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1 Introduction

Steel Beasts is a highly accurate simulator of the US M1A1 and German Leopard 2A4 tanks, designed to let you create and play scenarios of modern armored warfare. Scenarios can be played in either single-player mode against the computer, or in multiplayer-mode against (and with) other players over a network.

Scenarios (or missions) are created on a contour map using context-sensitive menus and click and drag techniques. Once created, a scenario can be played from the tank commander's or gunner's position (or from an external view) looking out into the virtual 3D battlefield, in combination with a 2D overhead map.

Of course, you don't have to create your own missions to enjoy Steel Beasts, since we've included an initial set of missions with the simulator. Our hope is that many players will create and share their missions with others, increasing the enjoyment for everyone.

Individual scenarios can vary widely in complexity, from simple missions, in which the player is just the gunner in a single tank, to large missions, in which the player is responsible for a company or more of tanks, IFVs and infantry. It all depends on what the mission designer has created.

Steel Beasts features the M1A1 and the Leopard 2A4, the two workhorses in the US and German armies. Although these tanks have a lot of similarities, there are some important differences that make them quite distinct. We've tried hard to model these two tanks as accurately as possible, implementing many details that are important to the operation of the tanks during battle. Because this level of detail means there is a lot for you to learn, we have included an extensive set of tutorials for both tanks. These tutorials introduce new concepts and game controls in a step-by-step manner, and we strongly recommend that you play all of the tutorials in their correct order for at least one of the tanks before playing or creating a mission.

To play a tutorial, first install Steel Beasts on your computer, as described in the next section. Once you're in Steel Beasts, select ***Tutorials*** from the main menu, and then open the tutorial of your choice. Tutorials that do *not* begin with *M1* or *Leo* are common to both the M1 and Leopard tutorial folders, whereas tutorials that *do* begin with *M1* or *Leo* discuss aspects that are unique to either the M1A1 or the Leopard 2A4. For example, *Driving A* is found in both the M1 Tutorial folder and the Leopard tutorial folder, and so contains information that is not specific to a particular tank. You don't need to play both of these tutorials. On the other hand, *M1 Gunnery B* and *Leo Gunnery B* discuss topics that are specific to the M1 and Leopard, respectively.

2 Installation

For Steel Beasts to run properly, your computer system must meet the following minimum requirements:

- Windows 95 / 98 / ME / 2000 with DirectX 7.0 or better
- 266 MHz Pentium-class PC (450 MHz recommended)
- 32 MB RAM (64 MB recommended)
- 225 MB free hard disk space
- 2MB SVGA video card
- Mouse
- CD-ROM

To install the simulator, insert the Steel Beasts CD-ROM into the CD-ROM drive and close the drive. The installation program should start automatically. If, for some reason, the AutoPlay feature does not function, open the My Computer window, double-click on the listing for your CD-ROM (usually D), and then double-click on the file setup.exe. Simply follow the instructions in the installation program to install the demo.

To run the simulator, select the Steel Beasts from the Windows 95 Start menu (click on ***Start > Programs > Steel Beasts***). You do *not* need the CD inserted in the CD-ROM drive to start or play Steel Beasts.

To uninstall the simulator, click on ***Start > Settings > Control Panel*** and select ***Add/Remove Programs***. Then select Steel Beasts and click on ***Add/Remove***.

Important! For Steel Beasts to run properly, you must have Microsoft's DirectX7.0, or better, installed on your system. You can find the DirectX installation file at Microsoft's web site: http://www.microsoft.com.

If you are using a joystick, make sure that you have calibrated it through Windows 95, and it is assigned ID #1.

3 Overview

The Main Menu

The main menu consists of the following items:

Instant Action: Play as the gunner of a single tank in a defensive position facing an unending stream of enemy tanks and APCs. Your score is based on how many enemy vehicles you destroy, and how quickly you destroy them, before your tank is destroyed.

Tutorials: Here you'll find an extensive set of missions designed to introduce you, step by step, to Steel Beasts.

Tank Range: Measure your gunnery skills on the tank range and obtain your gunnery rating. Your gunnery rating is important because the quality of all friendly computer gunners is directly proportional to your gunnery rating. (You must have entered a name in the Records Menu for this feature to apply.)

Single Player: Browse through all available mission, and select one to play in single-player mode. You can also delete a mission by highlighting it and pressing the delete key.

Multiplayer: Host or join a multiplayer networked game. Any mission can be played in multiplayer mode, as long as it has at least one player-controlled vehicle.

Mission Editor: Start the mission editor, which allows you to create or modify a mission.

Map Editor: Start the map editor, which allows you to create or modify maps, which are used in the mission editor.

Records: Enter (or remove) a call name in the simulator's roster to keep track of your mission statistics and gunnery rating. You don't need to enter a name to play a mission, although your gunnery rating will be zero when playing without enlisting first. You can also view your mission statistics here.

Options: Modify some basic properties of the simulator.

Help: Displays the help screen.

Exit: Exits the simulator.

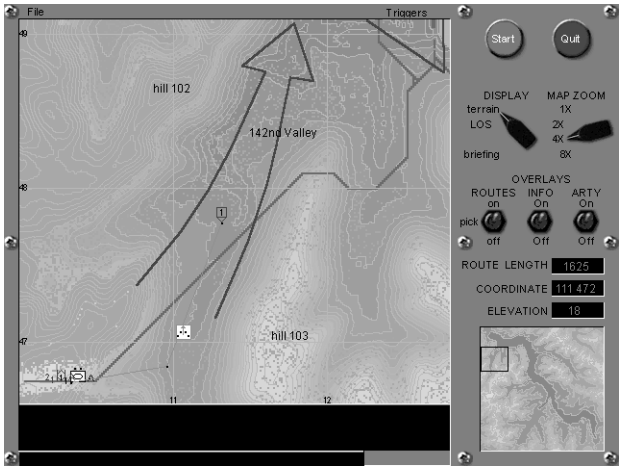
PLAYING A MISSION - OVERVIEW

Game play in Steel Beasts is centered around the individual mission, or scenario, which can be logically divided into three distinct phases: 1) The planning phase, in which a military-style text briefing and interactive contour map are presented to you for planning the mission. 2) The execution phase, in which the simulation runs in real time, and you can assume the role of gunner, tank commander or observer in one of the tanks you control. 3) The debriefing phase, in which you can review the battle, and view your score and some basic statistics of the battle.

To play a mission in single-player mode, select *Single Player* from the Main Menu Screen, and then open the mission you wish to play in the Single Player Screen.

THE PLANNING PHASE

After opening a mission to play, the planning phase of the simulation begins. Read the briefing that is presented to you and create an initial battle plan (if desired) using the interactive map to create checkpoints to mark tactically important locations, and to issue initial routes and response-tactics to units that are under your control. Simple missions won't require much, if any, planning, but other missions will be difficult to successfully complete without a good plan. The amount of planning needed also depends on how you want to play during the execution phase. If you want to play as the gunner in the heat of action, then your plans should be more detailed so you can concentrate on the action during the battle. On the other hand, if you prefer to spend most of the time observing and directing your units, a detailed initial plan is not as important. You can also save your plan and later reload it if you play the same mission again by clicking on the *File* Menu in the upper left-hand corner.



The Terrain View in the planning phase.

While in the planning phase, you have access to the line-of-sight (LOS) map, which is probably the most useful tool for planning a mission. By clicking on a particular point in the LOS map, the display changes to show portions of the map from which enemies can see most of you (pink), just the top of you (white), or none of you at all (brown), if your tank were to be located at the clicked point. This tool makes it easy to find tactically important ground for you and the enemy, thus enabling you to make educated decisions when creating a battle plan. The LOS map is NOT available in the execution phase.

While the LOS map is active, pressing F1 will transport you to the virtual 3D world to view the landscape from the LOS start coordinate. Although there are no restrictions on what regions you can view, no enemy or friendly units will be displayed in this mode, so you can't use this feature to spy on the enemy.

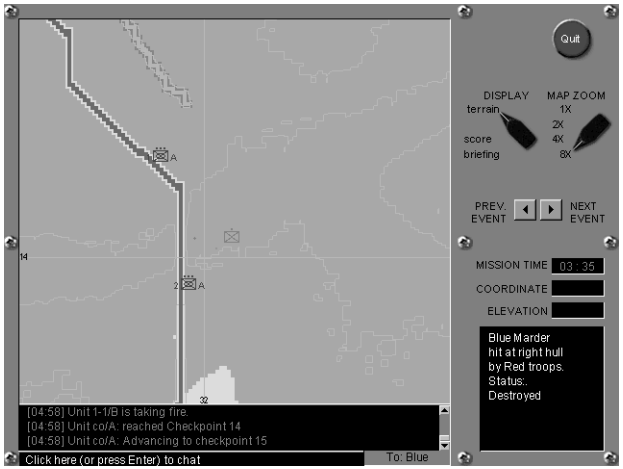
THE EXECUTION PHASE

Once you're satisfied with your initial plan, press the green start button at the upper right hand corner of the screen to begin the execution phase of the game. During the execution phase you can play as gunner, tank commander or observer in any player-controlled (as opposed to computer-controlled) tank. All other crew positions in all other units are manned by the computer. Although you cannot occupy the driver's position, you can drive the tank by manually steering using hot keys, or menus. You can also have the computer driver follow assigned routes, or find hull-down positions on demand.

While in the execution phase, you can check the positions of units, and issue orders to player-controlled units from the 2D map screen. Unlike most other simulators, the locations of units are not updated continuously in the map screen. Instead, a more realistic approach is taken. Friendly and enemy unit locations are updated *only* after a friendly unit has sent a report. If radio contact is lost, reports cannot be sent or received. Enemy units are displayed *only* if a friendly unit has detected the enemy, and has sent a report. **Since reports from units in other companies and battalions are delayed, the unit might not be displayed (or updated) until some time after the enemy has actually been detected.** If an enemy unit has not been seen for a few minutes, it will no longer be displayed on the map.

THE DEBRIEFING PHASE

Once the requirements for the mission are fulfilled, or all player-controlled units are destroyed, the execution phase ends, and the debriefing phase begins. In the debriefing phase, you can review the locations of friendly and enemy units at different times during the battle by pressing the NEXT EVENT and PREV. EVENT buttons. Although the true positions of all friendly units will be displayed, you will only be able to see the true position of the one enemy vehicle that was hit or caused a hit during that particular event. For all other enemy units, you will see their *reported* positions at the time of the event. Of course, enemy units that were not detected at the time of the event will not be displayed on the map.



Viewing events during the debriefing.

CREATING A MISSION - OVERVIEW

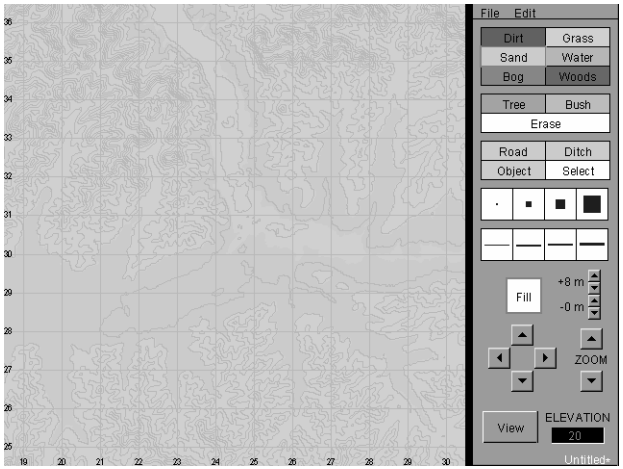
You can create or modify a mission using the integrated mission editor in Steel Beasts. Creating a mission is similar to creating a battle plan in the planning phase, with some added complexities. You can place units, checkpoints, mine fields, artillery fields, lines, regions and text anywhere on the map by right clicking on the map and selecting an item from the context-sensitive menu. By right clicking on any of these objects, you can adjust certain properties of the objects. For instance, you can decide to make a unit: player- or computer-controlled; damaged; destroyed; blind to the enemy; etc. By left clicking on an object, you can select it. By left clicking and dragging on a *selected* object or its control points, you can move the object or modify its shape or orientation.

From units and checkpoints, you can then create routes, again by right clicking on the unit or checkpoint. The properties of the routes, such as speed, formation, fire control, spacing and enemy-response tactics can be adjusted by right clicking on the route. In addition, conditions for embarking, retreating and changing fire control can be assigned to routes and checkpoints. This conditioned set of routes and checkpoints determines the high-level plan of both the enemy and computer-controlled friendly units.

In addition to creating the high-level battle plan, you can choose: which map to use; how the score of the mission is calculated; the maximum mission time; what crew positions the player can occupy, visibility conditions, etc…

CREATING A MAP

When you create a mission in Steel Beasts, the first thing you should do is select which map to use for the mission. If you don't like any of the existing maps, you can create your own map using the integrated map editor. If you've ever used a paint program, you'll find the map editor very easy to use. Simply select a terrain type and brush size, and start painting, or fill in a region using the fill function, or draw lines of varying thickness. You can also adjust the position of the map grid lines through the Edit menu. At any time, you can also view the 3D world you are creating by selecting the View button and clicking on a map location. Once you are done, you can save your map and it will then be available to use in any future mission.



The Map Editor

4 SOME BASIC CONCEPTS

UNITS

A unit is any homogeneous collection of tanks, armored personnel carriers (APCs), infantry, etc., that moves and acts in some type of formation. A unit may be computer controlled or player controlled, and may be friendly or enemy. Units can consist of a single vehicle or soldier, a section, or a platoon. Companies, and even battalions, can be created by adding multiple platoons to the map, but the simulator provides no way to combine these platoons into a single unit that moves in formation.

A unit can be split into two smaller units by right clicking on the unit's icon in the map screen and selecting *Divide Unit* from the context-sensitive menu. You can also split a unit in the execution phase by ordering a subset of the vehicles to *Advance to* or *Retreat to* a certain terrain point, as described later in the section on Unit Icons. In addition, if you occupy the non-lead vehicle of a unit and you manually steer the vehicle, it will detach itself from the unit and form a separate unit, which it leads.

Divided units can be rejoined by right clicking on a unit's icon in the map screen and selecting *Attach to* from the context-sensitive menu, and then left clicking on another unit. In addition, you can rejoin units within your platoon by using the context-sensitive menus of the unit icons, as described earlier. **The two units that are being rejoined must be within a few hundred meters of each other, and they must have originally been part of the same unit.**

CHECKPOINTS

A checkpoint is an object that marks a particular location in the virtual world. A checkpoint typically lies at the end of a route, but it can also be used to designate a tactically important location on the map. Checkpoints can be created in both the execution and planning phases, as well as in the mission editor.

ROUTES

A route is a sequence of points, ending with a checkpoint, in the virtual world that units travel along. All routes are one-way paths, although, in certain cases, units can retreat back along a route. Routes can originate from units or checkpoints, and multiple routes can originate from a single unit or checkpoint. Routes can be created in both the execution and planning phases, as well as in the mission editor.

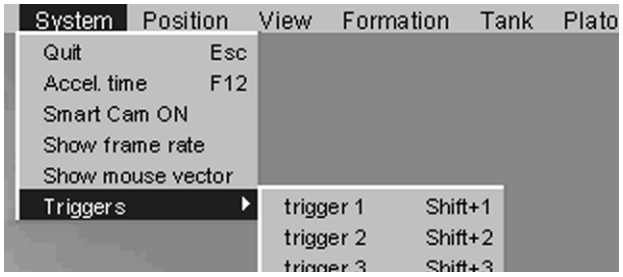
5 The Execution-Phase Interface

During the execution phase of the simulation, you can play as TC or gunner, or as an observer in the external position. Although each position of each tank has its own specific controls (covered later) every non-map screen shares some common user-interface features, which are now discussed.

The Menu Bar

The retractable menu bar at the top of the screen contains nearly all the commands you will use during the execution phase. Moving the mouse to the top of the screen will display the bar, which contains the following menus:

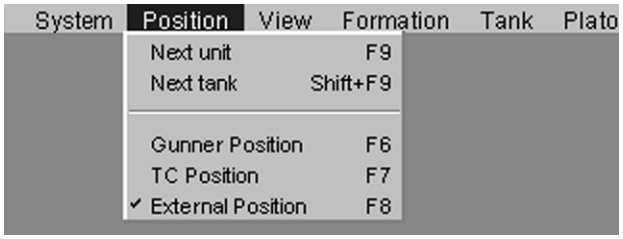
System: This menu allows you to: quit; turn time acceleration on or off; turn the smart cam on or off; show or hide the frame-rate; show or hide the mouse vector; and set or reset the triggers.



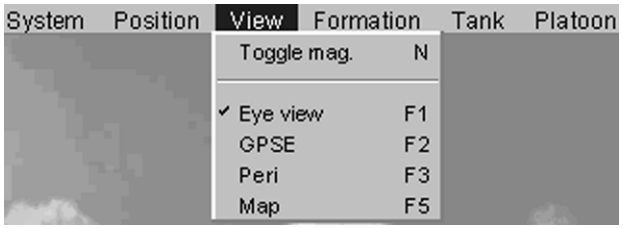
The mouse vector is simply a line drawn from the center of the screen to the current mouse coordinate when the mouse is used to control the viewing direction. It is intended as an aid to help visualize "mouse steering." The smart cam, available

only in the external view, automatically points the camera at the current target, or towards the current heading if there is no target. Triggers will be discussed later.

