

## Civil Simulate – White Paper

---

Last version: 11/11/2009

Civil Simulate

## Table of Contents

1. Introduction .....	3
2. Summary of Features .....	4
3. Creating 3D Simulation .....	5
3.1 Fast Simulation Creation .....	5
3.1.1 Recalculation of surfaces for better simulation viewing .....	6
3.1.2 Defining advanced simulation features .....	7
3.1.3 Simulation Cameras .....	7
3.1.4 Simulation Paths.....	8
3.1.5 Road's Color Lines .....	8
3.1.6 Barriers .....	9
3.1.7 Traffic Islands .....	9
3.1.8 Automatic and Manual Simulation of Intersections .....	9
3.1.9 Structures .....	10
3.1.10 Fences.....	10
3.1.11 Raster .....	11
4. Simulation and Visualization Tools .....	11
4.1 3D capabilities .....	11
4.1.1 Drive-through simulations.....	11
4.1.2 Distance measurements.....	12
4.1.3 Visibility and safety checks.....	13
4.1.4 View styles - polygon mode.....	13
4.1.5 Background - Sky image .....	14
4.1.6 Texturing - Terrain texture.....	14
4.1.7 Weather effects .....	14
4.1.8 Lighting effects .....	14
4.1.9 Notes .....	15
4.1.10 Scene objects .....	15
4.1.11 Navigation.....	16
4.2 Drive simulation .....	16
4.3 Creating a simulation viewing file .....	17

Civil Simulate

## 1. Introduction

Civil Simulate is a powerful 3D interactive simulation software tool, which transforms civil engineering designs into highly sophisticated 3D simulations.

Civil Simulate is capable of transforming any Civil 3D, CivilCAD and other Civil Engineering CAD Software projects into a 3D simulation. The software is unique in its ability to seamlessly merge the topography with the engineering design, including a raster image, and produce an accurate virtual reality 3D vision of complex structures such as junctions, bridges, ditches, traffic islands, etc. In addition, the designer can utilize the software to demonstrate aerial views (flyovers), conduct interactive drive simulations, perform distance measurements, and make visibility and safety checks with a click of a button.

3D simulation can be performed at every stage of the design:

- Existing topography
- Basic road (alignment only)
- Basic road with profile
- Full road design (alignment, profile and assembly)

Civil Simulate does it with speed, high accuracy to the CAD model, and most importantly, it has a proven success rate in handling large-scale engineering projects. From the "drawing board" perspective, the planning process is quicker because the designer is provided with a powerful online project-viewing capable tool, which bridges the gaps between the virtual and reality. Changes can be made with a click, saving time and money.

From all the available design tools in today's marketplace, Civil Simulate provides the most cost effective high quality 3D simulation, and redefining computerized engineering.

Civil Simulate

## 2. Summary of Features

This chapter summarizes the key features of Civil Simulate, while the following chapters detail the product's major capabilities.

- Creating 3D simulation, at a click, from the engineering design environment, at any stage of the design process.
- Integrated Simulation menu embedded within state-of-the-art civil engineering software like Civil 3D (Autodesk) and CivilCAD (Sivan Design), which enables immediate creation of a 3D simulation.
- Generic interface to civil-engineering CAD software, based on the LandXML protocol.
- 3D modeling of all project's elements with a high accuracy of +/- 2 cm to the CAD model.
- Ability to simulate large-scale projects with 3D meshes containing millions of triangles, and correspondingly creating simulations encompassing dozens of square miles.
- Ability to simulate complex project scenarios involving elements like: intersections, bridges, junctions, roadways with several lanes, a variety of road color lines, traffic islands, safety barriers, etc.
- Automatic tool for rapid 3D visualization and simulation of Junctions and Bridges, even before their detailed engineering design.
- Ability to enter into the simulation additional 3D objects that are not necessarily part of the engineering design, but still important for a comprehensive simulation, like: buildings, traffic signs, trees, lamppost, and more.
- Ability to project and drape a 'Raster' image (orthophoto, or any texture) onto the 3D scene.
- Variety of navigation options available within the 3D environment, including Manual and Automatic Navigation, as well as Drive Simulation on a roadway or a path.
- Auxiliary engineering tools for carrying-out measurements and line-of-sight visibility checks within the 3D environment.
- A variety of 3D environment setting options, as apply to: topography terrain and sky texture, lighting and shadowing, as well as weather conditions (Sun/Clouds/Rain/Snow/Fog).

