Scorched Earth Ground Movement Model

Table of Contents

Introduction

The Scorched Earth Online War system (SEOW) allows commanders to issue movement orders for all ground and sea units. This is an absolutely critical part of military operations – getting your forces to where they are most needed, when they are most needed. In many respects, military success is granted to those commanders who can maintain a mobile force, despite terrain, weather and the enemy.

Early versions of SEOW permitted unrestricted ground/sea movement, so unscrupulous commanders could direct tanks to traverse rivers, forests and mountains. This was a feature of convenience rather than design. Now, for land units, SEOW incorporates a route processing feature that can, optionally, force ground units to follow roads. The side effect of this is that bridges now come into play, since if a unit is forced to follow a road, it MUST traverse a bridge to cross a river. At last, SEOW steps up the pressure on ground commanders to protect their transportation lines!

The information in this document summarises design, data capture and coding work performed by RAF74_Taipan and IV/JG7_4Shades. Third party contributions are noted as appropriate. SEOW is a free add-on to the IL-2 series of simulations developed by 1C: Maddox and published by Ubi.

Ground Movement Basics: Oleg's FMB

Ground Movement in FMB

Most mission builders know that the FMB contains automatic, instant logic to determine the "best" route for a ground unit between two consecutive waypoints entered by the human mission builder. FMB does this by having in its memory the locations and directions of all roads, bridges, rivers and coasts. So, when you click out movements in FMB, it automatically fills in the routes for you, and does a pretty good job. But, and this is a big but, FMB is not perfect and it does make lots of mistakes.

Consider a mission builder trying to move a jeep from near Gouvy on the Ardennes map to near Vielsalm, without going east over the river. The following picture (Figure 1) shows how FMB fills in routes connecting 3 waypoints. You can see that the FMB-generated route between the first and second waypoint crosses a large stretch of forest. It should probably have continued west to an intersection and then come back north-east. Instead it jumped through 1 km of forest, which jeeps normally can't handle. If you look hard enough, you'll find similar (and multiple) errors on almost every map in FB+PF. Now, I don't know this for sure, but I am guessing that this is a symptom of the difficulty in getting maps built correctly for FB+PF. Oleg's FMB code might be very good, but if its highway route listing is not perfect, the results in certain parts might be as shown below.

Figure 1: FMB generated route error in the Ardennes.

FMB Route Format

The general format for a FMB route is a list of X,Y,Z coordinates, as follows (this is not the same route as in Figure 1):

```
[1_Chief_Road]
  136370.16 145677.67 120.00 0 18 3.055555582046509
  136500.00 145700.00 20.00
  136900.00 146100.00 20.00
  138700.00 146100.00 20.00
  138900.00 146100.00 -142.00
  139100.00 146100.00 -142.00
```

```
139300.00 146100.00 20.00
139700.00 146100.00 20.00
139900.00 146100.00 -143.00
140100.00 146100.00 -143.00
140300.00 146100.00 20.00
140900.00 146100.00 20.00
142500.00 147700.00 20.00
143300.00 147700.00 20.00
146500.00 150900.00 20.00
147300.00 150900.00 20.00
148100.00 151700.00 20.00
148520.42 151698.48 120.00
```

The first line designates the moving unit “0_Chief”, the second line places the unit at its starting location, then subsequent lines provide where the unit moves to next. All ground units move at constant, hard-coded speeds (given in this example by the number 3.055555582046509, measured in metres per second). The X,Y values are in metres on the map grid (FMB map cords). The Z values are mostly either “20.00” or “120.00”, although occasionally some negative numbers creep in. All these numbers have meanings:

Z Value	Meaning
20.00	Machine-generated highway node
120.00	Human-entered waypoint
Negative number	Bridge node for Bridge –Z-1

Table 1: Understanding Z Values

Every human entered waypoint has 3 additional fields: delay time, number of successive waypoints, and the speed. In the example above, the delay time is zero, the number of successive waypoints to the next human waypoint is 18 (inclusive), and the speed is as discussed above. SEOW contains exact FMB speeds for all ground units in the Object_Specifications table of the database. Note that the last waypoint in the generated route does not have the additional three fields. If you have understood the above, you will see that the above example route crosses bridges 141 and 142 along the way.

Building Ground Movement in SEOW

The whole point of SEOW is to present commanders with reconnaissance-filtered situation maps. That rules out using FMB to generate movement routes. So we need to build a system that emulates FMB’s route code and embed it inside SEOW.

Desirable Functionality

If we want to emulate road movements inside SEOW, we have to have some kind of functionality for understanding what to do in various contingencies. What if there are no

roads on the map, e.g. Guadalcanal? What if the roads are sparse, e.g. Stalingrad? What if we want to absolutely forbid off-road movement, e.g. New Guinea? You can see that there are different modes of ground movement that are potentially useful for different campaign scenarios. SEOW will need to cater for all of these.