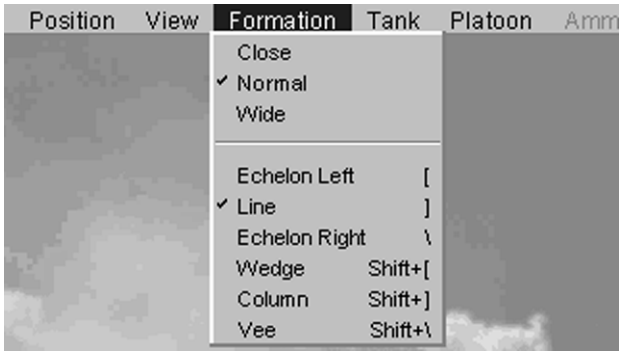
Position: Use this menu to switch between the TC, gunner and external positions, as well as to switch tanks or units.



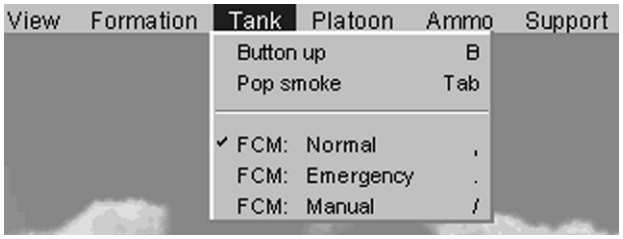
View: Allows you to switch to the views available for your current position.



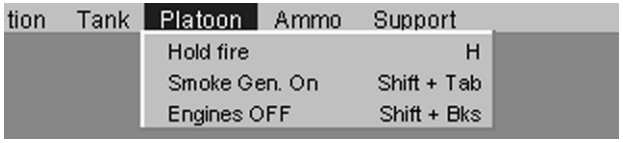
Formation: Allows you to change the formation type and spacing.



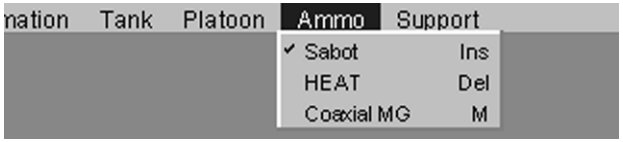
Tank: Contains any tank-specific commands that are available in your current position.



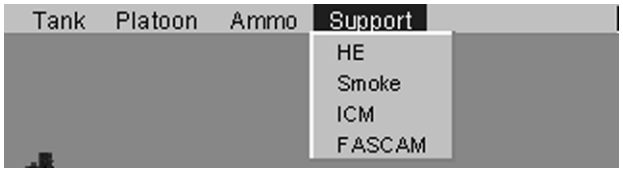
Platoon: Contains any platoon-specific commands that are available in your current position.



Ammo: Allows you to change the ammo type (if you're the TC) or the ammo-selection switch (if you're the gunner on the M1).

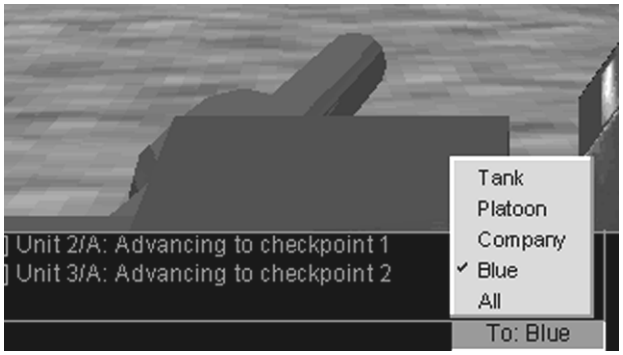


Support: Allows you to call for an artillery strike.



Message/Chat Windows

The lower left-hand corner of all screens in the execution phase contains a set of windows for displaying messages, as well as for entering and displaying chat messages in multiplayer mode. There is also a pop-up menu that allows you to control whom will receive your chat messages: only players within your tank, platoon, company, side, or everyone.



Unit Icons

Displayed just right of center at the bottom of the screen, are a set of unit icons, which show a graphical representation of your platoon. The individual vehicles that comprise each unit of your platoon are displayed below the unit icons. The vehicle you currently occupy is displayed as a filled-in icon. (Your platoon can consist of multiple units if you divide your platoon into sections or individual vehicles, or when a vehicle in your platoon is immobilized or destroyed.)

In addition to displaying the formation and spacing of the units in your platoon, you can also issue some basic commands to these units by left clicking on an icon and selecting an item from the context-sensitive menu. You can order a unit, or vehicles within a unit, to a certain location by selecting *Advance to* or *Retreat to* and then clicking on a point in the landscape. If you ordered only some of the vehicles within a unit to a certain point, these vehicles will automatically detach from their unit to form a new unit before moving to the point you selected. You can later rejoin the units by selecting *Attach to* from the menus.

TANK CLOCK

To the right of the unit icons is a tank clock, which shows the current orientation of the hull and turret of the tank you occupy, as well as your current viewing direction (shown as a green dot), if you are in the TC or external positions. Since the top of the tank clock always points north, you can use it as a compass to help navigate.

In multiplayer mode, the names of the TC and gunner of the tank you currently occupy are displayed on the top and bottom of the tank clock, respectively.

DRIVING BUTTONS

To the right of the tank clock are a set of buttons which can be used to manually drive the tank, and which also display the current speed level and turning status of your tank. There are also two additional buttons that can be used to order your unit into a hull-down position, or to resume the previous route (if you deviated from it by manually driving or going hull down).

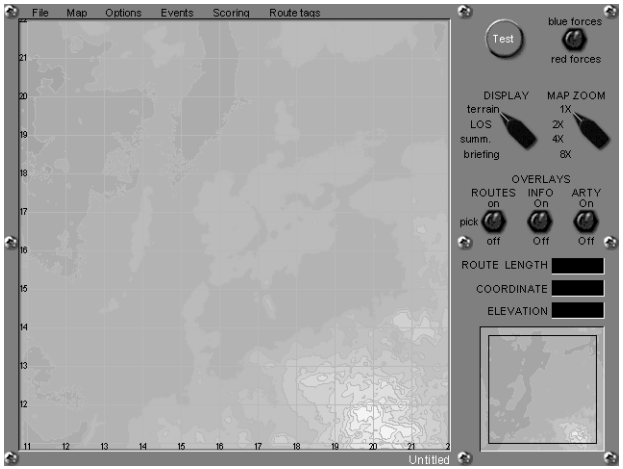
A FEW MORE CONTROLS

At any time during the execution phase, you can pause the simulation by pressing the **pause** key. To resume the simulation press the pause key again.

Another useful hot key with no equivalent menu item is F11, which transports you to the next engaged unit, if there is one. Pressing Shift F11 will capture a screen shot.

6 THE MAP SCREEN

You'll be using variations of the map screen in all phases of the simulation, as well as in the mission editor, so you should spend some time familiarizing yourself with it and its capabilities. **Most things in the map screen are accomplished through context-sensitive menus by right clicking on objects in the map or on the map itself.** This section will concentrate on the map screen as it appears in the planning, execution and debriefing phases, leaving the mission editor for later. (Note that the *Map Editor* has a different user interface, so don't get confused.)



The map screen (as it appears in the mission editor)

BASIC CONTROLS

The first control you should learn is the **Display Selector**, located near the upper left part of the control panel. The Display Selector determines what will be displayed in the display window of the map screen. You can choose between the terrain map, the line-of-sight (LOS) map, the briefing display, the summary display, and the score display, although not all of these choices are available in every phase of the game.

The **Map Zoom Selector,** located to the right of the Display Selector, sets the magnification of the terrain or LOS map to 1x, 2x, 4x or 8x.

The **Overlay Switches** (not available in the debriefing phase) control what information is displayed in the terrain or LOS maps. The map screen can be quite cluttered for some missions, so using these overlay switches wisely can help reduce that clutter, while still displaying the information you want.

The **Route Overlay Switch** controls which routes and checkpoints are displayed. Selecting *on* displays all the routes and checkpoint, while selecting *off* displays none of them. Selecting *pick* displays only those routes and checkpoints associated with units that have been picked. A single unit is picked by left clicking on it (or any route or checkpoint associated with that unit). Additional units can be added to the picked list by holding down the *shift* key while left clicking on the unit. Conversely, units can be removed from the pick list by holding down the *ctrl* key while left clicking on the unit.

The **Info Overlay Switch** controls whether informational lines, regions and text are displayed on the map

The **Arty Overlay Switch** controls whether artillery and mine field symbols are displayed.

The **Next Event** and **Previous Event** buttons (available only in the debriefing phase) control which logged event is displayed.

Two **information boxes** on the right side of the map screen display the *coordinate* and *elevation* of the cursor's current location within the terrain or LOS map. A third information box is used to display either the length of a selected route (in the planning phase), the current mission time or time remaining (in the execution phase) or the time of the logged event (in the debriefing phase).

A small **overview map** is also displayed in the lower right-hand corner of the map screen. The overview map contains a box that shows the region of the map that is being displayed in the display window to the left. Left clicking in this box and dragging will move the box, and the displayed region. Left clicking outside of the box will center the box on the clicked point. During the debriefing phase, the overview map is replaced with a text window that describes the logged event that is being displayed.

THE TERRAIN MAP

The terrain map is a topographical map with contour lines, which resembles a standard military map. Terrain features, such as woods, are denoted by different colors on the map. In the planning phase (as well as the mission editor, and when the space bar is depressed in the execution phase), the background of the map is color-coded to indicate elevation. The lighter the shade of brown, the higher the elevation.

The terrain map can be magnified using the map zoom selector in the control panel, or by pressing the + or – keys. The map can be scrolled in several ways: 1) pressing the arrow keys, 2) clicking and dragging the box in the overview map in the lower right-hand corner of the map screen, 3) holding down the space bar while clicking and dragging on the map in the display window.

The terrain map is divided into grids of 1 km x 1km, as in standard military maps. Each horizontal and vertical grid line is given a two-digit number, displayed at the left and bottom sides of the map, which together are used to create coordinates that identify small regions within the map. Typical coordinates consist of six digits; the first three digits indicate the horizontal position on the map, and the second three digits indicate the vertical position. Since each grid line has only two digits, the third digits are found by mentally dividing the grid into 10 x 10 sub grids, and picking the closest sub grid. Note that the resolution of a six-number coordinate is 100 x 100 meters. You can practice reading coordinates by passing the cursor over the terrain map and observing the coordinate display to the right.

A variety of objects can be displayed on the map, as described below:

Units are displayed as standard military symbols. There are symbols for individual vehicles, sections and platoons. **Note that the lower left-hand corner of the unit symbol designates the exact location of the unit on the map, and should be used as the origin when clicking on a unit**. The platoon number of the unit is displayed on the left side of the unit symbol, with the section number, if there is one, added as a subscript. The company letter is displayed on the right side of the unit symbol.

Unit symbols

The color of the unit symbol indicates whether it is a friendly or enemy unit, whether it is player or computer controlled, and whether it is destroyed or not. For single-player missions, friendly units are displayed as blue symbols, and enemy units are displayed as red symbols. For multiplayer missions, though, you can play as either blue or red. In both case, friendly units that the player can control are displayed in a dark shade (dark blue or dark red), whereas friendly units that the player cannot control are displayed in a light shade (light blue or light red). Detected enemy units that are not destroyed are always displayed in a dark shade. Destroyed units are displayed in a gray shade (red-gray or blue-gray). The one and only *yellow-and-black* unit symbol is the unit that the player currently occupies.

Checkpoints are displayed as the standard military symbol for a checkpoint (a rectangle with an attached triangle at the bottom). **The bottom point of the**

checkpoint symbol designates the exact location of the checkpoint on the map, and should be used as the origin when clicking on a checkpoint. The color of the checkpoint symbol has the same meaning as the color of the unit symbol. Dark shades are checkpoints that the player can control, whereas light shades are checkpoints that the player cannot control.

Routes are displayed as a set of connected lines that form a path, along with either an arrow, which indicates the route's direction and tactics, or an information box, which indicates the route's *formation*, *speed*, and *tactics*. The information box appears only when the route is selected (except in the mission editor, in which case you can choose whether to display an arrow or an information box).

Battle-position lines are displayed as a long black line, with two short black lines attached to each end (imagine a long, skinny rectangle that is missing one of its long sides). Battle-position lines always belong to either a unit or a checkpoint.

Reference points, which are used to mark geographical locations to help with situational awareness, are displayed as colored plus signs (crosses), with or without text.

Lines are displayed as a set of connected lines, with or without text. Lines can have various colors, and can be either solid or dashed.

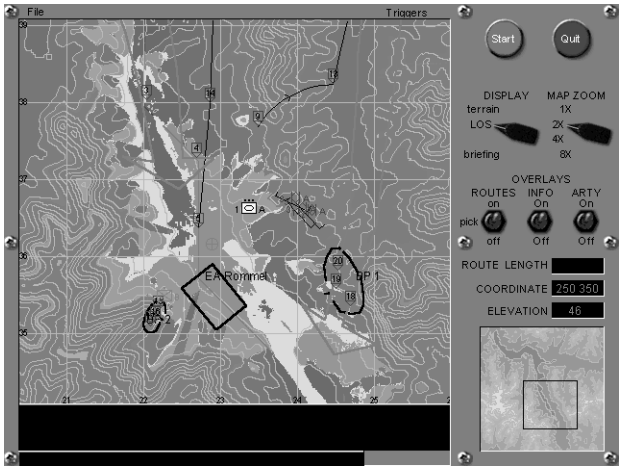
Regions are displayed as a set of connected lines that form a polygon, with or without text. Regions can have various colors, and can be either solid or dashed.

Text is simply a string of characters that can be placed anywhere on the map.

Mine fields are displayed as green rectangles.

Artillery fields are displayed as red rectangles. Active artillery fields will flash on and off, whereas planned artillery fields that you can modify will consist of dashed red lines.

THE LINE-OF-SIGHT (LOS) MAP



The Line-of-sight map, as it appears in the mission editor.

Perhaps the most useful tool for planning (or creating) a mission is the line-of-sight (LOS) map, which is available only in the planning phase and in the mission editor. The LOS map, which at first glance looks very much like the terrain map, has a special feature that enables you to quickly find tactically important ground. Left clicking on any point of the map will result in a display that shows line-of-sight information for a tank if it were located at that point (the LOS origin). Regions tinted dark denote points from which none of the tank would be seen (and hence points that the tank itself would not see). Regions tinted pink (danger areas) denote points from which the entire tank would be seen. Regions not tinted at all denote points from which only the turret of the tank would be seen. When planning possible battle positions, the untinted areas clearly show the regions from which the tank would be in a hull-down position, and thus better protected. Note that a small difference in the location of the LOS origin can make a big difference in the resulting LOS information. (For instance, on either side of the crest of a hill.) Because units will automatically find good hull-down (or turret-down) positions within a few hundred meters of their ordered destination, it is not necessary to find the exact locations for the best positions. It is enough to use the LOS map to find rough locations that provide the possibility of good protection.

You can also view the virtual 3D world from the LOS origin by pressing F1. While viewing the world, you can change you viewing direction by using the joystick, mouse or arrow keys. You can also move forwards and backwards by using the W and X keys, respectively. To return to the map screen, press F5.

When scrolling the LOS map, or when changing magnification, the LOS information will be erased. To display the LOS information with the same LOS origin, right click on the map and select *Refresh* from the context sensitive menu. Also, to select a unit or checkpoint while in the LOS map, left click with the *Alt* key depressed.

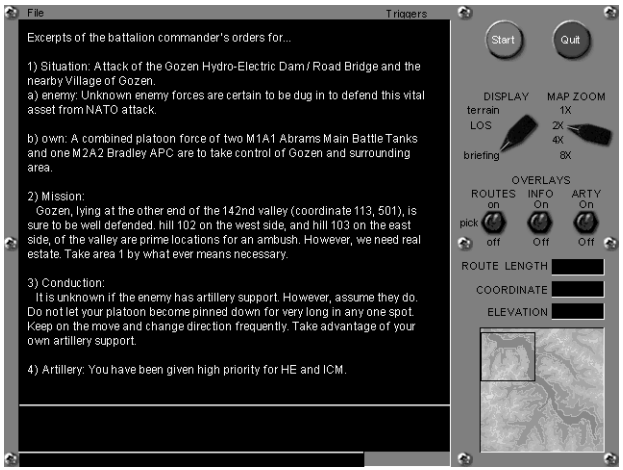
Although the LOS map is not available in the execution phase, there is a **point-to-point LOS tool** that can be used in the map screen. By holding down the *Alt* key while left clicking and dragging, the cursor will show whether a tank placed at the current cursor point and a tank placed at the clicked point would be visible to each other. A filled cursor indicates that the tanks would not be able to see each other, while a transparent cursor indicates that the two tanks would be able to see each other.

The Briefing, Summary and Score Displays

The *Briefing*, *Summary* and *Score* displays all show text in the display window. The Briefing display, which is always available, should show a military style text briefing, indicating the status of friendly and enemy forces, as well as what exactly you are supposed to accomplish in the mission. The exact content of the briefing will, of course, depend on the mission designer.

The *Summary* display, available only in the mission editor, allows the mission designer to enter a text summary of the mission, which players will see when browsing through missions in the *Single Player Screen* or *Multiplayer Screen*.

The *Score* display is available only in the debriefing phase. This display shows the score you received for the mission, as well as some basic statistics of the battle.



7 Moving Your Units

There are two basic ways to get one of your units to go where you want: have it follow a route, or take control of the unit and manually drive the lead tank in the unit. **Note: the mission designer can choose to prohibit the player from moving *any* units**. Although this feature is intended mainly for tutorial missions, you should be aware that certain missions may not allow you to move any of your units.