Civil Simulate

## 3. Creating 3D Simulation

The functionality of Civil Simulate contains two main parts:

- 1) Creating a 3D simulation from the CAD software environment – Civil 3D (Autodesk) or CivilCAD (Sivan Design), using a built-in menu within these software products.
- 2) Simulation and Visualization Tools for use in the Civil Simulate 3D environment (covered in the next chapter).

### 3.1 Fast Simulation Creation

Creating a simulation, is as easy as clicking the “Create Simulation” option from the “Simulate” menu (both in Civil 3D and in CivilCAD). The user has the option to select which elements (i.e. roads and topography surfaces) he wishes to include within the simulation.

A 3D model of the scene is then built based on the engineering design, and the Civil Simulate 3D environment is opened showing the 3D model. The whole process takes several seconds (depending on the project size), and requires no previous knowledge in visualization software.

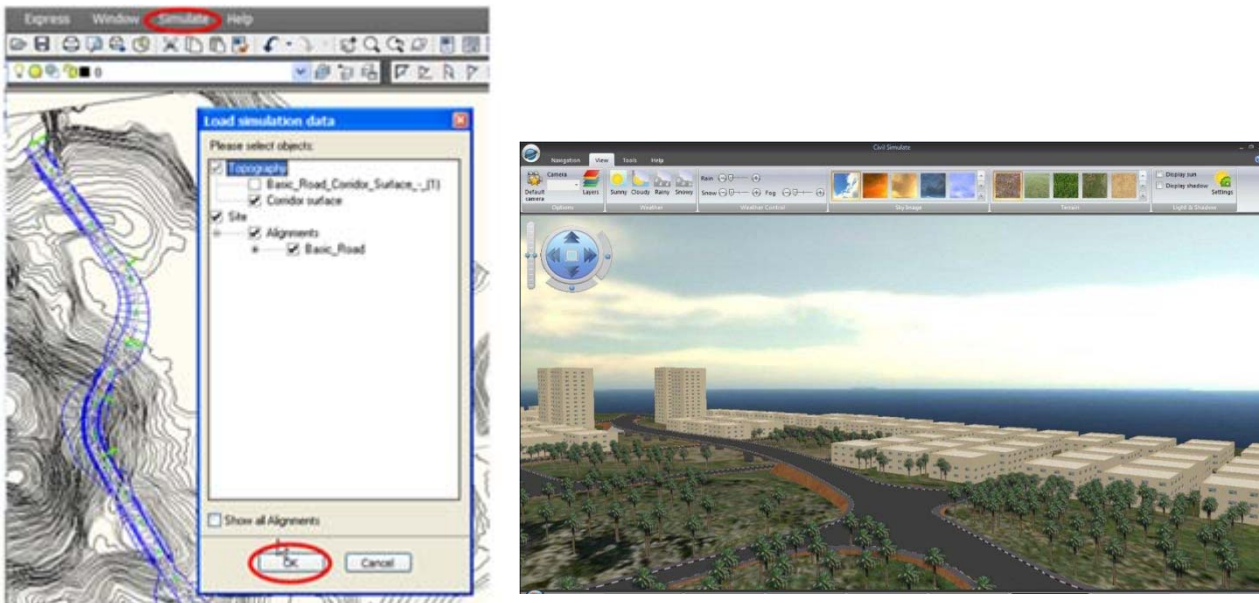
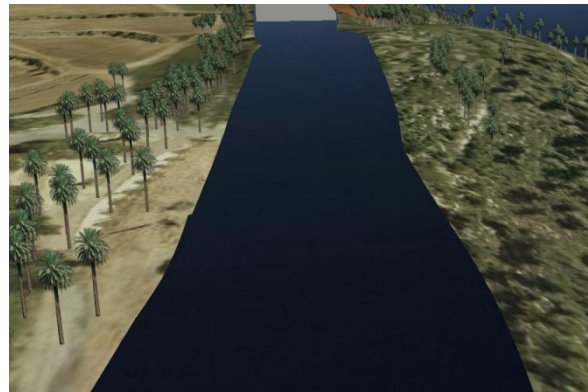