It would also be nice to be able to define your own routes, and have SEOW use them in the same way as it uses standard road routes.

Highway Capture

The first step is to capture ALL road nodes (Z=20.00) and bridge nodes (Z<0) defined on each map. RAF74_Taipan pioneered this, and with many other people (III/JG11_Tige, VFsMA_Paddington, 352nd_Oscar, Gauthier etc) we have now extracted over 70,000 highway nodes and over 4,000 bridges from 21 maps into SEOW. Furthermore, the nodes have been ordered into highway routes, just like in daily life. So Highway Route 23 in the Crimea consists of 8 nodes ordered consecutively from one end of the road to the other. Some routes terminate in villages or on the edge of the map, others stretch between two junctions with other routes. The highways are then processed by SEOW to extract from them the list of intersections for each map. There are about 12,000 of them!

Whenever a new map is added to SEOW, this effort of road and bridge capture must be performed. This is why adding Pacific maps is so popular – they normally have very few roads! RAF74_Taipan and VFsMA_Paddington are champion road mappers: Taipan because he did the first 8 maps all on his own, and Paddington because he did one very large map, the Gulf of Finland with 14142 highway nodes.

Ground Movement Model in SEOW

It is the Host's Choice

As from SEDB2.0beta(K), the so-called *Complex Ground Movement* (CGM) model is available in SEOW. This is an automated route generator embedded inside the DCS – it is entirely transparent to ground commanders! The campaign host can set up the CGM model and vary it from mission to mission without impacting the commanders or upsetting any planned missions. At mission Build time, the DCS will process any scheduled ground missions according to the current CGM mode setting. All "In progress" ground missions will continue as defined by previous Build sessions (they will not be reprocessed if the CGM mode has since changed).

Available Modes

CGM provides a choice of four different modes of road route generation; these are flexible enough to support many style of campaign scenarios.

Simple Mode

Simple Mode is the familiar SEOW direct movement mode. Ground units will completely ignore bridges and highways and seek to travel in straight lines between commander waypoints. If you select Simple CGM Mode, then you are effectively turning off the new GM feature. You would use this Mode for maps like Tunis, Guadalcanal, Iwo Jima, etc, where there are no roads anyway.

Here's an example, set near Houffalize in the Ardennes map (Figure 2). Defined roads are rendered as solid yellow lines. The Allied commander has selected a BT-7 platoon and issued 2 commander waypoints, intending the tank to move from the north-east to the south-west of the picture, crossing the river between the first and second waypoints. In CGM Simple Mode, the tank platoon will follow the red lines directly from waypoint to waypoint, ignoring rivers, forests, roads and bridges. Not very realistic, but it is Simple Mode, right?

Figure 2: Ground Movement in CGM Simple Mode

Relaxed Mode

Relaxed Mode allows you to combine road and off-road movement. All commander waypoints are visited in turn by the generated route, but roads are used wherever possible. Basically the unit travels along roads to get as close to the commander waypoint as possible, then goes off-road straight to the waypoint. Once it is there, if there is a next waypoint to visit, it returns to the road and follows roads to get close to the next waypoint. Then it goes off-road to make the visit, etc. One special feature that exists only for Relaxed CGM Mode is the "proximity feature". If successive commander waypoints are closer together than the distance to the nearest road, then the unit will shortcut straight to the next commander waypoint. This is useful if the commander intends to force his units off-road, say to a hill. It is more work for the commanders, but he can drive his units overland.

Here is an example, taken from Figure 2.