Putting Units on Routes

To attach a new route directly to a unit in the map screen follow these steps:

1) Right click on the **lower left corner of the unit's icon** in the map screen to bring up a context-sensitive menu.
2) Highlight *New Route* and then select any of the choices from the sub-menu (*Assault, Engage, March, Retreat, Scout*) to start the route.
3) Create a series of waypoints by left clicking on the map to form a smooth path.
4) To end the route, right click anywhere on the map, and the last waypoint will change into a checkpoint. If the last waypoint was near an existing checkpoint, that waypoint will snap to the existing checkpoint, otherwise a new checkpoint will be created.

If you're in the execution phase of the simulation, as soon as you end the route, the unit will immediately embark on the route, abandoning any route is was previously on.

You can also put any unit (or vehicle) within your platoon on a simple one-point route from any non-map screen:

1) Left click on a unit icon at the bottom of any non-map screen.
2) Select *Advance To* or *Retreat To* from the context-sensitive menu.
3) Aim the mouse cursor at the desired destination on the terrain and click the left mouse button.

Routes created this way will end with a checkpoint that has a battle-position line, so that the unit will assume a hull-down position upon reaching the checkpoint.

Routes contain parameters for *formation*, *spacing*, *speed*, *tactics* and *fire control*. **When a unit embarks on a route, the unit assumes the value of these parameters from the route.** The *formation* and *spacing* determine the relative locations of the members of the unit. The *speed* determines how fast the unit travels. The *fire control* setting determines the maximum range at which a unit will open fire at the enemy. *Hold fire* and *fire at will* are special cases that correspond to maximum ranges of about 500m and infinity, respectively. **A unit will return fire if fired upon, (unless the enemy is beyond the effective range of the vehicles' weapons), ceasing only when new hold-fire orders are issued.**

When a route is first created, it is given a default set of properties, based on the route type you chose. You can change any of these properties by right clicking on the route in the map screen and selecting an item in the context-sensitive menu. You can also edit the route's path by first clicking on the route, to select it, and then clicking and dragging on the route or any of its waypoints. The ending checkpoint can be moved in a similar way. The default values for a new route are as follows:

	Tactics	Formation	Spacing	Speed	Fire ctrl
Engage route:	engage	wedge	normal	fast	fire at will
Assault route:	assault	line	normal	top	fire at will
March route:	march	column	normal	fast	fire at will
Retreat route:	retreat	line	normal	reverse, then top	fire at will
Scout route:	scout	wedge	normal	slow	hold fire

The tactics property of a route determines how a unit on that route responds to enemy contact. When a unit is on a route, it will usually go from waypoint to waypoint, as you would expect. However, when enemies have been detected by the unit, and when a human player is **not** the tank commander in the lead tank of that unit, the tactics property determines how the unit moves as follows:

Tactics value for units on routes	Unit behavior
Engage:	If enemy is within range, stop to find a hull-down position facing enemy. The maximum range is determined by the value of the fire-control property and ammo range.
Assault:	Stay on route, unless enemy is very close and flanking (in which case stop to find a hull-down position facing enemy).
March:	Stay on route unless under direct fire or enemy is near and flanking (in which case stop to find a hull-down position facing enemy).
Retreat:	Always stay on route. At the start of route, backup and pop smoke, if enemy are present.
Scout:	Always stop to seek a turret-down position facing enemy. If under fire, retreat back along route, (thus taking on retreat tactics). Look for and expose enemy mine fields.

A unit embarking on a retreat route will always start the route in reverse, and then, after a default distance or if no enemies are present, switch to the speed designated by the route. The default reverse distance depends on the type of unit. Western tanks can move in reverse much faster than Russian tanks, and so will travel in reverse much longer than Russian tanks.

Note that only units with Scout tactics will look for enemy mine fields, and they will only do so when traveling at slow speed (the default speed for a Scout route). A unit is not guaranteed to find enemy mine fields when looking for them, but they will usually uncover them before sustaining any damage.

Remember that the tactics just described apply to a unit only when you are NOT the tank commander in the lead tank of that unit! Once you take over the role of unit leader, all decisions about when to stop and move are yours. If you are the unit leader, and your unit is on a route, the unit will simply follow the route until you issue an order to do something else, such as assuming a hull-down position facing the enemy or a particular direction.

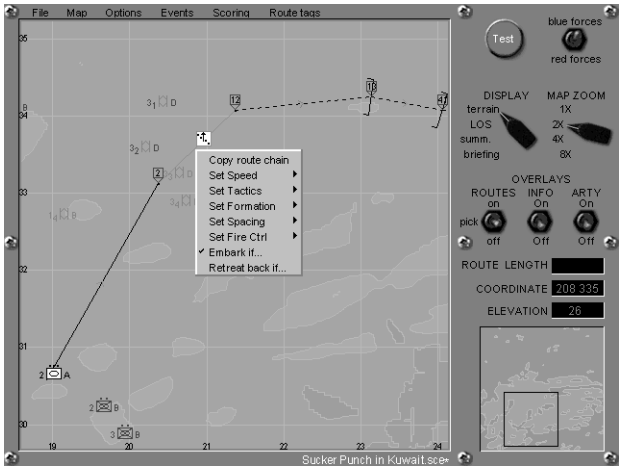
Creating a new route directly from a unit is not the only way that routes can be attached to a unit. When a unit reaches a checkpoint that has routes originating from it, the unit will, under certain circumstances, embark on one of the routes. The circumstances under which the unit will embark on a particular route are the topic of the next section. For now, it's enough to know that if a unit of yours is stuck at a checkpoint that has routes originating from it, you can always make it embark on one of the routes by right clicking on the unit's icon in the map screen and selecting *Proceed* or *Proceed to* (if there are multiple routes) from the context-sensitive menu.

CONDITIONED ROUTES

The key behind complex unit movement in Steel Beasts is the use of conditioned routes. There are two types of conditions that you can place on routes: Embark conditions and Retreat-back conditions.

- **Embark conditions** determine when a unit at the start of a route will embark, or proceed, on that route.
- **Retreat-back conditions** determine when a unit already on the route will retreat back to the beginning of the route. Once the unit retreats back to the checkpoint where the route began, it will act as if it just arrived at that checkpoint; it will NOT continue to retreat back along routes that ended at that checkpoint, even if the retreat conditions for those routes are satisfied.

To place these conditions on a route, right click on the route and select *Embark if* or *Retreat back if*, then fill out the condition window to meet your needs. (The details of how to fill out the condition window will be discussed in a later section.)



To help you keep track of the conditions assigned to routes, the map screen displays routes differently, depending on which, if any, conditions have been assigned to them:

- Routes with no assigned conditions are displayed with black lines.
- Routes with assigned *embark* conditions are displayed with dashed lines.
- Route with assigned *retreat-back* conditions are displayed with blue-green lines.
- Routes with assigned *embark* and *retreat-back* conditions are displayed with dashed, blue-green lines.

Besides these *explicit* conditions, there are also **implicit route conditions** that arise only in certain circumstances. The following table lists all the possible implicit conditions for embarking and retreating back. (Note that an implicit condition will apply only if there is no explicit condition overriding it.)

Unit's situation	Implicit condition on route	Condition type
Defend tactics at CP	Has unit suffered moderate losses?	Embark
Guard tactics at CP	Has unit comes under fire?	Embark
Scout tactics on route	Has unit comes under fire?	Retreat back

DECIDING WHICH ROUTE TO TAKE

When a unit first reaches a checkpoint, it adopts the *tactics* and *fire-control* characteristics of that checkpoint. If the checkpoint has routes originating from it, the unit will constantly check to see if it should embark on any of these routes, as follows:

1. First, all routes **with** explicit embark conditions are checked. If the embark condition assigned to the route is satisfied, and the retreat-back condition is NOT satisfied, the unit will embark on the route.
2. Next, all routes **without** explicit embark conditions are checked. If the retreat-back condition is NOT satisfied and either a) the checkpoint does NOT have a battle-position line, or b) the implicit embark condition is satisfied, then the unit will embark on the route.

Note that a player can force one of his units to take a route by ordering it to proceed on it. Also note that a unit can **never** embark on any route unless the retreat-back conditions, both explicit and implicit, are NOT satisfied. Since implicit retreat-back conditions appear only in scout routes, be careful when using them! A unit will not embark on a scout route if it is under fire because its implicit retreat-back condition is satisfied.

ISSUING DIRECT DRIVING COMMANDS

Even though you cannot assume the driver's position in Steel Beasts, you can *essentially* drive the tank (or squad of soldiers) you occupy from any crew position, and any view, except the map screen. In Steel Beasts, driving commands are interpreted as orders to the driver. If your tank is the lead vehicle of its unit, the other tanks in the unit will follow your lead, trying to stay in formation as best they can. If your tank is not the lead vehicle of its unit, once you start manually driving it will detach itself from the unit, to become the lead vehicle of a new unit.

You can issue most driving commands from menus on the menu bar or by using the driving buttons, as described earlier in the section on the execution-phase interface. Typically, however, it is more convenient to use the following hot keys:

Hot key	Command
W	Drive at next higher speed level
X	Drive at next lower speed level
S	Stop
A, D	Turn left / right 22.5 degrees
Shift A, Shift D	Turn left / right continuously
E	Assume battle position (towards view direction)
C	Continue on last route / Go to next route
lase button*	Drive to this point (In TC eye view or external position)

*lase button = joystick button 2 or Ctrl or right mouse button.

If you're in the external position, or the eye view of the tank commander's position, you can order the driver to any point that you mark on the terrain by pressing and releasing the lase button. Holding down this button results in a red checkpoint icon being displayed in the center of the view. Simply aim the tip of the checkpoint icon at a piece of terrain, release the button, and the driver will immediately head to that location.

Pressing E puts your unit in a battle position. Your viewing direction at the time you pressed they key is used as the direction of the battle position. If there is no hull-down position within 150 meters in front of or behind your tank in the battle-position direction, your driver will simply stop. If an enemy is present when you are in a battle position, your driver will try to find a hull-down position facing the enemy. Thus, the battle-position order also serves as an "engage" order when an enemy is detected..

If your unit is on a route, and you issue a direct driving command that causes your unit to deviate from that route, you can return to the route by pressing C. (Pressing C also causes your unit to embark on the next route, if you're stuck at a checkpoint that has a route originating from it.) A unit will deviate from a route when you order it into a battle position, when you steer your tank left or right (using A, D), when you press W, X multiple times quickly, or when you order your driver to head to a terrain point that you marked with the lase button. Note that some driving commands will NOT cause the unit to deviate from a route. Pressing W, X or S will only alter the speed of the unit on its current route.

At any time, whether your unit is on a route, has deviated from a route, or is at a checkpoint, you can change the unit's formation, spacing and fire control settings by using menus, or the hotkeys listed below.

Note that if your unit is in a battle position, or is engaging an enemy from hull-down positions, and you issue and order to change formation, the tanks in your unit will move from their hull-down positions to get into formation (thus abandoning the battle position). This can spell disaster for your unit, since the tanks might expose their vulnerable sides to enemy fire, so **formation changes upon enemy contact should be used with extreme caution**.

Hot key	Command
[	Echelon-left formation
]	Line formation
\	Echelon-right formation
Shift [	Wedge formation
Shift]	Column formation
Shift \	Vee formation
-	Decrease spacing
+	Increase spacing
H	Hold fire
F	Fire at will

NAVIGATIONAL AIDS

To help you navigate through the virtual 3D world, you can place reference points anywhere you like on the 2D map (by right clicking on the map screen and selecting *new ref. point*). **The relative direction of these reference points will be displayed on the tank clock if you have the realism setting set to *Low***. Reference points look like crosses, and have four unique colors. (You can place more than four reference points on the map, but the colors will repeat after the fourth one.) You can also add text to the reference points. Typically, you would place several reference points at important locations that you want to keep track of, such as a hill with suspected enemy tanks, or the current defensive positions of your units. You can also mark any location in the 3D world from the gunner's or tank commander's position and look at its position on the 2D map. From the gunner's position, simply lase a point on the terrain, and the location of the point will be marked in the terrain map. From the TC's position, you'll have to hold down the shift key while pressing the lase button.

8 Battle Positions

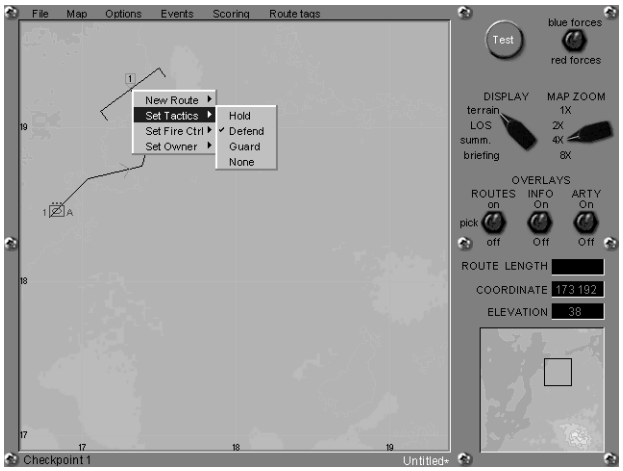
In Steel Beasts, when a unit is given **Hold**, **Defend** or **Guard** tactics, it is in a *battle position*, and an adjustable battle-position line will be drawn on the map to indicate the location and orientation that the unit should maintain. When no enemies are present, vehicles in a battle position will try to find a turret-down position in the direction of the battle-position line. Individual vehicles in a battle position have the freedom to move back and forth a few hundred meters from the battle-position line to find good positions, so keep this in mind when planning.

The behavior of vehicles in a battle position are summarized in the following table:

BP tactics	Vehicle behavior
Hold:	• While no enemies are seen, assume a turret-down position facing a specified direction. • Temporarily move from position to avoid ICM arty attack. • Do NOT move from position to engage enemies that cannot be seen, or to avoid HE arty attacks.
Defend:	• While no enemies are detected, assume a turret-down position facing a specified direction. • Temporarily move from position to avoid ICM arty attack, or to avoid HE arty attack if not engaging an enemy. • Can move a few hundred meters from position to engage enemies on front flanks that cannot currently be seen. • Embark on the first attached, non-conditioned route if moderate losses are sustained.
Guard:	Same as Defend except: • Embark on the first attached, non-conditioned route if under fire.

There are several ways to place your unit in a battle position:

1) Issue a direct driving command to the unit you currently occupy by pressing E, as described earlier.
2) Right click on a unit icon in the map screen and select *Hold*, *Defend* or *Guard*, from the *Tactics* menu. If a unit is on a route, you must delete the route first for this to work.
3) Add a battle-position line to a checkpoint at the end of a route (by setting the *Tactics* of the checkpoint to *Hold*, *Defend* or *Guard*). When the unit reaches the checkpoint, it will assume a battle position.
4) Click on a unit icon at the bottom of any non-map screen and select *Advance to* or *Retreat to* from the context-sensitive menu. Then click on a destination point on the terrain and the unit will assume a battle position once it arrives at the destination.



Adding a battle position to a checkpoint

9 Conditions, Events and Triggers

Conditions

A *condition* in Steel Beasts is simply an expression that can be tested for a true or false result. Conditions can be assigned to a variety of different objects, such as routes, checkpoints and events, in order to activate different actions, such embarking on route. Conditions are assigned in the map screen through context-sensitive menus.

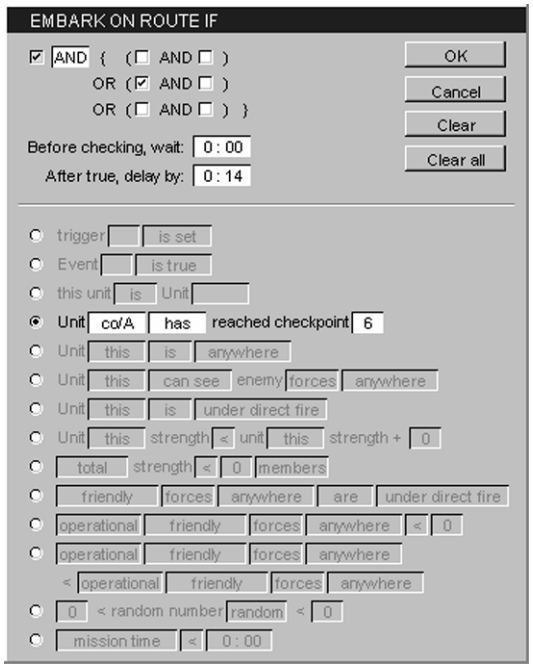
After assigning a condition to an object, you will be presented with a dialog window, which you will have to fill out. The upper part of the dialog window displays a Boolean expression of sub-conditions. The lower part of the dialog window displays the possible sub-conditions. For the entire condition object to be true, the Boolean expression on top must be true, which in turn, depends on the sub-conditions selected. Only the boxes in the Boolean expression that have checkmarks play any role in evaluating the expression. Boxes without checkmarks are ignored.

To assign a sub-condition in the Boolean expression, first click on a white box to highlight it and change it to a green box. Now select one of the available sub-conditions by clicking on a radio button in the lower part of the dialog window. Once you click on a radio button, a checkmark will appear in the green box of the Boolean expression above, indicating that a sub-condition has been assigned. The sub-conditions have text boxes that can be changed by clicking on them. Left clicking on the text box will show the next available value in the text box, whereas right clicking in the text box will show the previous available value in the text box. To clear the sub-condition, press the *Clear* button at the right of the dialog window.

Once the Boolean expression is evaluated as true, is remains set to true, until it is reset. The embark condition of a route is reset whenever a unit arrives at the checkpoint where the route begins. The retreat condition of a route is reset whenever a unit embarks on the route. The open-fire condition at a checkpoint is reset whenever a unit arrives at the checkpoint.