Figure 1: (a) 'Simulation' of a designed project (b) 3D model of the project in Civil Simulate

## 3.1.1 Recalculation of surfaces for better simulation viewing

One of the challenges that 3D simulation software has to deal with is surfaces overlap, which causes visibility order conflicts. A common example in Civil Engineering design involves the surfaces of the roadway, which are designed to be partially above and partially below the ground level. Such a design can cause a lot of rendering problems, since the visibility order of the surfaces is not well defined.

Civil Simulate overcomes this problem by automatically cutting “holes” in the topography whenever other surfaces (roadway, plot, etc.) overlap it, thereby bypassing the visibility order dilemma, and achieving smoothly *integrated surfaces in the simulation*. See figure 2.



**Picture 2: (a)** The problem:  
Topography and Design surfaces overlap each other

**(b)** Solution strategy:  
Cutting “holes” in the topography and merging the design surfaces

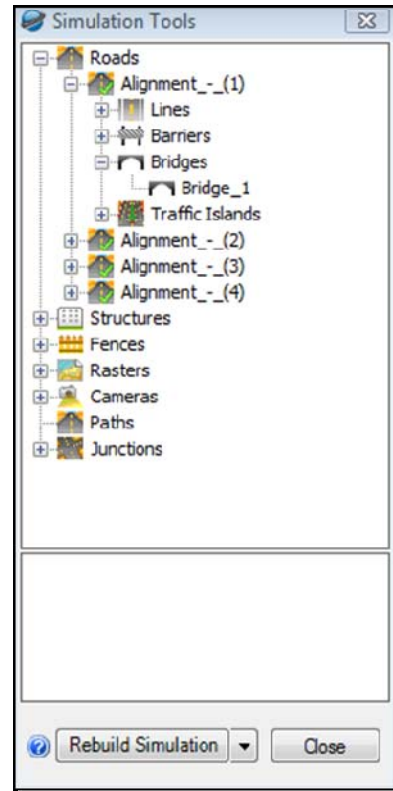


**(b)** The result:  
Smooth integration between the surfaces

Civil Simulate

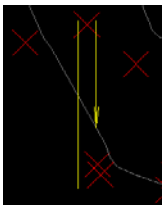
### 3.1.2 Defining advanced simulation features

In addition to the basic and rapid simulation creation, the user can easily define additional 3D elements and features, in order to create more comprehensive simulation. All definitions are made within the design environment of the project (Civil 3D / CivilCAD).

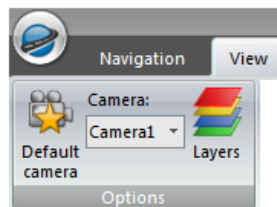


### 3.1.3 Simulation Cameras

Cameras which define a simulation viewpoint can be added by drawing the corresponding line of sight in the CAD design environment. Once created Civil Simulate allows you to switch between multiple positioned cameras in the 3D environment.