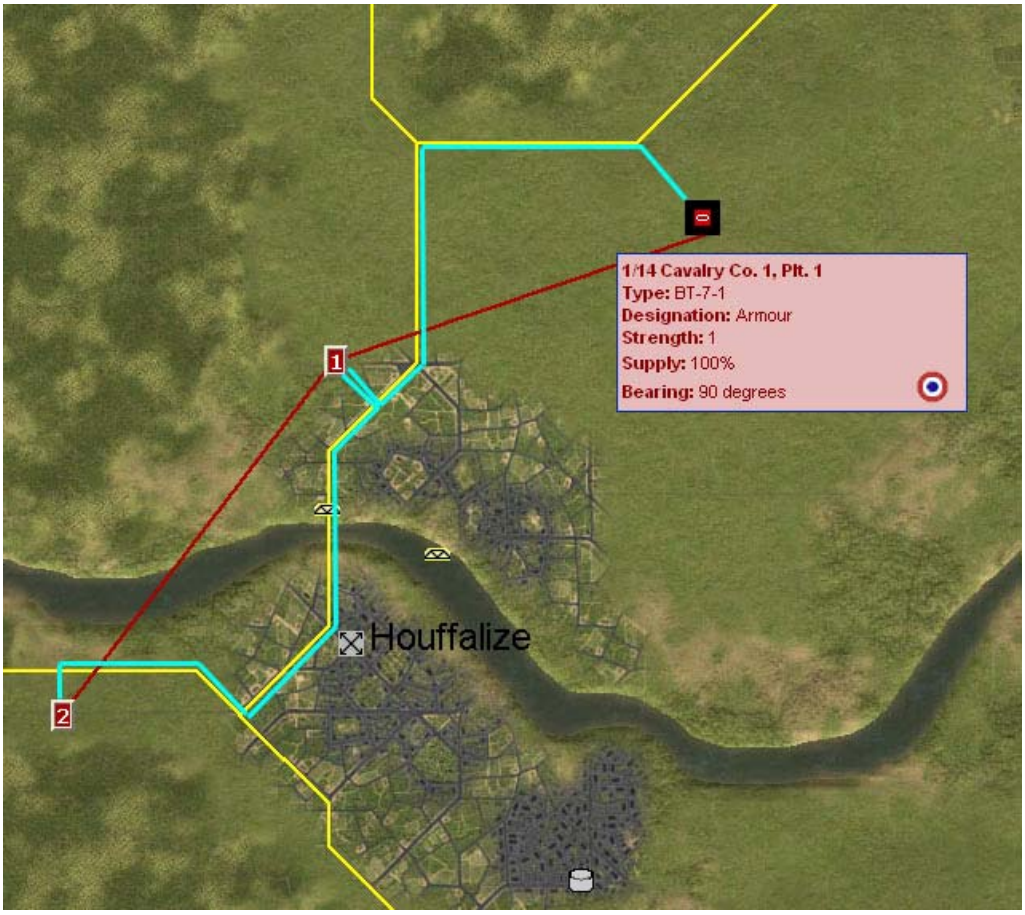

Figure 3: Ground Movement in CGM Relaxed Mode

In CGM Relaxed Mode, SEOW takes the two commander waypoints entered in the MP and automatically generates a road route between them (shown in light blue in the picture). The majority of the movement takes place on the roads, but each waypoint is

visited by the tank platoon with short off-road excursions. Note that the commander will NOT see the blue lines – these will be generated by SEDCS at mission Build time. Essentially, the commander tells the platoon to visit waypoints 1 and 2; the platoon "makes its own mind up" on how to get there. If the bridge was damaged, the platoon wouldn't even make it to waypoint 2. Instead it would stop on the north side of the road short of the bridge and await further orders. This is very realistic, especially if you consider that units will briefly go off-road if ordered too, but they will prefer to stay on-road at all other times.

Normal Mode

Normal Mode resembles Relaxed Mode, but with two differences. The first difference is that only the last commander waypoint is visited by an off-road departure. For all prior waypoints the unit goes to the nearest point on the road, then heads off along the road towards the next commander waypoint without bothering about the off-road excursion. In this way most waypoints are seen simply as indicators of the road route to use – they are not explicitly visited. The other difference is that the proximity feature does not apply in Normal CGM Mode.

Here is the example.

Figure 4: Ground Movement in CGM Normal Mode

In CGM Normal Mode, only the last commander waypoint is visited off-road (see magenta lines in Figure 4). Even though waypoint 1 is not visited, it is still useful because it coerces the platoon to pass on a nearby road. In Normal Mode, commander waypoints are used to fix the overall route. If the commander had only specified a single waypoint at the location of waypoint 2 in Figure 4, the platoon should still eventually arrive there. However, in some circumstances there can be many choices of route, so specifying extra waypoints along the way can often help the platoon "find" its way through. Again, if the bridge was damaged, the platoon would stop on the road on the north bank of the river. Normal Mode is a blend of strict and relaxed modes. In Normal Mode, the off-road component only happens as the unit reaches its destination, simulating a "digging in" process.

Strict Mode

Strict Mode uses defined roads 100% of the time, regardless of where the commander waypoints are located. No off-road movement will be generated. Routes will be generated to get as close to the commander waypoints as possible without leaving the roads. This is perfect for heavily forested maps like New Guinea, Singapore and L'vov.

Here is the Strict Mode example.