You can also add a delay before the condition is tested or after it becomes true by filling in a time in the two boxes just below the Boolean expression. Adding a delay before testing is useful, for instance, at an embark conditions in which the unit should advance if it doesn't see any enemies. In this case, you would want the unit to observe for a little while before determining that there are indeed no enemies around.

If you want to have a simple delay condition, then you can leave the Boolean expression blank, and just fill in a delay time.



The condition dialog window for an embark route

Sub-conditions

Most sub-conditions are self explanatory, although a few items deserve some explanation.

- The terms *friendly* and *enemy* have a relative meaning. For blue forces, red is the enemy, and for red forces, blue is the enemy
- Before you can use a condition that references a region, you must create a region.
- Incremental time is the time since the condition was reset (such as when a unit first reaches a checkpoint).

Finally, the random number sub-condition needs some explanation. At the start of a mission, a set of 64 numbers are initialized to independent random values between 0 and 100. Once the mission starts, these numbers do not change. The value of any one of these 64 random numbers can be tested in the random-number sub-condition. For example, the sub-condition might be true if random number 8 is greater than 0 and less than 20. By using the same random number in different conditions, you can create coordinated random behavior. Note that this is unlike the random numbers in many other games' scenario editors.

In addition, there is also a random number that **is** randomly generated every time the condition is tested. This is denoted by Random Number *random*. You should use this random number sub-condition only if the condition will be tested once, since repeated testing will eventually result in a True value.

EVENTS

An *event* is simply a binary state variables with a condition assigned to it. Events, which can be either *true* of *false*, start out as false and become true when its assigned condition is satisfied. **Once an event is true, it stays true until the game ends.** (This is unlike a condition, which can be reset during the game.) Note that some conditions can also reference events. For example, two different embark conditions for a route can be set up so that they are both true if Event 1 is true. Events are also an important part of the scoring formula, which will be discussed later.

TRIGGERS

A trigger is a binary state variable that is set or reset by the player any time during the game. A trigger starts out as reset and can be set and later reset by the player any number of times during the execution phase of the game by pressing a hot key (Shift + trigger number) or through context-sensitive menus. Since triggers are referenced by most conditions, triggers provide a simple way for players to coordinate some type of action, such as having certain units embarking on pre-planned routes. For example, a player can create one set of conditioned routes for a left flank attack and another set of conditioned routes for a right flank attack. The embark conditions for the left flank routes might be set to Trigger1, and those for the right flank routes might be set to trigger 2. This way, the player can quickly choose which way he wants to conduct the attack by simply pressing a hot key during the game.

10 THE GUNNER'S POSITION

You can occupy the gunner's position for either the M1A1 or the Leopard 2A4 by pressing F6, or by using menus to change your crew position. Be aware, however, that some missions (mainly tutorials) will prohibit you from occupying the gunner's position.

The gunner's primary job is to aim and fire the tank's main gun to destroy enemy targets. In a sense, the rest of the crew exists mainly to aid the gunner in performing this task. The TC will usually designate targets to the gunner, decide which ammo the loader should load, and issue the order to fire. When a target is spotted, the TC will issue a short warning, such as, "Gunner, sabot, tank!" or perhaps just "Tank!" At the same time, the TC will override the gunner and slew the turret towards the target that he wants the gunner to shoot. When the gunner sees the target, he says, "Identified!" which is the cue for the TC to give control of the turret back to the gunner. The TC will then issue the order to fire by saying "Fire!" If the TC wants to designate a different ammunition type, he would follow the fire command with the type of round he wants loaded next, such as "Fire! Fire HEAT!" **Notice that when the TC orders a change of ammo type for the main gun, the loader will not remove the round that's currently loaded.** In battle, once a round is loaded it comes out only by being fired.

If you're playing from the gunner's position in Steel Beasts, you have two hot keys at your disposal to help simulate this communication with the TC. Pressing T will tell the computer TC that you have found a target, causing him to stop overriding you for the next 15 seconds, even if a more dangerous target appears. (The computer TC will stop overriding even if you don't press this key, but if you don't want him to disturb you for a little while, then be sure to press this key.) Pressing I will cause the computer TC to slew the turret to the current target, if there is one, which is useful if you lose track of the current target. In multiplayer games in which a human player is your TC, pressing T will play an "Identified!" speech sound on the TC's system, whereas pressing I will play a "Cannot identify!" speech sound on the TC's system.

Before explaining the gunner's controls for each tank in Steel Beasts, a brief discussion of modern tank gunnery is in order.

BASIC GUNNERY CONCEPTS

Modern tanks are amazingly accurate killing machines, able to destroy a moving target several kilometers away in most weather conditions while traveling over rough terrain. This is by no means an easy task, and several key systems make it possible.

Stabilization: The stabilization system of a tank keeps the main gun aimed at the target, even when the tank is turning and pitching as it moves. Without stabilization, firing on the move is almost impossible. The stabilization system also makes it possible for the gunner to simply keep the target centered in his sights while the tank automatically adds superelevation and lead to the main gun to ensure a hit.

Stabilization is actually done in a two-step process. The tank's ballistic computer uses signals from gyroscopes and input from the gunner's control handles to maintain a line-of-sight reference with respect to the outside world, and to stabilize a head mirror that is located on top of the turret. (The head mirror is the adjustable top mirror of a periscope that makes up the gunner's primary sight.) The ballistic computer then uses the position of the head mirror, along with the calculated superelevation and lead, to move the turret and main gun to the proper position, through the use of hydraulic actuators. In stabilized mode, the gun is often said to be "slaved to the sights."

Because the head mirror is light, it can be moved very quickly to compensate for the motion of the tank. When looking through a stabilized sight, the gunner will notice very little bounce, even when the tank is moving over very rough terrain. The gun, on the other hand, can exceed two metric tons, and is not as quick to move as the head mirror. When the tank makes a sudden move, or a new value of superelevation or lead is calculated, the gun will need a fraction of a second to catch up to where it belongs. Most modern tanks inhibit firing until the gun actually gets to where it is supposed to be. It's also important to keep in mind that the range of motion of the head mirror is greater than that of the gun. In particular, the head mirror can usually be aimed lower than gun tube can actually move, especially when the gun tube is over the rear deck of the tank.

Laser rangefinder (LRF): A lot of information is input into the ballistic computer of a modern tank to help ensure a first-round hit. One of the most important of these inputs is the range (or distance) to target. The range is needed to calculate the proper superelevation and lead in order to hit the target. (*Superelevation* is the angle the gun tube must be raised above the line of sight to compensate for the distance the shell will fall during its flight. *Lead* is the angle the gun must be moved left or right of the line of sight to compensate for the lateral distance the target and/or tank will move during the shell's flight.)

The laser rangefinder is the standard instrument on modern tanks used to find a target's range. When the gunner lases a target, a pulse of laser light is sent out from the tank and the return times of the reflected laser light are used to calculate the range. Note that there may be more than one return time to measure because the laser beam might reflect off multiple objects. Although the pulse of laser light is a focused beam, this beam does widen over distance. At a distance of two or three kilometers, the beam will be spread out so much that a tank may NOT block the entire beam. In this case, some laser light might be reflected off the ground well in front of the target, and some may be reflected off the ground or trees well behind

the target. In addition, smoke and dust clouds will reflect the laser beam, which could result in an erroneous range reading.

The ballistic computer: As mentioned above, the ballistic computer receives input about the target's range, as well as turret motion, hull velocity, cant, wind speed, and other information about the air and the round that is being fired, to calculate the proper lead and superelevation.

The thermal imaging system (TIS): Although most modern western tanks have thermal imaging systems, most non-western tanks do not. The TIS forms an image based on the relative temperature of the objects being viewed, and so provides excellent night vision for the tank crew. In addition, the TIS can see right through most types of smoke, which makes smoke screens an almost useless defense for prospective targets.

Because engines, tracks and wheels get hot, vehicles can be easily detected in a thermal view of the landscape, even when they are camouflaged. This is why, even in daytime, the TIS is preferred over the day optics when scanning for targets.

M1A1 Gunner's Position

The tables below summarize the gunner's controls for the M1A1 in Steel Beasts.

M1A1 gunner's hot key mappings		
Fire button	=	joystick button 1 or Spacebar
Lase button	=	joystick button 2 or Ctrl or right mouse button.
Palm button	=	joystick button 3 or P or middle mouse button.
Mag button	=	Joystick Button 4 or N.

M1A1 Gunner's Hot keys

Hot key	Command
F1	Gunner's primary sight (GPS)
F2	Gunner's auxiliary sight (GAS)
F3	Gunner's unity sight
F4	Gunner's interior view
F5	Map screen
Fire button	Fire
Lase button	Lase
Palm button	Palm switch off while depressed
Mag button	Toggle day or TIS magnification in GPS
M	Toggle gun select: main / coax
T	Notify TC of target in sights (TC will stop overriding)
I	Ask TC to show you current target
Insert	Set ammo select to Sabot
Delete	Set ammo select to HEAT
Home / End	Set ammo select to amo #3 /#4 (M1 only)
,	Set fire control mode to NORMAL
.	Set fire control mode to EMERGENCY
/	Set fire control mode to MANUAL
~	Toggle laser return: first / last
R	Toggle GAS reticle: Sabot / HEAT
Keypad +	Toggle TIS: on / standby
Keypad -	Toggle TIS polarity: white hot / black hot
↓ ↑ → ←	Hand-crank gun steering
0 - 9 then Enter	Manual range entry (in GPS view)

Fire Control Modes

There are three modes of operation for the gun and turret on the M1A1: *normal*, *emergency* and *manual*. You can switch between these modes using menus, by clicking on the display box showing the current fire control mode (at the left of the gunner's screen), or by using hot keys.

Normal mode , should be used in all cases, unless a malfunction has occurred. In normal mode, the gun is fully stabilized with the direction and rate of travel of the gun and turret controlled by either the gunner's handles or commander's handle. In either case, the palm switch on the handles must be depressed in order to activate stabilization and to enable steering, lasing and firing. The commander's handle overrides the gunner's handles whenever the palm switch on the commander's handle is depressed.

In normal mode, a range entry into the ballistic computer with a palm switch depressed will cause superelevation and automatic lead to be added to the gun, while the view through the gunner's primary sight remains on target. Automatic lead is then continuously added to the gun until both palm switches are released.

Emergency mode . is a backup to normal mode, and should be used if stabilization is lost. In emergency mode, the gunner's handles and the commander's handle control gun and turret movement without stabilization. Because of this, **emergency mode should be used only from a stationary vehicle**. Automatic lead is not added in emergency mode, since there is no stabilization. Superelevation is added to the mirror, not the gun, so when a new range is entered into the ballistic computer, the sight will move and the gun must be re-laid on the target.

Manual mode / is a backup to emergency mode, and should be used if hydraulic pressure is lost. In manual mode, the gunner's and commander's handles are disabled and hydraulic power is removed. The gun and turret must be steered by turning manual crank handles. Of course, there is no stabilization in manual mode.

Views

The **Gunner's Primary Sight** (GPS) F1 is the normal viewing sight used by the gunner, and offers a 3x or 10x view for both day optics and the thermal imaging system (TIS). The GPS is actually a periscope that looks out from an armored box (the "dog house") sitting on top of the turret. You can toggle between 3x and 10x for both the TIS and the day sights by pressing the Mag button.

M1 gunner's primary sight (GPS)

In the GPS, the red horizontal and vertical lines together with the center circle comprise the GPS reticle. The distance between the top and bottom horizontal lines is about 2.5 mils, which is about the size of a Russian tank at 1000 meters. (A mil is the angle subtended by 1 meter at a distance of 1000 meters.)

The green numbers at the bottom of the GPS show the current range stored in the ballistic computer. The multiple-returns bar appears over the range display if the laser rangefinder receives more than one return. The range valued displayed will be either the first return or the last return, depending on the position of the range switch.

The ready-to-fire box appears to the left of the range display whenever the gun is ready to fire. This box may be absent if there is no round loaded into the main gun, if a palm switch is not depressed, or if the gun tube is not aligned with the proper ballistic solution.

The malfunction symbol, a green F, indicates a failure in the laser rangefinder (LRF) or the thermal imaging system (TIS).

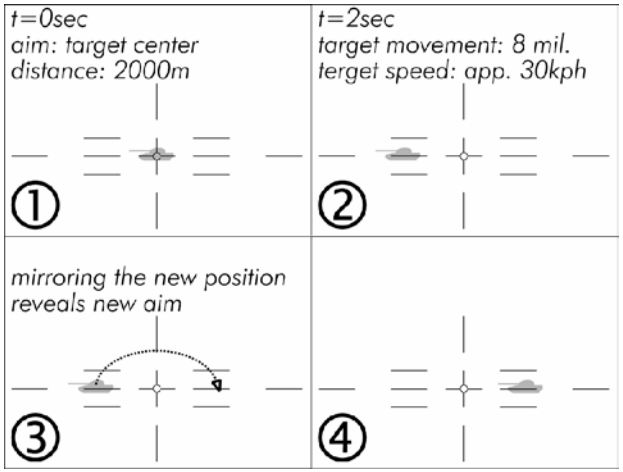
The **Gunner's Auxiliary Sight** (GAS) F2 is the backup sight for the gunner. Unlike the GPS, which is a relatively fragile periscope that gives a view from the top of the turret, the GAS is a sturdy 8x *telescope* that is mounted very close to the gun tube and moves with the gun tube. **The GAS will always give a view of what the gun can "see," so it is useful for making sure that the gun can clear a hill crest that you may be hiding behind.**

M1 gunner's auxiliary sight (GAS)

There are two reticles for the GAS: one for APFSDS (sabot) rounds, and the other for HEAT rounds. You can toggle between the two by pressing R, using the menus, or clicking on the display box to the left of the screen that shows the current reticle type. Of course, you should select the reticle that corresponds to the round loaded in the main gun.

When using the GAS to shoot targets, you'll have to manually add superelevation and lead. If you know the range to the target, then adding superelevation is easy: line up the target with the proper horizontal line on the GAS reticle. The range (in hundreds of meters) of each horizontal line is displayed to the right of the line. If you don't know the range of the target, you can estimate it by using the stadia lines at the top of the GAS reticle. Simply find the stadia line that snugly fits the target's height between it and the horizontal line below it, and read the range listed above the stadia line (again, listed in hundreds of meters). This assumes the target is about 2.5 meters high, which is true for most Russian tanks, but it obviously won't work for other target types.

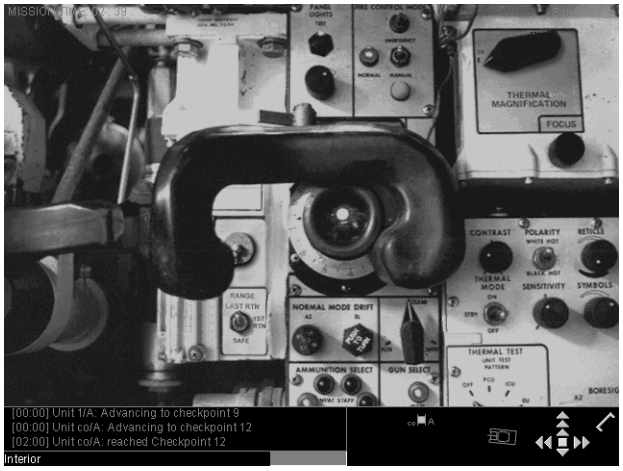
Adding lead is more difficult, because it depends on the lateral speed of the target, and takes a lot of practice. However, if you know the approximate range to the target, you can use the following technique, illustrated in the figure below, to help you. 1) Line up the target in the center of your sights. 2) Mentally mark the horizontal distance that the target has traveled during the time of flight of the round. For a rough rule of thumb, assume one second of flight for every thousand meters of range. 3) Flip this horizontal distance to the other side of the reticle, and 4) center the target at this new aiming point.



The **gunner's unity sight** F3 is simply an unmagnified view through the periscope of the GPS. Since the unity sight is actually part of the GPS, it is stabilized whenever the GPS is stabilized. Although not used much in real life, the unity sight offers the widest field of view from the gunner's position, and is useful for navigating or for getting the big picture.

M1 gunner's unity sight

The **interior view** F4 shows the gunner's station from within the turret. This view might be useful for learning some of the hot keys of the gunner's position, but you probably won't spend much time here.



M1 gunner's interior view

Setting the Ammunition Selection Switch

On the M1, the gunner must mentally keep track of what ammo type is currently loaded in the main gun, and set the ammunition selection switch to that ammo type. The gunner should also listen to the loader, who will notify the crew when he starts loading a different type of ammo by saying, for example, "HEAT up!", instead of his usual "Up!" The setting of the Ammunition Selection switch is used by the ballistic computer to calculate superelevation and lead. Sabot and HEAT rounds have very different muzzle velocities and ballistic properties, so setting this switch incorrectly will result in a severe miss.

You can set the ammunition selection switch through the menus, by clicking on the FCM box in the GPS window, or by using the following hot keys:

Hot key	Sets ammo selection switch to:
Insert	Sabot
Delete	HEAT
Home	Ammo #3
End	Ammo #4

Selecting the Gun

The gunner controls both the main gun and the coaxially mounted machine gun (the coax). He chooses between these weapons by setting the gun selection switch to either main or coax. (On the real M1, he can also choose to set it to safe, to

prevent firing.) This switch not only controls which weapon fires when the gunner pulls the trigger, but it also affects the superelevation and lead computed by the ballistic computer. You can toggle between main and coax in Steel Beasts by using menus, or by pressing M.