a. Defining camera in the design drawing



b. Selecting camera in the simulation

Civil Simulate

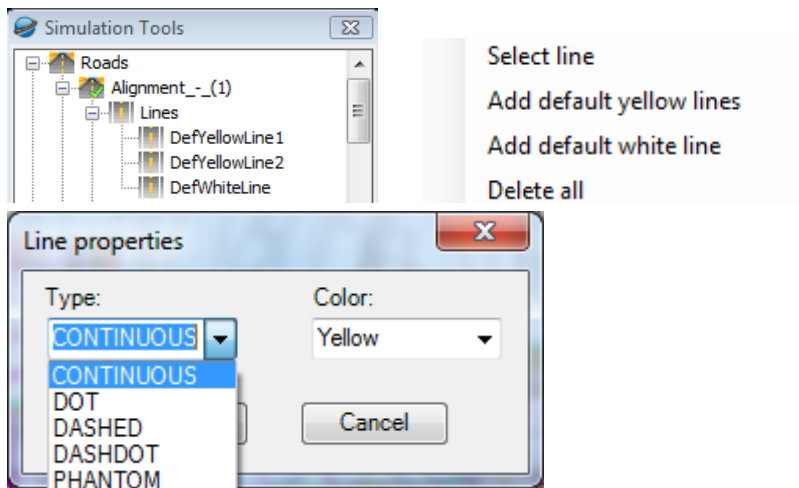
## 3.1.4 Simulation Paths

Civil Simulate creates paths within the 3D environment based on paths specified by the user in the designed drawing. These paths can either be drawn as 2D polylines – where their height is automatically calculated based on the terrain, or as 3D polylines – where their height is specified by the user.

These paths are used for the Drive Simulation (see chapter 4). This is in addition to the Drive Simulation along Roadways option – which is available without any preparations.

## 3.1.5 Road's Color Lines

Civil Simulate allows the user to define color lines on the roads, by either defining or selecting a polyline in the drawing or just by selecting the “default lines” option. The color and the style of a given line can be specified.





### 3.1.6 Barriers

Simulation Tools enables you to define a specific barrier type for every designed road. A barrier's definition can be easily specified by selecting on a polyline that is designated as the barrier's center line in the drawing environment; coordinates and height of the barrier are calculated automatically. The barrier's style and face direction can be chosen from the three pre-installed styles within Civil Simulate.

### 3.1.7 Traffic Islands

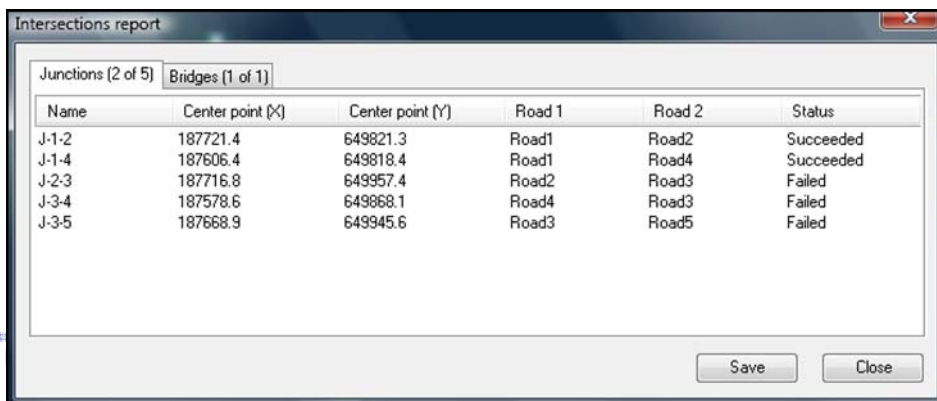
Simulation Tools enables you to define Traffic Islands for every road in your design simply by selecting a polyline in the drawing environment, coordinates and top platform levels are calculated automatically by Civil Simulate. The Traffic Island's top platform can be chosen from of three pre-installed materials and the height can be set according the design's specific needs.

### 3.1.8 Automatic and Manual Simulation of Intersections

Civil Simulate has an automatic tool for creating and simulating junctions or bridges (flyovers) associated with intersections between roadways. The tool automatically and rapidly executes the following steps:

- 1) Locates intersections between all roads in the project.
- 2) Analyzes each intersection and decides whether it should be simulated as a junction or as a "fly over" bridge (according to default parameters specified by the user).
- 3) For each created junction and/or bridge, Civil Simulate simultaneously builds a corresponding 3D visualization.

For a more accurate simulation of a given intersection, there is also an option in Civil Simulate to manually define junction and/or bridge set-up parameters. Defining a junction is done by selecting the junction's alignments, and defining a bridge is done by drawing two polylines perpendicular to the alignment, which determine the bridge start and end positions on a road. All additional information (i.e. profiles, heights, etc.) will be taken directly from the road's design.