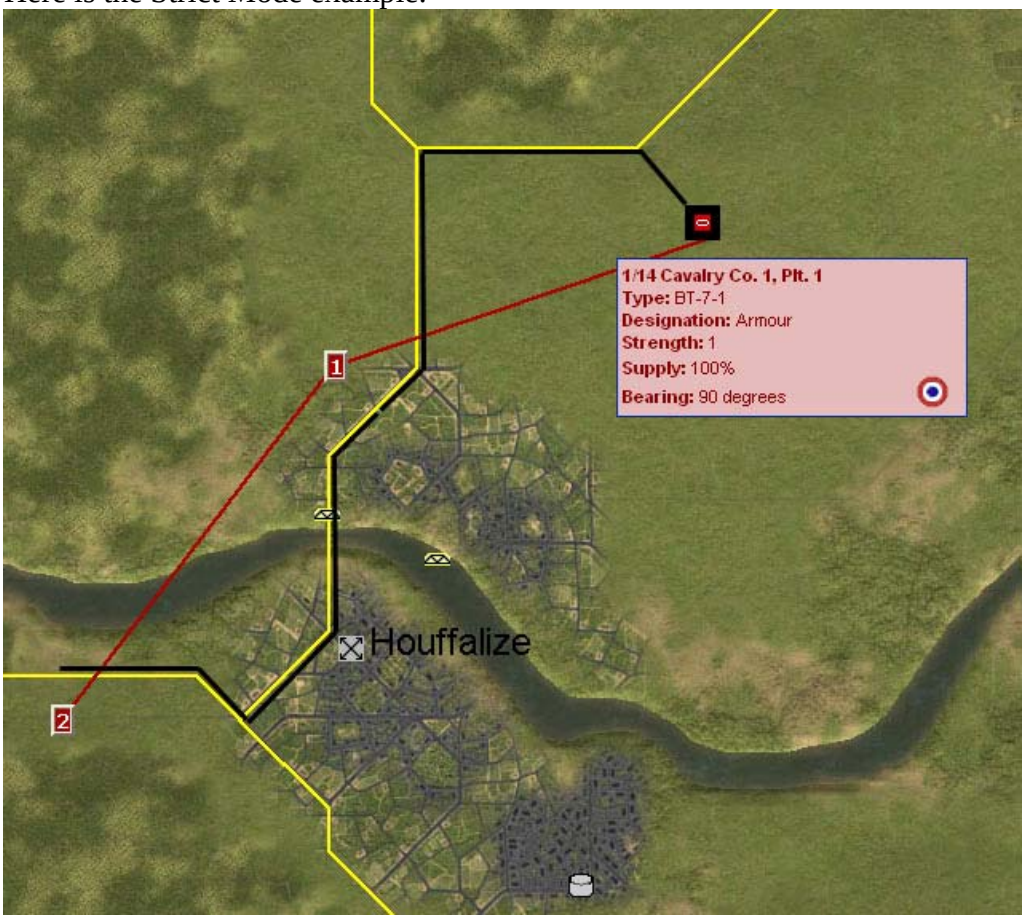

Figure 5: Ground Movement in CGM Strict Mode.

In Strict Mode, no off-road movement is allowed at all, except where a unit starts off-road. Thereafter the unit will stay on defined roads at all times, regardless of whether the commander waypoints lie on roads or not (see black lines above). This seems unduly restrictive, but in some sectors the off-road conditions were so poor that on-road movement was the only practical option. SEOW allows the host to choose this restriction, if desired. Of course, bridge damage is still recognized in Strict Mode.

Strengths and Limitations

Strength – Bridge Damage

Because SEOW keeps track of all bridges and their damage states, CGM Modes (apart from Simple Mode) will automatically terminate routes if a damaged bridge is encountered. CGM will NOT attempt to find a way around a damaged bridge – that is the commander's job. Thus, SEOW now has the automatic capacity to limit ground movement according to bridge infrastructure damage!

Strength – Route Additions

Template designers and hosts can now add/delete highway routes from the Highways table mid-campaign. This can simulate a variety of phenomena from road closures to the actions of Seabees (Construction Battalions), making your campaigns more fun than ever!

Strength – Better Routes than FMB

In our experience, SEOW ground movement routes are usually better and more realistic than those produced by FMB from the same set of waypoints. And, in the rare cases where problems are found, adjustment of the highway nodes in the database can always fix the problem. SEOW therefore provides a quality algorithm that is 100% flexible and adjustable by the host/administrator.

Limitation - Route Lengths

One problem with CGM is that it generates many more waypoints than the commander enters, since it follows every dogleg in each road traversed. If many units and task forces are moving, the resulting mission files could be huge. The CGM Model uses a truncation feature. The Complex_Ground_Movement_MaxWP field in the Campaign_Settings table of the SEOW database (SEDB29 or later) provides the maximum waypoint number in a generated route; by default it is set to 50. This might be too high in some circumstances.

Limitation - Crazy Routes

CGM uses a "steepest descent" algorithm to select routes between waypoints. Sometimes this can produce bad routes, especially where many intersections must be traversed between waypoints. Units can easily get lost or take "long cuts" instead of "short cuts"! Commanders need to help their units find the correct routes! One way to help your unit is to give it a waypoint on the desired exit road at each intersection.