CHOOSING TIS OR DAY OPTICS

In the GPS screen, pressing the + key on the keypad will toggle the TIS on and off. Pressing the - key on the keypad will toggle between white hot and black hot, for the TIS display. You can also control these settings through menus.

M1 GPS with TIS on

STEERING THE GUN

Most of the time, as a gunner on the M1, you'll be looking through the gunner's primary sight (GPS) and operating the gun in normal fire control mode. In order to activate stabilization, as well as to aim, lase and shoot, the gunner must squeeze the *palm switch* located on the gunner's control handles. Since the standard joystick has no button that is convenient to keep depressed for a long time, the palm switch button for the gunner in Steel Beasts is reversed. That is, **in the gunner's position, the M1's palm switch is always on unless you hold down the palm button** (Joystick button 3 or P or the middle mouse button). If you hold down the palm button to turn off the palm switch, you'll see a red warning sign in the upper part of the GPS screen, and you won't be able to steer the gun. The reason that the palm switch is modeled at all, is because on the M1 automatic lead is disabled by releasing the palm switch.

To steer the gun in normal and emergency modes, simply move the joystick left, right, up or down. You can also use the mouse to steer the gun by first left clicking in the GPS window, and then moving the mouse. To stop steering with the mouse, click the left mouse button again. In manual mode, you'll have to repeatedly press the arrow keys to steer the gun. This is meant to simulate the turning of the hand cranks on the real tank. (On the M1, you can use the hand cranks in normal and emergency modes too.)

LASING A TARGET

As long as the fire control mode is in normal or emergency mode, and the LRF is functional, you can lase a target by pressing the lase button. Upon lasing, the range will automatically be entered into the ballistic computer. In normal mode the main gun will automatically be raised or lowered to the calculated superelevation, while the view through the GPS will remain the same. In emergency mode, the angle of the head mirror will change to match the superelevation, so the view through the GPS will change, and the sight will have to be re-laid back onto the target.

When lasing a target, try to ensure that the target fills the most of the center part of the reticle circle to avoid multiple returns. If you receive multiple returns (indicated by the multiple returns bar in the GPS), the range value accepted and displayed will depend on the setting of the range switch (*first return*, *or last return*).

You can toggle the range switch between *first return* and *last return* by pressing ~. *Last return* should be used when the target is big enough to block the entire laser beam. In this case, you might want to lase a little low so the beam does not spill over the top of the target and reflect off the distant landscape. Be careful with targets that have spaces in them, like wheeled vehicles, since the beam may pass through these spaces. *First return* should be used when there are no obstacles between your tank and the target, especially for distant targets that cannot block the entire beam. In this case, you might want to lase a little high, so that the beam does not reflect off the ground in front of the target. In both cases, the gunner should aim at the center of the target when actually firing the gun.

Besides lasing targets, you can also lase the terrain to find the range to a certain point you are interested in. If you switch back to the map screen, you'll see the last spot you lased marked on the map to help you identify points.

WARNING! The laser in the M1's LRF can burn out if you overuse it, so be careful! To be safe, never fire more than four pulses in an 80 second period. Don't hold the lase button down for a long time. If you see a green *F* next to the range numbers in the GPS and the red reticle disappears, then you probably burned out the LRF.

ADDING LEAD

If you're shooting at a target that appears to be moving laterally with respect to your tank, lead will have to be added to the gun to compensate for the amount the target and/or your tank will move during the flight of the round. In normal mode on the M1, automatic lead is continuously added once a range value has been entered into the ballistic computer while a palm switch is depressed. In most cases, this range entry occurs when the gunner lases the target, although the range may be entered manually as well. Automatic lead is disabled once the palm switches are released. The amount of lead added is based on the average angular speed of the turret over the last 1.5 seconds, as well as the range entered into the ballistic computer, and the type of ammunition selected. Note that automatic lead is added ONLY in normal mode.

It's important to realize that once automatic lead is enabled, it is *continuously* applied until the palm switches are released. Once the gunner is finished with an engagement, he should release the palm switches to cancel the automatic lead, and then squeeze them again. This is called "dumping the lead." Failure to dump the lead can result in the round missing left or right of the new target, unless you track it for at least 1.5 seconds. In Steel Beasts, you dump the lead when in the gunner's position by pressing the palm button, since holding down this button turns off the palm switch.

In emergency and manual modes, lead must be manually added, which is a very difficult task requiring a lot of practice, and quite a bit of luck. You need not make wild guesses, though. Estimate the time of flight for the round, and then measure the distance the target moves across your reticle in that time. That distance is how far you should lead the target. Make sure you note the amount of lead you added when firing at the target so you can make adjustments if your first shot misses.

FIRING THE GUN

To fire the gun, press the fire button. The proper way to aim and shoot at moving targets in normal mode is to steadily track the target for at least 1.5 seconds, lase the target, and then quickly fire the gun. M1 tankers will tell you to "lase and blaze." You should fire quickly after lasing so that the target does not change its range significantly from the time you lased it, until the time you pull the trigger. This is especially important if the target is moving quickly towards you or away from you. Once you have finished an engagement, dump the lead and move on to the next target.

MANUAL RANGE ENTRY

If you find that your laser rangefinder (LRF) is damaged, but you still have a functioning ballistic computer, you can still use the GPS by estimating the range to the target and manually entering it into the ballistic computer.

In Steel Beasts, you manually enter the range by pressing the numbers keys [0]-[9] (NOT on the keypad) while in the GPS view. You'll notice that once you start entering the numbers, the range display at the bottom of the GPS will change from green, to white with a black background. After you have entered the correct range value, press [Enter] to input this range into the ballistic computer. The range display will once again appear in green. If you want to enable automatic lead, make sure that the palm switch is on when you hit [Enter].

LEOPARD 2A4 GUNNER'S POSITION

The tables below summarizes the gunner's controls for the Leopard 2A4 in Steel Beasts.

Leopard 2A4 gunner's hot key mappings		
Fire button	=	joystick button 1 or Spacebar
Lase button	=	joystick button 2 or [Ctrl] or right mouse button.
Dynamic lead button	=	joystick button 3 or [P] or middle mouse button.
Mag button	=	Joystick Button 4 or [N].

Leopard 2A4 Gunner's Hot keys

Hot key	Command
F1	Gunner's primary sight (GPS)
F2	Gunner's auxiliary sight (GAS)
F3	Gunner's vision block
F4	Gunner's interior view
F5	Map screen
Fire button	Fire
Lase button	Lase
Dynamic lead button	Add dynamic lead while button is depressed
Mag button	Toggle TIS magnification in GPS
M	Toggle gun select: main / coax
T	Notify TC of target in sights (TC will stop overriding)
I	Ask TC to show you current target
,	Set fire control mode to NORMAL
.	Set fire control mode to EMERGENCY
/	Set fire control mode to MANUAL
Keypad +	Toggle TIS: on / standby
Keypad -	Toggle TIS polarity: white hot / black hot
Shift ↓ ↑	Adjust GAS range setting
↓ ↑ → ←	Manual-mode gun steering
0 - 9 then Enter	Type manual range entry (in GPS view)

Fire Control Modes

Like the M1, there are three modes of operation for the gun and turret on the Leopard 2A4: *normal*, *emergency* and *manual*. You can switch between these modes using menus, by clicking on the display box showing the current fire control mode (at the left of the gunner's screen), or by using hot keys.

Normal mode , should be used in all cases, unless a malfunction has occurred. In normal mode, the gun is fully stabilized with the direction and rate of travel of the gun and turret controlled by either the gunner's handles, or commander's handle if the commander is overriding the gunner.

In normal mode, a range entry into the ballistic computer will cause superelevation to be added to the gun, while the view through the gunner's primary sight remains on target. Automatic lead is added to the gun only while the gunner is pressing the dynamic lead button.

Emergency mode . is a backup to normal mode, and should be used if stabilization is lost. In emergency mode, the gunner's handles control gun and turret movement without stabilization. Because of this, **emergency mode should be used only from a stationary vehicle.** The commander cannot override the gunner in emergency mode, and automatic lead cannot be added, since there is no stabilization. Superelevation is added through the mirror, not the gun, so when a new range is entered into the ballistic computer, the sight will move and must be re-laid on the target.

Manual mode / is a backup to emergency mode, and should be used if hydraulic pressure is lost. In manual mode, the gunner's handles are disabled and hydraulic power is removed. The gun and turret must be steered by turning manual crank handles. Of course, there is no stabilization in manual mode.

Views

The **Gunner's Primary Sight** (GPS) F1 is the normal viewing sight used by the gunner, and is actually a periscope that looks out from an armored box sitting on top of the turret. Unlike the M1, the day optics on the Leopard's GPS has a single 12x magnification, although the thermal imaging system (TIS) has both 12x and 4x magnifications. You can toggle between 4x and 12x for the TIS by pressing mag button.

In the GPS, the red horizontal and vertical lines together with the center circle comprise the GPS reticle. The distance between the center and either top or bottom horizontal lines is 2 mils, which is about the size of a Russian tank at 1200 meters. (A mil is the angle subtended by 1 meter at a distance of 1000 meters.)

The range (in tens of meters) is displayed near the bottom of the GPS in the three center digits of a five-digit display. The first digit of the display indicates whether the main gun is ready (F) or not ready (0) to fire. The last digit (A,b,C or d) indicates what type of ammunition the loader has loaded as follows: "A" for sabot, "b" for HEAT, "C" for special ammo, "d" when the coaxial machine gun is selected. For example, when the display reads "F125A" the range is 1250 meters and the gun is ready to fire with a sabot round loaded. A flashing display indicates that the LRF

received multiple returns, warning you to check whether the range is valid and possibly re-lase.

Leopard gunner's primary sight (GPS)

The **Gunner's Auxiliary Sight** (GAS) F2 is the backup sight for the gunner. Unlike the GPS, which is a relatively fragile periscope that gives a view from the top of the turret, the GAS is a sturdy 8x *telescope* that is mounted very close to the gun tube and moves with the gun tube. The GAS will always give a view of what the gun can "see," so it is useful for making sure that the gun can clear a hill crest.

Leopard gunner's auxiliary sight (GAS)

When using the GAS to shoot targets, you'll have to manually add superelevation and lead. If you know the range to the target, then adding superelevation is easy: Press the up/down arrows while holding down the SHIFT key until the proper triangular marker (on the left side of the GAS) lines up with the desired range. The scales indicate the range in hundreds of meters for both HEAT (MZ) and sabot (KE) rounds, as well as marking the 500 meter range for the coaxial machine gun. Once the correct range is set, place the center of the reticle on the target and fire. If you don't know the range, you can estimate it using the chart below.

mils	Tank front (width)	Tank (height)	Tank turret height	Tank side (width)	PC front (width)	PC (height)	PC turret height	PC side (width)
0.5	7000	4450	1600	13850	5550	4400	1000	13325
1.0	**3500**	**2225**	**800**	**6925**	**2775**	**2200**	**500**	**6675**
1.5	2350	1475	550	4625	1850	1475	325	4450
2.0	**1750**	**1100**	**400**	**3450**	**1375**	**1100**	**250**	**3350**
2.5	1400	875	325	2775	1100	875	200	2675
3.0	**1150**	**750**	**275**	**2300**	**925**	**725**		**2225**
3.5	1000	625	225	2000	800	625		1900
4.0	**875**	**550**	**200**	**1750**	**700**	**550**		**1675**
4.5	775	500		1550	625	500		1475
5.0	**700**	**450**		**1375**	**550**	**450**		**1350**
5.5	625	400		1250	500	400		1200
6.0	**575**	**375**		**1150**	**450**	**375**		**1100**
6.5	550	350		1075	425	350		1025
7.0	**500**	**325**		**1000**	**400**	**325**		**950**

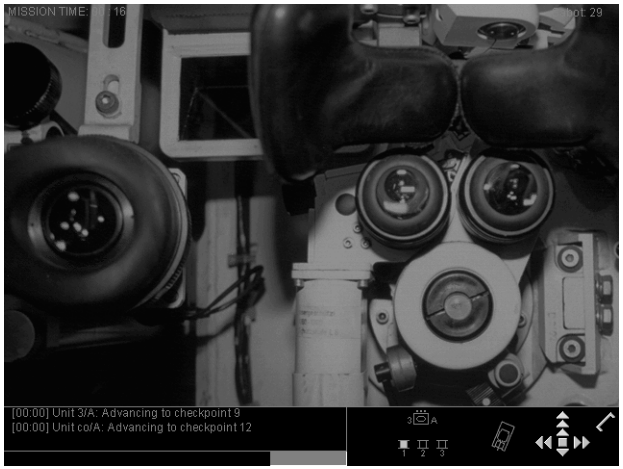
$$[range]m = \frac{[width]m}{[mils]} \cdot 1000$$

Adding lead is more difficult, because it depends on the lateral speed of the target, and takes a lot of practice. However, the same technique described in the section on the M1A1's GAS can be used to add lead.

The **gunner's vision block** F3 provides a 1x, unstabilized view of the outside world.. Although not used much in real life, the vision block offers the widest field of view from the gunner's position, and is useful for navigating or for getting the big picture.

Leopard gunner's vision block

The **interior view** F4 shows the gunner's station from within the turret. This view will give you an idea of how the gunner's station looks, but you probably won't spend much time here.



Leopard gunner's interior view

SELECTING THE GUN

The gunner controls both the main gun and the coaxially mounted machine gun (the coax). He chooses between these weapons by setting the gun selection switch

to either main or coax. This switch not only controls which weapon fires when the gunner pulls the trigger, but it also affects the superelevation and lead computed by the ballistic computer. You can toggle between main and coax in Steel Beasts by using menus, or by pressing M.

CHOOSING TIS OR DAY OPTICS

In the GPS screen, pressing the + key on the keypad will toggle the TIS on and off. Pressing the - key on the keypad will toggle between white hot and black hot, for the TIS display. You can also control these settings through menus. Because the Leopard's GPS day view has a single 12X magnification, the TIS is especially important when scanning for targets because of the wider field of view it provides

Leopard GPS with TIS on

STEERING THE GUN

Most of the time, as a gunner on the Leopard, you'll be looking through the gunner's primary sight (GPS) and operating the gun in normal fire control mode. To steer the gun in normal mode or emergency mode, simply move the joystick left, right, up or down. You can also use the mouse to steer the gun by first left clicking in the GPS window, and then moving the mouse. **To stop steering with the mouse, click the left mouse button again.** In manual mode, you'll have to repeatedly press the arrow keys to steer the gun. This is meant to simulate the turning of the hand cranks on the real tank. (On the Leopard, you can use the hand cranks in emergency mode too.)

LASING A TARGET

As long as the fire control mode is in normal mode or emergency mode, and the LRF is functional, you can lase a target by pressing the lase button. Upon lasing, the range will automatically be entered into the ballistic computer. In normal mode the main gun will automatically be raised or lowered to the calculated superelevation, while the view through the GPS will remain the same. In emergency mode, the angle of the head mirror will change to match the superelevation, so the view through the GPS will change, and the sight will have to be re-laid back onto the target.

When lasing a target, try to ensure that the target fills the entire circle of the GPS reticle. The divergence of the laser beam is indicated by this circle, so if the target is too small to contain the entire reticle circle, the LRF will probably receive multiple returns. If you receive multiple returns, the display at the bottom of the GPS will flash. Unlike the M1, the Leopard 2A4 always uses the LAST return time to calculate the range. Because of this, you might want to lase a little low so the beam does not spill over the top of the target and reflect off the distant landscape. You should aim at the center of the target when firing, though.

Besides lasing targets, you can also lase the terrain to find the range to a certain point you are interested in. If you switch back to the map screen, you'll see the last spot you lased marked on the map to help you identify points.

Unlike the laser on the M1's LRF, the laser on the Leopard will not burn out with overuse. It will, however, shut down to prevent overheating. To ensure that you have a working LRF when you need it, never fire more than four pulses in an 80 second period. Don't hold the lase button down for a long time, either.

ADDING LEAD

If you're shooting at a target that appears to be moving laterally with respect to your tank, lead will have to be added to the gun to compensate for the amount the target and/or your tank will have moved during the flight of the round. In normal mode on the Leopard, if the target is stationary and your tank is moving, you don't have to do anything special; the ballistic computer calculates lead based on your tank's relative velocity with respect to the target, as well as the range entered into the ballistic computer, and the type of ammunition selected. **If the target is moving, you must hold down the dynamic lead button**. In this case, the (nearly) instantaneous angular velocity of the turret is also used in the lead calculation. Dynamic lead is cancelled as soon as you release the dynamic lead button. Note that in both cases, automatic lead is added ONLY in normal mode.

In Steel Beasts, the dynamic lead button is joystick button 3 (or P or the middle mouse button). Some joysticks may not handle multiple, simultaneous button presses, so pressing button 1 (fire button) while pressing button 3 may result in the loss of dynamic lead. If you have one of these rare joysticks, use P for dynamic lead instead.

In emergency mode and manual mode, lead must be manually added, which is a very difficult task requiring a lot of practice, and quite a bit of luck. You need not make wild guesses, though. Estimate the time of flight for the round, and then measure the distance the target moves across your reticle in that time. That distance is how far you should lead the target. Make sure you note the amount of lead you added when firing at the target so you can make adjustments if your first shot misses.

FIRING THE GUN

To fire the gun, press the fire button. The proper way to aim and shoot at moving targets in normal mode is to steadily track the target, lase, hold down the dynamic lead button and then fire. Be sure to keep the dynamic lead button depressed until the gun has fired. Firing will be disabled until the gun has moved to the correct lead position, so you will usually have to wait a fraction of a second after first pressing the dynamic lead button before you can fire.