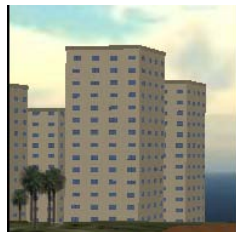
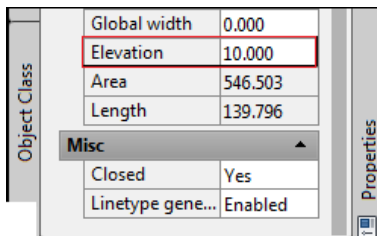


Name	Center point (X)	Center point (Y)	Road 1	Road 2	Status
J-1-2	187721.4	649821.3	Road1	Road2	Succeeded
J-1-4	187606.4	649818.4	Road1	Road4	Succeeded
J-2-3	187716.8	649957.4	Road2	Road3	Failed
J-3-4	187578.6	649868.1	Road4	Road3	Failed
J-3-5	187668.9	649945.6	Road3	Road5	Failed



### 3.1.9 Structures

Structures can be easily added to the scene in Civil Simulate by selecting any 2D or 3D polyline in the drawing located at the desired position of the structures. Civil Simulate automatically generates a 3D building structure, with a height that corresponds to the specified elevation of the selected polyline.



### 3.1.10 Fences

3D Fences can easily be generated in Civil Simulate via a 2D polyline selection in your drawing. Corresponding Fence coordinates and height are calculated automatically based on the location and elevation of the polyline. Civil simulate allows you to choose a specific Fence Style from a predefined set of materials.

## 3.1.11 Raster

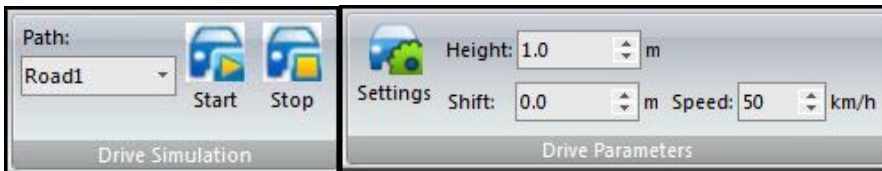
Civil Simulate allows the user to drape a raster image on the surface of their 3D model following a simple and intuitive workflow. Using the images Geographic Coordinates, Civil Simulate calculates the exact match between the Aerial Photo being draped and the existing Topography Surface. Large image files can be introduced without losing navigation speed or model quality.

## 4. Simulation and Visualization Tools

### 4.1 3D capabilities

#### 4.1.1 Drive-through simulations

Civil Simulate allows you to experience your road design by driving through a 3D depiction of it. For a given project, the Drive Simulation path is automatically calculated from designed road in the CAD model. In addition, Civil Simulate enables the user to define their own free path – diverting from a main road – simply by selecting a polyline drawn at the location of interest. The Drive Simulation feature has several parameters available for user definitions, including: height, speed, offset from Alignment's centerline, and much more. One of Drive Simulation's major sub-features is Object visibility, which simulates a vehicle in front or on the opposite lane traveling in front of the driver at a predefined speed and located at a predefined distance.

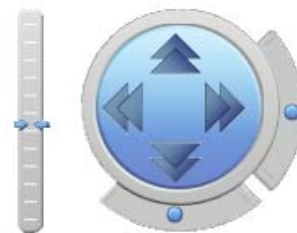


#### Manual navigation

Civil Simulate allows you to manually navigate around your 3D visualization model in 2 ways:

1. Simulate controller

With the Simulate controller you can wander intuitively around your model, it's controls created especially for comfortable and easy navigating.



Civil Simulate

## 2. Keyboard and Mouse

Manual navigate with the keyboard and/or mouse is designed to be like the most advanced 3d games which demand full and precise control on movement or navigation.

