a. Top and back views - body width must be scaled to 1000 units.
- b. Side view icons – 1000 units from tip of front bumper to center of the cab.

**Excavator**

- a. Side and top view of the excavator body - 1000 units from the body/boom pivot point to the back of the excavator.
- b. Side and top view of the boom, stick, & bucket - 1000 units from pivot point to pivot point.
- c. Bucket (Back) view – 1000 units from left to right side of the bucket.

**Drill**

- b. Side and top view of the drill body - 1000 units from the body/mast or similar pivot point to the front of the drill (opposite end of drill as mast).
  - c. Side and top view of hydraulic connectors (if articulating arm type of drill) - 1000 units from pivot point to pivot point.
  - d. Side and top view of drill mast – 1000 units from pivot point to drill point.
  - e. Mast (Back) view – 1000 units from left to right side of the drill mast.
- 6) Make sure all the lines in the dwg file can be converted to polylines. To do this select Edit -> Polyline Utilities -> Entities to Polylines. Select all.
- 7) Write the .veh file. Select Misc -> Write Polyline File from the Cogo/Design module. Use all the default options except for “Reduce Polyline Vertices” and “Decimal places for coordinates.” For “Reduce Polyline Vertices” select No and for “Decimal places for coordinates” select 6.

# Appendix G — Simulation Mode Key Strokes

**Keys** – Keyboard entries for use in Simulation Mode of vehicles.

## **Common to All Vehicles:**

- **Left arrow** – Turn left
- **Right arrow** – Turn right
- **Up arrow** – Move machine up
- **Down arrow** – Move machine down
- **R** – Reverse direction of machine
- **F** – Make machine go faster
- **S** – Make machine go slower
- **T** – Reset vehicle to starting position on project
- **Q** – Pause / un-pause simulation

## **Dozer Specific:**

- **INS** – Raise right side of blade
- **DEL** – Raise left side of blade
- **HOME** – Pitch blade up
- **END** – Pitch blade down
- **Page Up** – Rake right side of blade forward
- **Page Down** – Rake left side of blade forward
- **1** – Raise left slope board
- **2** – Lower left slope board
- **0** – Raise right slope board
- **9** – Lower right slope board

## **Excavator Specific:**

- **INS** – Move boom up
- **DEL** – Move boom down
- **HOME** – Move stick up
- **END** – Move stick down
- **Page Up** – Move bucket up
- **Page Down** – Move bucket down

## **Drill Specific:**

- **INS** – Roll/Tilt mast left
- **DEL** – Roll/Tilt mast right
- **HOME** – Pitch/Tilt mast forward
- **END** – Pitch/Tilt mast backward