Remember that dynamic lead is based on your turret's movement at the very moment you pull the trigger. A common mistake made my novice Leopard gunners is to fire while compensating for falling behind (or getting ahead of) the target. In this case, the angular speed of turret is faster (or slower) than the actual target, resulting in too much (or too little) lead being added, and, hence, a miss.

You may have noticed that the Leopard gunner does not have to set an ammunition selection switch. On the Leopard, the loader sets a switch indicating what round he loaded, making the gunner's job easier than that of his M1 counterpart, who must mentally keep track of the ammo currently loaded and set the ammunition selection switch accordingly.

MANUAL RANGE ENTRY

If you find that your laser rangefinder (LRF) is damaged, but you still have a functioning ballistic computer, you can still use the GPS by estimating the range to the target and manually entering it into the ballistic computer.

In Steel Beasts, you manually enter the range by pressing the numbers keys 0-9 (NOT on the keypad) while in the GPS screen. You'll notice that once you start entering the numbers, the range display at the bottom of the GPS will change from green, to white with a black background. Once you have entered the correct range value, press Enter to input this range into the ballistic computer. The range display will once again appear in green

11 The Commander's Position

You can occupy the commander's position for either the M1A1 or the Leopard 2A4 by pressing F7, or by using menus to change your crew position. Be aware, however, that some missions (mainly tutorials) will prohibit the player from occupying the commander's position.

The tank commander's main function is to coordinate the actions of the crew. He tells the driver where to go; he tells the loader what ammo to load; and he tells the gunner what targets to shoot. In addition, he can request an artillery strike, although it might not be granted.

Unlike the gunner, who is seated deep within the tank, the TC can view the outside world with his head out of the hatch. This improves situational awareness and makes navigating easier, but it is potentially more dangerous for the TC. If the tank comes under fire, the TC can "button up," by closing the hatches, and then the TC would look through the vision blocks. Because the TC's view is higher than both the gunner's sight and the gun tube, he also has to remember that he might be able see things that the gunner cannot, as illustrated below.

Remember that in Steel Beasts, driving from the TC's position is different than driving from the gunner's position or from the external view. (See the earlier section on *moving you units*.) As TC, it's your job to decide when to stop and face the enemy, so the tactics of any route you may be on are irrelevant.

M1A1 Commander's Position

The tables below summarizes the commander's controls for the M1A1 in Steel Beasts.

M1A1 Commander's hot key mappings		
Fire button	=	joystick button 1 or Spacebar
Lase button	=	joystick button 2 or Ctrl or right mouse button.
Palm button	=	joystick button 3 or P or middle mouse button.
Mag button	=	Joystick Button 4 or N.

M1A1 Commander's hot keys

Hot key	Command
F1	TC eye view (buttoned or unbuttoned)
F2	Gunner's primary sight extension (GPSE)
F3	0.50 Cal. Machine Gun sight
F5	Map screen
B	Button/unbutton tank
Fire button	Order gunner to fire at target. (Fire gun if overriding.)
Lase button	Drive to this point upon release. (Lase, if overriding.)
Palm button	Palm switch ON, which overrides the gunner. **(Pressing the Shift key keeps palm switch on.)**
Mag button	Toggles binos on/off in TC unbuttoned eye view. (Toggles magnification in GPSE if overriding.)
Shift joy hat or Shift ↑ → ←	Order gunner to move turret front, left or right, with respect to the hull.
M	Order gunner to use main gun / coax
Insert	Order loader to load Sabot next round
Delete	Order loader to load HEAT next round
Home / End	Order loader to load amo #3 /#4 next round (not used)
,	Order gunner to set fire control mode to **normal**
.	Order gunner to set fire control mode to **emergency**
/	Order gunner to set fire control mode to **manual**
Keypad +	Order gunner to toggle TIS (on / standby)
Keypad -	Order gunner to toggle TIS polarity (white hot / black hot)
0 - 9 then Enter	Change battle sight range
Backspace	Enter current battlesight range into ballistic computer

VIEWS

The TC's eye view F1 provides a 1x view of the virtual world. You can change the viewing direction by moving the joystick, or by left clicking in the view window and then moving the mouse. You can also set your view to face front, back, left or right, with respect to the turret, by using the joystick hat, or the arrow keys on the keypad of the keyboard. This is especially useful when your gunner spots a target and you want to look in the direction of the gun.

To button or unbutton the tank, press B, or use the menus. If you are NOT buttoned, you can toggle the binocular view on and off by pressing the mag button.

M1 commander unbuttoned

The gunner's primary sight extension (GPSE) F2 provides an exact view of what the gunner is viewing through the GPS. This is useful for identifying targets before giving the order to fire, and should also be used if you want to lase and shoot the target yourself. You won't be able to change viewing directions in this view unless you override the gunner.

The 0.50 caliber machine gun sight F3 is an unstabilized 3x sight that you can use to fire the 0.50 cal machine gun. Although it's the gunner's job to shoot at targets, the .50 cal. can be useful in desperate situations to fire at lightly armored targets up to about 1200 meters. Because the 0.50 cal is an unstabilized gun, you should fire it only when at a halt. (Note that the 0.50 cal on the M1A2 can be moved and fired from the unbuttoned position, but on the M1A1, it is aimed and fired from within the tank using the 3X sight.)

M1 commander's caliber .50 sight

DESIGNATING TARGETS

On the M1A1, the TC has a joystick-like control that he can use to aim, lase and shoot the main gun (when the fire control mode is set to normal or emergency). Although these tasks should be left to the gunner, the TC will typically designate a target by pressing the palm switch on this control to override the gunner and slew the gun to face the target. Once the gunner sees the target in his sights, he'll say, "Identified!" and the TC should release the palm switch to give control back to the gunner. The TC should then issue the order to fire.

In Steel Beasts, the palm button serves as the palm switch for the TC. When the TC's palm switch is depressed, you can use the joystick or mouse to aim, lase and shoot the main gun. The palm switch works in all three TC views. It takes quite a bit of practice for M1A1 TC's to efficiently slew the gun to face a target. In Steel Beasts, you have a little help if the realism level is not set to *high*: a crosshair (or box) will appear in the TC eye view when you override the gunner to help you place the gun on the target.

If you will be overriding the gunner for a long time, pressing the shift key while the palm switch is depressed will make the palm switch "sticky" so you can let go of the palm button. Pressing the palm button again, will reset this sticky switch.

You can also order the gunner to slew the turret in a certain direction, thus guiding him to a target, by pressing the joystick hat up, left or right (or the up, left or right arrow keys) while holding down the Shift key. The gunner will then slew the turret to the front, left or right (with respect to the hull).

DESIGNATING AMMO TYPE

You can change the ammunition type of the next round that the loader will load by using or by using menus or the hot keys Insert, Delete, Home or End. **(Currently, only sabot and HEAT rounds are available.)** The ammo type currently designated is displayed at the top, right of the TC's screen. You can also order your gunner to use the coax or main gun by pressing M to toggle between the two.

FIRING THE GUN

Once your gunner says, "Identified!" you should stop overriding the gunner, by releasing the palm button, and then press the fire button to issue the order to fire. You can also choose to fire the gun yourself, by pressing the fire button while overriding the gunner. Be careful not to confuse these two commands.

BATTLESIGHT ENGAGEMENTS

As the TC on the M1A1, you can enter the current battlesight range into the ballistic computer by pressing the backspace key. This also starts a battlesight engagement, in which the gunner will NOT lase the target before firing. This is useful when it's urgent that the gunner fire quickly at a nearby target. If you start a battlesight engagement, your gunner will fire the gun *without* waiting for you to issue an order to fire.

The default battlesight range is 1200 meters, but you can change it to whatever you want by typing the desired range on the keyboard in the GPSE view, and then pressing Enter. After pressing Enter, the range display in the GPSE will return to its previous value, but the ballistic computer will remember the value you just entered and use it every subsequent time you hit the backspace key in a given engagement, until you change the range value again.

LEOPARD 2A4 COMMANDER'S POSITION

The tables below summarizes the commander's controls for the Leopard 2A4 in Steel Beasts.

Leopard 2A4 Commander's hot key mappings		
Fire button	=	joystick button 1 or Spacebar
Lase button	=	joystick button 2 or Ctrl or right mouse button.
Cancel button	=	joystick button 3 or P or middle mouse button.
Mag button	=	Joystick Button 4 or N.

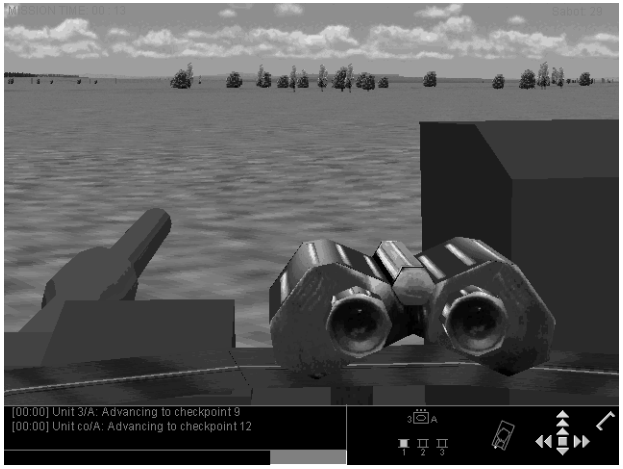
Leopard 2A4 Commander's hot keys

Hot key	Command
F1	TC eye view (buttoned or unbuttoned)
F2	"GPSE" Peri view
F3	Normal Peri view
F5	Map screen
B	Button/unbutton tank
Fire button	Order gunner to fire at target. (Fire if overriding.)
Lase button	In TC eye view, drive to this point upon release. (Lase, if overriding and in KW mode.
Cancel button	Cancel override or surveillance mode of peri.
Mag button	Toggles binos on/off (GPSE mag if overriding in GPSE.)
Joy hat Up or ↑	Slave gun to Peri, which overrides the gunner.
Joy hat Down or ↓	Slave Peri to gun.
Keypad *	If overriding gunner, enter KW mode.
Shift joy hat or Shift ↑ → ←	Order gunner to move turret front, left or right, with respect to the hull.
M	Order gunner to use main gun / coax
Insert	Order loader to load Sabot next round
Delete	Order loader to load HEAT next round
Home / End	Order loader to load amo #3 /#4 next round (not used)
,	Order gunner to set fire control mode to **normal**
.	Order gunner to set fire control mode to **emergency**
/	Order gunner to set fire control mode to **manual**
Keypad +	Order gunner to toggle TIS (on / standby)
Keypad -	Order gunner to toggle TIS polarity (white / black hot)
0 - 9 then Enter	Manual range entry
Backspace	Enter battlesight range into ballistic computer

VIEWS

The TC's eye view F1 provides a 1x view of the virtual world. You can change the viewing direction by moving the joystick, or by left clicking in the view window and then moving the mouse. You can also set your view to face front, back, left or right, with respect to the turret, by using the joystick hat, or the arrow keys on the keypad of the keyboard. This is especially useful when your gunner spots a target and you want to look in the direction of the gun.

To button or unbutton the tank, press B, or use the menus. If you are NOT buttoned, you can toggle the binocular view on and off by pressing the mag button.



Leopard commander unbuttoned

The "GPSE" peri view F2 provides an exact view of what the gunner is viewing through the GPS. This is useful for identifying targets before giving the order to fire, and should also be used if you want to lase and shoot the target yourself. You won't be able to change viewing directions in this view unless you override the gunner. Be warned, though, that dynamic lead is never available from the TC's position, so you'll have to add lead manually if you want to shoot from the TC's position. In addition, you cannot use the laser rangefinder unless you enter a special mode called KW mode, by pressing * on the keypad while overriding the gunner.

The normal peri view F3. Unlike the M1A1, the Leopard 2A4 has a stabilized periscope (peri, for short) for the tank commander, which he can use to observe a full 360 degrees at 2x or 8x magnifications. Although the peri does not have an independent thermal imaging system (TIS), it does have an optical channel to the

GPS, which the TC can use to view the gunner's TIS, as well as the gunner's 12x day sight. (This is the GPSE peri view described above.)

Leopard commander's peri

DESIGNATING TARGETS

On the Leopard 2A4, the TC designates targets using the peri by pressing an override button that slaves the gun to the peri, causing the gun to come into alignment with the peri. Once the gunner can see the target, he says, "Identified!" and the TC then presses a cancel button, stopping the override and giving control back to the gunner. The TC then issues the order to fire. Note that the TC can override the gunner **only** when the gun's fire control mode is set to normal.

If the gunner spots a target before the TC, the TC will usually verify the target without overriding the gunner by flipping a switch to view the GPS. (Since this view is similar to the GPSE on the M1, we call it the GPSE view.) However, the TC can also have the peri automatically come into alignment with the gun by pressing a surveillance button, which slaves the peri to the gun. To cancel surveillance mode, he presses the cancel button.

In Steel Beasts, pressing the joystick hat up (or the up arrow key) puts the peri in override mode, while pressing the joystick hat down (or the down arrow key) puts the peri in surveillance mode. Pressing the cancel button cancels both override and surveillance modes, returning the peri to normal mode.

You can also order the gunner to slew the turret in a certain direction, thus guiding him to a target, by pressing the joystick hat up, left or right (or the up, left or right arrow keys) while holding down the Shift key. The gunner will then slew the turret to the front, left or right (with respect to the hull).

DESIGNATING AMMO TYPE

You can change the ammunition type of the next round that the loader will load into the gun by using menus or by using the hot keys Insert, Delete, Home or End. **(Currently, only sabot and HEAT rounds are available.)** The ammo type currently designated is displayed at the top, right of the TC's screen. You can also order your gunner to use the coax or main gun by pressing M to toggle between the two.

FIRING THE GUN

Once your gunner says, "Identified!" you should stop overriding the gunner, by pressing the cancel button, and then press the fire button to issue the order to fire.

You can also choose to fire the gun yourself, by pressing the fire button while overriding the gunner. **Remember, when you override the gunner on the Leopard, the gun moves to align with the peri -- even if you're in the GPSE view.** If you want to shoot a target that's lined up in the GPSE view, make sure you first align the peri with the gun by pressing the joystick hat down (or the down arrow key). After waiting for the peri to come into alignment with the gun, you can then safely press the joystick hat up (or the up arrow key) to override the gunner without having the gun move off the target.

Here are some final notes for those who really want to do a lot of shooting from the TC's position: The TC can lase a target **only** when he puts the peri in special mode, called KW mode, by pressing the KW-mode button (* on the keypad) while overriding. In KW mode, the TC directly controls the gun through the GPS mirror, and the peri is slaved to the gun. The TC can, however, manually enter a range into the ballistic computer when overriding the gunner. In Steel Beasts, simply type the desired range on the keyboard in the GPSE view, and then press Enter. Also, remember that **dynamic lead is never available from the TC's position**, so the TC must always add lead manually when shooting at moving targets.

BATTLESIGHT ENGAGEMENTS

As the TC on the Leopard 2A4, you can enter the battlesight range (fixed at 1000 meters) into the ballistic computer by pressing the backspace key This also starts a battlesight engagement, in which the gunner will NOT lase the target before firing. This is useful when it's urgent that the gunner fire quickly at a nearby target. If you start a battlesight engagement, your gunner will fire the gun **without** waiting for you to issue an order to fire.

12 THE EXTERNAL POSITION

You can occupy the external position of any player-controlled combatant by pressing F8, or by using menus to change your crew position. **Be aware, however, that some missions (mainly tutorials) will prohibit the player from occupying the external position.** For all combatants besides the M1 and the Leopard, the external position is the only position available.

In the external position, all crew positions are manned by the computer, so you can sit back and just watch the action. For this reason, the external position is ideal if you prefer to issue a lot of commands from the map screen during the execution phase. However, you can still issue direct driving commands and platoon commands using hot keys or menus as if you were in the commander's position. (Make sure you read the earlier section on moving your units.)

External view

13 Calling Artillery

Steel Beasts models four types of artillery: HE, smoke, ICM and FASCAM. HE is conventional high-explosive artillery. Smoke is self-explanatory. ICM (improved conventional munitions) is a particularly deadly type or anti-tank artillery. FASCAM (family of scatterable mines) is an instant minefield delivered by artillery. **Depending on the mission, you may or may not have support for a particular type of arty.** Although ICM and FASCAM are very deadly and effective types of artillery, you will usually not have access to them because they are also rather rare. All units would like to have the best artillery support, but there is only so much to go around, and much of it is used against enemy artillery.

There are two ways to request an artillery strike: use the *Support Menu* from the TC eye view, or use context-sensitive menus from the map screen.

From the TC eye view, move the mouse to the top of the screen and select the ammo type you want from the Support Menu. A white arrow pointing down will appear on the screen. Move this cursor to the point on the terrain you wish to be the center of the barrage and left-click the mouse. (To cancel a request, left click on the sky, or select *cancel* from the Support Menu.)

After selecting a location for the strike, you will be transported to the map screen where you will see a dashed red box, indicating where the arty strike will hit. (If you were unbuttoned at the time, you will automatically be buttoned up.) You can adjust the position, size and orientation of this arty box by clicking on it to select it, and then clicking on one of the control points and dragging. Make sure you adjust the arty box quickly, because once the shells are in the air, you will not be able to make any adjustments.

Alternatively, you can call for artillery directly from the map screen by right clicking on the map and selecting *New arty field* from the context-sensitive menu. You can then adjust the field as described earlier.

After you have requested an artillery strike, the time till impact (or splash) will be displayed in the center of the arty field in the map screen. The time till the next arty impact will also be displayed in the upper right corner of the non-map screens.