Button	Operation
Left Button	Click and hold down the button to rotate left/right or up/down
Right Button	Click and hold down the button to move up/down
Middle Button	Click and hold down the button to move forward/backward

Key	Operation
Shift	Move Down
Ctrl	Move Up
S	Move Backward
W	Move Forward
A	Rotate Left
D	Rotate Right
↑	Move Forward
↓	Move Backward
→	Rotate Right
←	Rotate Left

### Automatic Navigation

Civil Simulate allows you to Navigate hands free around your model using an Automated Dynamic Path. In addition to using this feature for conducting a viewing Flyover of your 3D environment for presentation purposes, it also enables the user to conduct checks on a project from various overhead aspects.

#### 4.1.2 Distance measurements

Civil Simulate allows you to Perform and execute accurate measurements in 3D between any 2 points in your model. The measure function returns detailed information and exact coordinates of the points that were chosen.

Civil Simulate

**Measure & Visibility**

Point1: X:  Y:  Z:

Point2: X:  Y:  Z:

Point special height

Point1:  m Point2:  m

**Results**

2D distance (m):

3D distance (m):

Height difference (m):

Slope (%):

Visibility:

Set view from:  to



### 4.1.3 Visibility and safety checks

When solely relying on 2D cad drawings, performing a Line-of-Sight Visibility Check can be a complex task. Civil Simulate makes this design process easier by letting the user identify visibility problems in a real 3D world. Visibility problems are observed directly from a specified driver's view with respect to every target object on the designed road. Civil simulate will inform the user whether the road is safe enough to drive based on their visibility definitions. Upon carrying out a Visibility check, Civil Simulate provides exact coordinates of the points of interest, where if necessary the user can go back and change road's design accordingly within the 2d cad environment.

**Results**

2D distance (m):

3D distance (m):

Height difference (m):

Slope (%):

Visibility:

Set view from:  to

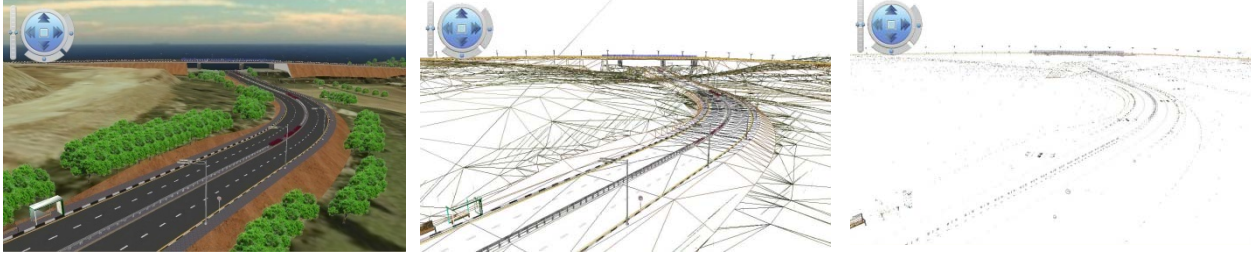


### 4.1.4 View styles - polygon mode

Civil simulate presents scenes with texture and lighting as its default style mode. However, in some cases users may prefer to see the 3D model in wire frame, or as a cloud of points. Civil Simulate

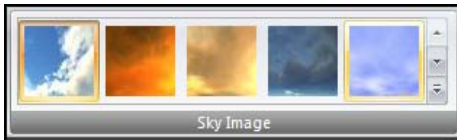
Civil Simulate

supports all three of these modes: solid , wireframe , points , in order to enable maximum presentation flexibility according to the designed visibility conditions or the user's aesthetic needs.



#### 4.1.5 Background - Sky image

Civil simulate has a variety of preset background images in different visual styles. Choose a specific background sky image to enhance scene realism.



#### 4.1.6 Texturing - Terrain texture

Use a terrain texture to add a realistic look to a 3D surface. Civil Simulate's terrain texture mechanism allows the user to select from a number of pre-installed texture images.

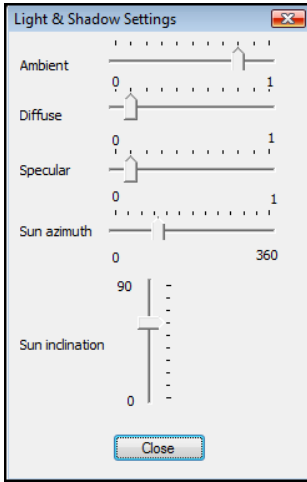


#### 4.1.7 Weather effects

Civil Simulate's uses Weather Conditions engine incorporates four different types of animated weather states: sunny, snowing, cloudy, and raining. The user can choose the right geographic weather characteristic to enhance scene realism.

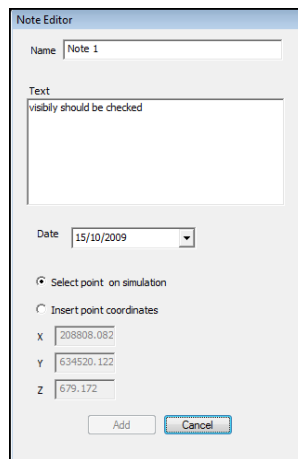
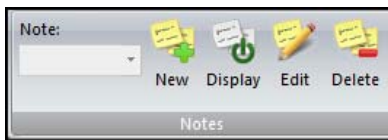
#### 4.1.8 Lighting effects

Civil Simulate's Lighting Engine allows the user to set a vast range of lighting conditions that occur throughout a given day. Season and hour are represented by sun azimuth and inclination, respectively. Sun lighting also draws shadows which contribute to scene realism.



## 4.1.9 Notes

Civil Simulate's Notes feature allows users to highlight critical points tied to observations made upon navigating through a given project's 3D environment. Notes are physically represented in the 3D environment with a cone flag, accurately placed at the position of interest. The program also allows for including a related text description with a given note



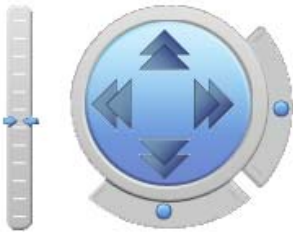
## 4.1.10 Scene objects

Civil Simulate has the ability to present accurate real world 3D objects like trees, traffic signs, street lamps and much more. These objects are defined in the CAD environment with a specific code located at a specific coordinate point, which is recognized by Civil Simulate for incorporation into the 3D environment. A given Civil Simulate project is able to incorporate large quantities of 3D objects with no loss in ease of navigation or navigation speed.



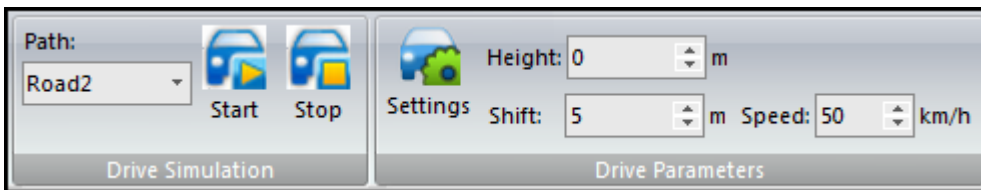
## 4.1.11 Navigation

Civil simulate has a variety of comfortable and intuitive navigation tools. You can navigate using the "navigation tools", by clicking a button on screen or, navigate using the keyboard arrows together with mouse for more fluent movement.



## 4.2 Drive simulation

Drive simulation is an advanced animation module, capable of performing realistic drive simulations through your designed roads. By default, drive Simulation uses road center axis as a path but enables you to set a free path by polyline selection from your drawing environment. Speed, height and shift parameters can be set during simulation. In drive simulation settings submenu you can find additional features enable visibility check through driving called "visual object" it represents a vehicle in front or on the opposite lane, set by size, distance and height.



Civil Simulate





### 4.3 Creating a simulation viewing file

Civil Simulate allows users to share a created 3D simulation using the CVU file sharing format. Saving files in CVU format enables other applicable parties to open, view, navigate, and edit a created 3D Simulation. To access a previously saved 3D Simulation file all that is required is to download and install Civil Simulate **Free Viewer** from Sivan Design's website.

Civil Simulate