14 Multiplayer

Overview

Playing a multiplayer game in Steel Beasts is very similar to playing a single-player game, except that you can play with and against other human players. Any mission available in single-player mode can be played in multiplayer mode, as long as the mission contains at least one player-controlled tank. Before the mission begins, each player chooses which side to play on, and picks an initial vehicle to start off in. As with single-player mode, all unoccupied vehicles and positions are manned by AI crew members. Once the execution phase begins, players can jump to any unoccupied position of any vehicle or squad on their side (with some restrictions, explained later), again, similar to single-player mode. When the game is over, the score calculations are determined exactly the same way as in single player mode.

Depending on the mission, and how the players choose sides and positions, any form of cooperative or competitive play is possible. For the M1 and Leopard, two human players can even occupy the same tank as TC and gunner. For those who like to play "wargamer style," playing a one-on-one competitive mission is very much like playing a single-player game, except that a human, not the computer, is controlling the other side. For those who like more action, adding more players in the mix, and playing simpler mission is the way to go.

Although any mission can be played in either single-player or multiplayer mode, inherent differences in the style of play for these two modes makes certain missions better suited for one or the other. With the exception of one-on-one "wargamer style" games, missions designed for multiplayer mode will typically have clear and simple goals, and quite often a maximum time limit, so that game play does not drag on too long. In addition, these "multiplayer missions" will usually have fewer vehicles and infantry, reducing the strain on bandwidth, which is especially important when there are more than two players. Of course, if you don't find a mission that exactly suits your needs, you can always create it using the integrated mission and map editors.

Who Controls What?

One complication of cooperative multiplayer games is ensuring that more than one player doesn't try to control the same vehicle or unit at the same time. Although it's straightforward to prevent players from occupying the same position in the same vehicle, there still is the potential problem of multiple players issuing conflicting routes to the same unit.

The approach used in Steel Beasts to solve this problem is to assign ownership of each unit to a single player before the game begins, and then allow only the owner of a unit to issue driving commands to that unit. Different players can own different units, but each unit has only one owner. Once the game begins, ownership does

not change, unless one player gives a unit he controls to another player, or a player drops out of the game. **Only the owner of a vehicle can occupy the TC position, issue driving commands or assign routes for that vehicle**. Other players can jump into the external position (or gunner's position, if you allow it) but they cannot control where the vehicle will go.

Just before the game begins, all the units are assigned an owner. **The decision of who owns what is based on the rank of the initial vehicle you pick in the Assembly Area. The higher your rank, the more you control.** Since you choose your initial vehicle before the game begins, make sure you choose wisely. The general rules for assigning control at the start of a game are as follows:

- Gunners own no vehicles. If you want to issue driving commands to a tank, do NOT start in the gunner's position.
- Tank commanders (TCs) always own their own vehicle.
- Platoon leaders always own their own vehicle, as well as all vehicles in their platoon that do not have a human TC.
- Company commanders (or the player with the highest rank in the company, if there is no CO) own their own vehicle, and all vehicles in their company that are not owned by a human TC or platoon leader.
- If there is a company that has no human TC, platoon leader or CO, then all the vehicles in that company are owned by the player in the overall highest ranking vehicle.

Once the game begins, you can tell which units you own by looking at the map screen. Units in dark blue are owned by you, whereas units in light blue are owned by either the computer or another player.

STARTING A MULTIPLAYER GAME

COORDINATING PLAYERS

The first step to playing a multiplayer game is to find other people to play with, coordinate a time to play, and decide who will host the session. If you're playing over a home or work LAN, then this should not be a problem. If you're playing over a modem, then it's simply a matter of calling up a friend. If you're playing over the Internet, then using a game lobby service like Kali can be a convenient way to coordinate games. Alternatively, you can use a program like ICQ to get a group of players together to start a game.

When you join a multiplayer session over the Internet, you generally must know the IP address of the host player's computer to connect to it. If you're hosting a session, you'll need to find your IP address and tell all the other players what it is. For players who dial up to an Internet Service Provider (ISP), your IP address will usually change every time you log on. You can find your current IP address by logging on to the Internet, starting Steel Beasts, and selecting Multiplayer from the

Main Menu. Your IP address will be displayed at the bottom of the screen. If your computer is also connected to a LAN, you will see two IP addresses listed. Make sure you give your friends the IP address allocated by your ISP. Alternatively, you can run the Windows command *winipcfg* from the Windows Start Menu after logging on.

To optimize performance for Internet play, the player with the fastest connection to the Internet should host the game. (Hopefully, this player also has a fast computer.) While most home DSL and cable modem connections offer very fast download rates, the upload rates are typically much slower (usually only four times faster than a 28k modem). Unfortunately, during a game the host player's machine will have to upload as much or more information than it downloads, so use the average of the upload and download rates when comparing Internet connection speeds.

HOSTING A SESSION

To host a session, start Steel Beasts and select *Multiplayer* from the Main Menu. Once in the Multiplayer screen, make sure that the first line below the title reads *Act as: Host*. (If it reads *Act as: Client*, click on the word *Client*.) Next, enter a call name that will identify you to other players. If you've previously entered a call name in the *Records* screen, that call name will automatically be entered whenever you start a multiplayer game. Finally, select a connection type (IPX, Internet TCP/IP, or modem) and click on *Go*.

You will now be transported to the *Host Game* screen. Enter a session name so that players who are joining your session can identify you. If you've previously entered a call name in the *Records* screen, a default session name will automatically appear. Select a mission to play and then click on *Open* to go to the *Assembly Area* screen, which is discussed shortly.

JOINING A SESSION

To join a session, start Steel Beasts and select *Multiplayer* from the *Main Menu*. Once in the Multiplayer screen, make sure that the first line below the title reads *Act as: Client*. (If it reads *Act as: Host*, click on the word *Host*.) Next, enter a call name that will identify you to other players. If you've previously entered a call name in the *Records* screen, that call name will automatically be entered whenever you start a multiplayer game. Select a connection type (IPX, Internet TCP/IP, or modem) that matches what the host player is using. If you're connecting over a modem or the Internet, you'll have to enter a telephone number or IP address of the host player. Once you've entered the required information, click on *Go*.

You will now be transported to the *Join Game* screen, which lists all the sessions that you can join. Select the session you want to join and click on *Join*, to go to the *Assembly Area* screen.

THE ASSEMBLY AREA

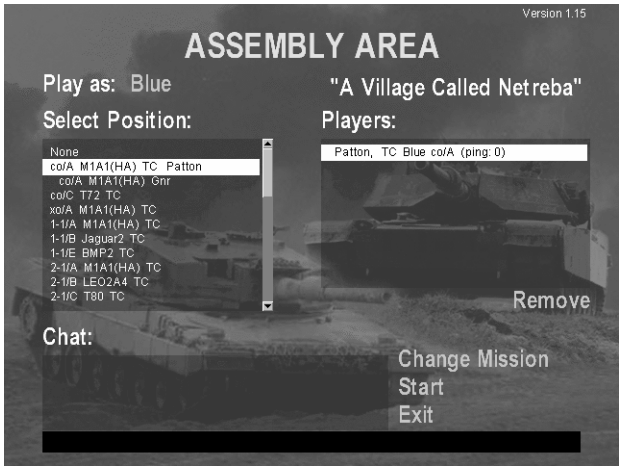
After opening the mission when hosting a session, or joining a session hosted by another player, you will be sent to the *Assembly Area* screen. You can see the names of all players currently in session and chat with them. If you're the host, you can remove any player you want by highlighting a player's name and clicking *Remove*. As host, you can also change the mission if you like, and you decide when to start the mission. If you're not the host, you can click on *Ready* to let the host know that you're ready to start.

The most critical part of the Assembly Area is choosing which side (Red or Blue) to join, and which tank and position to start out in. Remember that the rank of the vehicle you pick will determine what other vehicles you own. To help you decide which vehicle to pick, the vehicles are listed on the left side of the screen in descending order of rank.

If you pick an M1 or Leopard to start out in, you will be asked whether you want to let another player in your tank as gunner. This applies not only to the tank you picked, but all tanks that you own. If a player has allowed others to join his tanks, then you can choose to be in the gunner's position of his tank. Remember, if you start out as a gunner, you will not own any vehicles, and, hence, cannot control where any vehicle goes.

Once all the players have made their choice of side and vehicle, the host player clicks on *Start* to launch the game. **Any players that have not selected a starting unit at this time will be kicked out of the session.** Once the game launches, the

session is closed to all other players who might want to join until the game ends and the players return to the *Assembly Area*.



Playing a Multiplayer Game

Once the game launches, you go through the same phases of play as in a single-player game. You start in the planning phase, then go to the execution phase, and end in the debriefing. After the debriefing you can return to the *Assembly Area* to quit or start a new game.

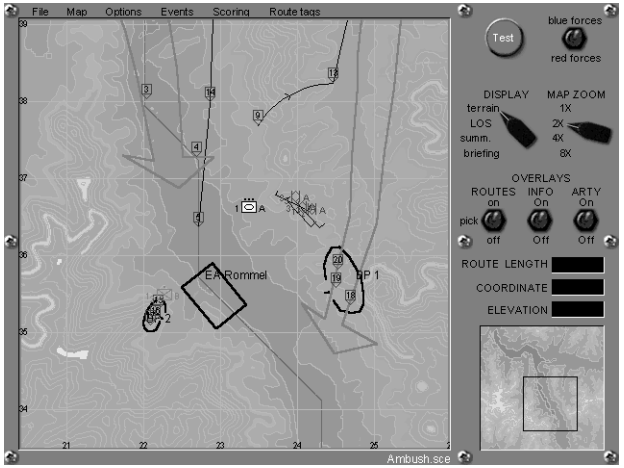
The game play of a multiplayer game can be very similar to that of a single-player game, except for the added psychology of playing with humans. You can chat with other players in your tank, platoon, company, side or everyone by setting the chat channel in at the bottom of the screen. If your tank is destroyed, you can jump to any other vehicle, although you can only become TC and issue driving commands if you control the vehicle. You can also transfer ownership of any unit you own to another player on your side by right clicking on the unit in the map screen and selecting the appropriate item in the context-sensitive menu.

Besides being able to chat with other players, you can also send players on your side reference points and (in the planning phase) lines and map text, all of which you create in the map screen. To send these informational objects to other players, right click on the object in the map screen and select whom to send the object to. The planning phase is a great time to draw out a battle plan and send it to other players to coordinate you actions. Once the execution phase begins, the only map object you can send to other players is the reference point (which can contain text).

15 Creating a Mission

Steel Beasts provides an integrated mission editor for you to create and modify missions. To start the mission editor, simply click on *Mission Editor* from the *Main Menu* screen. You'll notice that the mission editor looks similar to the 2D map screen in the planning phase. In fact, creating a mission is very much like creating a battle plan in the planning phase, with some added complexities and options. The main complexity is the addition of conditioned routes to make up the high-level AI of the computer-controlled units.

The following sections will go through all the steps needed to create your own mission, although you don't have to follow them in the order presented. (If you're modifying an existing mission, you'll have to load it from the *File* menu, located at the top, left of the screen.) If you haven't already done so, read the sections on the *Map Screen*, on *Units, Routes and Checkpoints*, and on *Moving Your Units* before proceeding.



Mission editor

In the mission editor, you add or modify objects on the map for only one side at a time. A switch located at the upper right-hand corner of the screen controls which side, blue forces or red forces, your editing affects. Any object placed on the map belongs to either the blue forces or the red forces, and you can only see the objects for one side at a time. In addition, some items contained in the menu bar at the top of the screen will apply only to the side selected by the forces switch.

Select a Map: The first thing you should do when creating a mission is to decide which map you want to use. Click on the *Map* menu at the top of the screen to pick an existing map. If you don't like any of the existing maps, you can create your own in the map editor.

Set Visibility: Set the maximum visibility range for your mission in the *Options* menu.

Set Support Levels: Set the support levels for different types of artillery in the *Options* menu. The support levels apply only to the side set by the forces selection switch.

Set a Time Limit: If you want the game to end after a certain time, you can set a maximum time in the *Options* menu. Time limits are probably most useful in multiplayer games.

Set Player Restrictions: In most cases, you'll want to let the player occupy the gunner's, commander's and external positions, as well as letting him move his units. You can restrict any of these options by removing the check mark next to the corresponding item in the *Options* menu. Note that it doesn't make sense to restrict the player from all three positions. If you do this, the player will have access to only the external position.

Place Units on the Map: Once you decide how many and what types of units you want for each side, you can start placing them on the map. Simply right click on an empty space of the map and highlight *New Unit* from the context-sensitive menu. You'll see a list of all the available units. Select a unit from the list, and it will be created at the point you clicked. You can move this unit anywhere you like by left clicking on the lower left corner it to select it, and then left clicking and dragging on the selected unit.

Units are created as platoons, filling first A company, then B company, etc... Note that for the US, companies consist of three platoons of four tanks each, plus the CO's and XO's tanks. For Germany, a company consist of four platoons of three tanks each, plus the CO's tank. For Russia, companies consist of three platoons of three tanks each, plus the CO's tank. For example, the first unit you place on the map will be 1/A (first platoon of A company). Subsequent units for US tanks will then be 2/A, 3/A CO/A XO/A 1/B, 2/B, etc… Subsequent units for Russian tanks will be 2/A, 3/A CO/A 1/B, 2/B, etc… Special units, such as the FISTV, can only be placed one per company.

You can split up any unit into smaller units by right clicking on the unit and selecting *Divide Unit*. Any unit can be deleted by selecting the unit and then pressing the delete key. Units from the same platoon and company can be recombined by right clicking on one of the units and selecting *Attach to*, and then left clicking on the second unit. The two units must be within a few hundred meters of each other for the attachment to succeed. For example, to create a platoon of three tanks plus a single tank from a platoon of four tanks, you would first divide the original platoon, resulting in two sections of two tanks each. Then divide one of the sections into two individual tanks. Finally, attach one of the individual tanks to the section of two tanks.

If you want a unit to assume a battle position, you can do so by right clicking on the unit and selecting *Hold*, *Defend* or *Guard* from the *Tactics* menu. You can also set the initial formation, spacing and fire control for the unit in a similar way.

Set Unit Options: Once you have a unit place on the map, you can choose to alter some of its properties by right clicking on the unit and selecting *Options* from the context-sensitive menu.

You can make a unit computer controlled or player controlled by selecting the owner. The unit can also initially be computer controlled, and then become player controlled once a condition is satisfied during the execution phase. (Useful for giving a player control over reinforcements.)

Useful for tutorial missions, you can choose to make any unit *blind*, *impotent*, or *return fire only*, by altering the *Status*. Blind units are completely oblivious to enemies, even if they bump into them. Impotent units behave just like normal units, except that they fire harmless blanks. Return-fire-only units will only fire if fired upon first if not manned by a human player. In addition, you can set a unit to be destroyed. You might want to do this if your mission takes place after a battle (such as a counterattack) so that there should be some destroyed vehicles on the battlefield. Along the same lines, you can add a specific type of damage, or a random damage.

If you want to give the player (or computer) some knowledge about the initial position of an enemy unit, you can do this by setting the *Enemy Info*. If you choose exact or rough knowledge for a unit, an enemy player will see the location of that unit (with an added error for rough knowledge) in the planning phase and at the beginning of the execution phase. The unit's symbol will disappear from the map in a few minutes of the execution phase if no blue units can detect it.

Set the Initial Active Unit: You can set the unit that the player will initially occupy by double clicking on any player-controlled unit. The unit icon will change to yellow and black, indicating that the player occupies that unit.

Create Events: Events are referenced in the scoring formula, and in some conditions. In the scoring formula, events serve as mission goals, which you can assign points to if True.

Add Routes and Checkpoints: This is where the meat of mission design takes place. The goal is to create a network of conditioned routes and checkpoints that the computer-controlled units can follow during the execution phase. Making a rigid suicide assault is pretty easy, since the units will always follow the same paths, no matter what happens. If you want to make a more flexible plan for the computer-controlled units, you'll have to add battle positions and multiple branching routes with conditions at key checkpoints to allow the units to stop at certain points, and to take one of several routes, depending on the situation. Refer to the earlier sections on *Moving your Units* and *Conditions* for more information on creating routes.

You can also choose to make any computer-controlled checkpoint or route invisible to the player during the game by selecting *Set Display* from the context-sensitive menu. Invisible routes and checkpoints are drawn in yellow.

As noted earlier, you can assign explicit conditions for embarking and retreating on a route. These conditions are assigned to a route by right clicking on the route's information box and selecting *Embark if…* or *Retreat if…* . You can also assign an *open-fire* condition to checkpoints by right clicking on the checkpoint and selecting *Open fire if…* . This is useful for setting up ambushes, for instance. Of course, any event you create will also have a condition assigned to it.

Add Mine Fields: You can create mine fields by right clicking on the map and selecting *New mine field*. The position and shape of the mine field can be adjusted by left clicking and dragging on the control points of a previously selected mine field. Mine fields created for one side, red or blue, will be known to all unit on that side, but unknown to the other side. Once an enemy unit hits a mine field, the mine field becomes uncovered to all enemy units.

Add Artillery Fields: You can place pre-planned artillery strikes by right clicking on the map and selecting *New arty field*. Once you do this, a condition dialog window will appear, which determines when the arty field will become active. Note that there will be a 30 second delay from the time the condition is true until the arty shells actually hit the ground because of the time of flight of the artillery. Once you fill out the condition window, you can alter the position and shape of the arty field by left clicking and dragging on the control points of a previously selected arty field. You can also control how often the arty strike repeats.

Add Regions : Regions are polygons that you create by right clicking on the map and selecting *New region*. Make a series of left clicks on the map to add vertices to the region, and right click anywhere on the map to end the region. You can modify the shape and location of the region by selecting the region and then clicking and dragging the selected region or vertex.

Regions are used by some conditions, as noted earlier, and they can also be used as informational aids to the player, such as denoting an objective area. If you want a region to be visible to the player, you must type a label in the region's text box. Most regions used by conditions should remain invisible to the player, so you would leave the text boxes in these regions blank.

You can also convert an ordinary region into a special type of region: a *penalty zone* or a *deployment zone*. In mission editor, right click on a region and select *Penalty zone* to select the type of penalty, units that are exempt from the penalty, and the likelihood of penalty. Penalties are assessed every 30 seconds on units that enter the region, with a 30 second warning before any penalty is inflicted. Warnings are only given to the player if the unit he occupies has entered a penalty zone.

Deployment zones are created by right clicking on a region in mission editor and selecting *Deployment zone*. During the planning phase, a player can move any unit that is in a deployment zone anywhere within any deployment zone of the same color by clicking and dragging the unit icon in the map screen.

Add Lines and Map Text: Lines and map text are used only as informational aids to the player. A line is really a connected series of points that you create by right clicking on the map and selecting *New line*. Again, you would left click to create the series of points, and right click anywhere to end the line. You can choose to fill in the text label of the line if you wish, but the line will always be visible to the player. Typical uses for lines are to create phase lines, or boundary lines, on the map, or to create large arrows that show the direction of movement for forces.

You can modify the style and color of both regions and lines by right clicking on the object and selecting the appropriate choice from the context-sensitive menus. In addition, you can modify the location of the attached text by clicking and dragging the text box of a highlighted line or region.

Set Minimum Mission Requirements: If you want to give the player a zero score unless he satisfies a certain condition, you should fill out the minimum mission requirement (for red or blue). You might do this, for example, in a defense mission where you insist on having the player wait until the enemy has conducted its attack before calculating the score. If the score is based on surviving units, then it's important to make sure that the attack actually took place!

In general, you should be very careful using a minimum mission requirement. If it is set too high, the player might always receive a zero score, which can be very frustrating. It's better to set an easy minimum requirement and then create a scoring formula with a large range.

Set the Scoring Formula: By clicking on the *Scoring* menu item on the top menu bar, you open a dialog window that allows you to create a scoring formula. Similar to the condition dialog window, the scoring dialog window has text boxes that can be modified by left and right clicking on the boxes. The maximum possible score for your formula is shown at the bottom of the dialog window.

Although there are items for hit percentage and kill times, these quantities are calculated based on the *player's* hit percentage and kill times when he is in the gunner's position. Because of this, you should use these items only when you force the player to be in the gunner's position (such as in training missions).

When creating a scoring formula, make sure that it closely matches the objectives you state in the mission briefing. You don't want to tell the player that it's critical to capture a certain region, and then give him no points for doing so. Likewise, if the mission must be completed in a certain time period, make sure you lower the score for taking too long.

Write the Briefing: By setting the display switch to *Briefing*, you can type in the briefing that the player will read at the start of the mission. Since the text editor in the briefing screen is rather crude, you can also compose the briefing using your favorite text editor and then import the text file into the briefing. To import or export a briefing, select ***File > Briefing***.

Write the Summary: By setting the display switch to *Summary*, you can type in the summary text that the player will read when browsing through the missions. The summary should be a one- or two-sentence description of what the mission is about. You can choose to leave the summary blank, if you wish, in which case the entire briefing will be displayed in its place.

Test the Mission: Once you've created your mission, you can click on the test button to make sure the units behave as you expected. In test mode, you can toggle between play-style icons and debug-style icons. Play-style icons are exactly what you would see if you were playing the mission outside of the mission editor. Debug-style icons allow you see the positions of all individual tanks at all times on the map screen, as well as the positions of fired rounds.

You can also switch sides, between red and blue, through the *Play As* menu.

Appendix A: A Brief History of Tanks

By Ssnake

Tank construction always has been a struggle for the best compromise between armor, armament and mobility. In WW2, the famous German Tiger and King Tiger tanks were the most heavily armored, and fitted with a superior gun, but the result was poor performance in mobility. High fuel consumption and frequent breakdowns of transmission parts were the weak side of these monstrous tanks. The Panzer V, better known as the Panther, as well as its Soviet counterpart, the T-34, were better compromises. Good armor protection, good weaponry, but a far better mobility made it more useful to the tank troops than the Tigers.

After WW2, two major development philosophies emerged. While western countries were more concerned about their tanks' combat survivability, the Soviet Union rated high mobility in combination with high firepower more important than armor protection. This required a high superiority in numbers, but the socialist empire was willing to pay that price.

With the T-64B, the Soviet constructors built a tank with numerous new gadgets like the automatic loader, superior speed due to suspension track wheels, and improved night vision devices. The drawback was that the T-64 was not very reliable; its autoloader tended to load the gunner's arm instead of the ammunition, sometimes even the tracks fell apart! In the following decades, the Soviets improved the reliability of their tanks, while reducing the amount of new developments. A good testing ground for the quality of their material was the Near East in a series of wars between the Arab states and Israel.

Israel developed reactive armor to deflect HEAT rounds in the early seventies. This rather simple armor type has been subject to intense studies all over the world, and the Soviet T-80 main battle tank, especially, features this HEAT protection from the end of the eighties up to now. Together with improvements in their night vision capabilities -- especially the development of their own thermal imaging device -- the T-80 seems to be a reliable tank with excellent firepower, especially at long distances (up to five kilometers), since it is equipped with the AT-11 laser ATGM. Newest developments indicate that the Russians may have developed an active armor system named "ARENA." This ARENA system is based on a radar system that scans the area around the tank for incoming missiles and gun shells. Within milliseconds, it will blast explosives and armor plates towards the threat even before impact. They hope to destroy or destabilize the incoming round so that it will do no harm to the tank. A similar system is under construction in many other countries today.

The western tank development philosophy rated technical sophistication and supreme training of the tank troops higher than a simple superiority in numbers. The result was a major breakthrough in all aspects of tank construction when both the Leopard 2 and the M1 Abrams were put into service in 1979. Since they were

the result of a widely joint development team, it is not surprising that they feature more or less the same properties.

Both are heavily armored with Chobham armor. While the M1 versions since the M1A1(HA) have additional armor plates of depleted uranium (making them even heavier than the high weighted 62 metric tons of the old M1A1, or the 55 tons of the Leopard 2, and the 42 tons of the light weighted T-72), the Germans still "just" use highly sophisticated steel to protect their tank crews. However, due to their experiments on armor protection against modern AP ammunitions, the Germans decided to give their newest Leopard 2A5 version a wedge shaped turret front, improved armor to the driver's hatch, and additional armor on the turret roof as a protection against bomblet artillery submunitions.

Despite their heavy weight, both the Leopard 2 and the M1 provide excellent mobility on the battlefield. They have proven to be comparatively reliable. Their Rheinmetall 120mm smoothbore gun is very accurate, accelerating its shells to a top speed of more than a mile per second. While the tank's HEAT shells are rather conservative in design, the armor piercing sabots have proven to be devastating to nearly any armor today – except, perhaps, the modern versions of the Chobham armor featured by these two tanks types. Their thermal imaging systems made them the world's first tanks fully capable of conducting a battle 24 hours a day. The laser rangefinder, the all-axes stabilization system, and the ballistics computer increased the gun precision even far beyond their engineers' expectations. Both tanks were a major breakthrough in all aspects of tank construction.

There are differences, though. While the US forces preferred to have the Lycoming gas turbine built into the M1's engine compartment, the Germans decided to build in a rather conservative diesel engine by Mercedes-Benz. The gas turbine will give more torque, thus accelerating the M1 faster than the Leopard 2 despite its 15% heavier mass (The Leopard, however, will outrun the M1 with its top speed of more than 45 mph by a good 5 mph). Also, the high frequency noise of the turbine won't carry that far as the low grumble of the Leopard engines, which makes it a little bit harder for infantrymen to locate approaching tanks beyond their visual range.

On the other hand, the gas turbine exhausts are about five times hotter than that of diesel engines, making it much easier to locate the US tank in a thermal imaging device. Additionally, the gas turbine's fuel consumption is a logistic nightmare. The good news is that it doesn't need significantly more fuel on full speed than in idle state. The bad news is that the M1 eats about 50 gallons per hour wile just sitting around.

Diesel engines are equally thirsty only when pushing the surrounding tank forward at top speed; being idle, the Leopard will need just 5 gallons per hour to keep the engine alive. In defense operations, Leopard tank battalions won't suffer that much from interrupted supply lines. On the other hand, the US army traditionally is the world leader in military logistics.

Nit pickers might mention the higher life time of the Leopard's steel tracks, a more ergonomic handling of the Leopard crew's controls, superior deep-wading of the German gear and other minor details. In other aspects, the M1 might be rated higher by its crews. Summarizing these details, both the M1A2 and the Leopard 2A5 mark the acme of tank construction. This resulted in exports into numerous countries. While the Arab world widely ordered M1 tanks after the Second Gulf War, many European countries favored the Leopard 2; the Leopard owners club includes all NATO members of the European continent as well as the neutral states of Austria, Sweden, and Switzerland. France and Great Britain, however, opted for own developments like the new Leclerc and the Challenger 2 (currently in development).

Appendix B: Battlefield Hazards

by Andrew Jaremkow[1]

Steel Beasts simulates the technology of the mechanized battlefield in the mid 1990s, when the last of the Cold War inspired systems were still coming into service. An MBT in that battlefield environment faces a wide range of deadly threats, each with different strengths and weaknesses. The most immediate danger comes from enemy tank guns and powerful anti-tank missiles, which have the capability to destroy armored targets at a range of 3 to 4 kilometers. Man portable anti-tank weapons and small autocannons do not have the same punch or the same range as larger anti-tank systems, but they are widespread, and they can be just as deadly in close terrain. Artillery shells can arrive overhead without warning, dispensing hundreds of small armor-piercing bomblets to attack the thin roof armor of your MBTs, or clusters of sophisticated anti-tank mines to attack their weak belly armor.

A basic understanding of these systems is essential to exploit their strengths and take advantage of their weaknesses. Ignorance, on the other hand, is death.

Tank Ammunition - APFSDS technology

Tank ammunition has undergone continuous development since the birth of the tank, most of it devoted to improving armor piercing ammunition. The current top-line armor piercing round is a type of ammunition called APFSDS (Armor Piercing Fin Stabilized Discarding Sabot), which can penetrate modern compound armors more effectively than any other type of ammunition fielded today.

APFSDS projectiles have two major components: a dense central penetrator, and a wide lightweight sabot[2] that surrounds it. The penetrator resembles a long headless metal arrow, with a pointed nose, cylindrical rod-shaped body, and tapered metal tail-fins. The body of the penetrator is made of a very dense alloy of tungsten or uranium, and the nose and tail are usually made of lightweight aluminum alloy. A typical modern APFSDS penetrator is between 60 and 80 cm long from tip to tail, and is 2 to 2.5 cm in diameter. A large lightweight aluminum adapter, called a

[1] This version has been editing slightly for the manual. An unedited electronic version is part of the Steel Beast installation.

[2] "Sabot" is actually the French word for a wooden shoe, like those worn by French peasants in the 18th and 19th centuries. Cannonballs and shells of that era were sometimes fitted with wooden pusher plates, to improve the gas seal, and the shells sat in the wooden plate like a foot in a shoe. At some point the pusher plate was nicknamed a "sabot", and name has become a technical term in ballistics ever since.

sabot, is fitted around the midsection of the penetrator, to fill the gap between the penetrator and the barrel walls. The sabot is made of three identical segments, called petals, which fit around the penetrator and interlock with a set of threads or grooves machined into its surface.

When the gun is fired, the gas pressure from the burning propellant pushes on the rear of the sabot, forcing it forward at high velocity and taking the penetrator with it. The acceleration is enormous, peaking at over 50,000 Gs, and by the time the APFSDS projectile has reached the muzzle it is typically moving between 1600 and 1800 meters per second, or roughly Mach 5. Aerodynamic forces then break the sabot petals apart, and force them outwards and backwards as the projectile moves away from the muzzle. The lightweight sabot petals decelerate quickly after they have been discarded, and they fall to the ground within a few hundred feet of the muzzle. This leaves the dense low-drag penetrator to fly to the target on its own, stabilized by its tail-fins.

The armor piercing ability of the APFSDS penetrator depends on its kinetic energy, derived from its very high velocity and dense metal body, as well as its elongated shape. When the front end of the dense rod strikes the target, its high kinetic energy allows it to push the armor material to the side, making a narrow crater in the armor. As the rod continues to move forward, it presses against the bottom of the crater with tremendous force, continuously pushing aside the armor and making the crater deeper and deeper. However, the front of the rod is continuously being eroded while it penetrates, and the rod gets shorter and shorter, and gradually slows down. This race between rod erosion and crater growth determines whether the target survives. If the armor wins, the eroded stub of the rod comes to a harmless halt at the bottom of the crater. If the armor looses, the shortened rod bursts through the back of the armor, showering the inside of the tank with a spray of deadly incandescent metal fragments.

Strenuous efforts have been made to improve the performance of APFSDS rods, through a series of tradeoffs between velocity, length, and strength. The longer the rod is the longer it takes to erode, and the deeper it can penetrate into its target, so designers try to make APFSDS projectiles as long as possible. Unfortunately, increasing the length of the penetrator rod also increases its weight, and as the projectile's weight increases its muzzle velocity decreases. To counteract this the designers make the rods thinner at the same time as they make them longer, keeping the weight growth and velocity loss to a minimum. The slenderness of the rod is often described by its l/d ratio, which is the length of the rod divided by its diameter. (For example, a rod with an l/d ratio of 16 is sixteen times as long as it is wide.) Successive generations of APFSDS rounds have had higher and higher l/d ratios, and the US Army's four generations of 105 mm APFSDS make a good example. Their l/d ratios grew from 10:1 to 14:1 to 17:1 to 27:1 in the space of fourteen years.

Increasing the l/d ratio of the rod increases penetration, but it also causes problems. As the rod gets longer and thinner, it becomes weaker and more likely to bend or break during the enormous accelerations of launch. Longer and sturdier

sabot petals can be used to protect the lengthened rod, but they weigh more than shorter sabot petals, and their added mass will slow the projectile down and reduce its performance. The need for larger sabots can sometimes be limited by making the penetrator out of stronger alloys, so it can withstand the stress of launch with less support, but stronger alloys are not always available, and finding better processing and alloying techniques is an expensive business.

In addition, rods with high l/d ratios are more likely to bend or break during impact, particularly when forces act on them from the side, such as the forces caused by sloped armor, spaced armor, or heavy reactive armor. Penetrator rods have to be kept thick enough to withstand these lateral loads, and this prevents them from being made as long as the designers might like. The effect of the lateral loads can also be mitigated by careful processing of the dense alloys, leaving them slightly flexible so they can bend a little bit without breaking. Balancing all of these factors (and others) within the changing limits of metallurgical manufacturing technology is a complex art.

German APFSDS ammunition for the 120 mm L44 gun represents "conventional" APFSDS design techniques, and there are numerous rounds worldwide which follow the German pattern. All the German 120 mm APFSDS penetrators use a sintered tungsten alloy, which is a mixture of dense but brittle tungsten grains (usually forming 90% or more of the alloy) held together in a tough slightly flexible matrix of nickel and iron, with an overall density of 17.5 to 18.5 grams per cubic centimeter. The penetrators are held in conventional aluminum sabots that vaguely resemble large spools.

The Germans have developed five APFSDS rounds for the Leopard 2, but the DM13 and DM23 are now out of service. In 1987 the West Germans fielded the DM33, which fired a 4.6 kg penetrator at 1,650 m/s. The round's dense core had an l/d ratio of about 21, which was good for its day, and the penetrator was given a slightly thickened nose in an effort to improve its performance against certain forms of armor. Unfortunately, this was a high drag design, causing the DM33 to decelerate slightly faster than comparable rounds, and the design was not repeated on later penetrators. The DM33 is also used in the Leopard 2s of the Swiss Army, and probably the Dutch Army as well.

The DM43, co-developed with the French, was intended to replace the DM33 in the early 1990s, but the end of the Cold War and the costs of reunification of the two Germanys meant that tank ammunition upgrades got very low priority. The DM43's development was finally finished in early 1996, but it didn't replace the DM33. Instead, the German Army purchased a limited number of the rounds for emergency use, and elected to postpone total replacement of the DM33 until the DM53 (then under development) was complete. This left the aging DM33 in service throughout the 1990s, and it still forms the bulk of the German inventory.[3] The rare

[3] The DM43 was eventually produced in large quantities in America, as an export round for Egypt.

DM43 is much longer than the DM33, with an l/d ratio of 30, and it is much faster, with a muzzle velocity of 1740 m/s. It is also lighter, at 4 kg, and has less drag, which reduces its drop in performance at long range.

The DM53 is the next generation German APFSDS round, and it is due to enter service along with the lengthened 120 mm L55 gun which will be retrofitted to the German Leopard 2s during the next few years. Few details have been released about its performance, but it is longer than the DM43 and has improved propellant for a higher muzzle velocity. The Swiss have committed to the acquiring DM53 for their Leopard 2s at some point in the future.

American APFSDS rounds for the 120 mm M256 gun differ from German models in one important respect: they are made of a depleted uranium alloy, not tungsten. Natural uranium is a mixture of several isotopes, typically 99.27% U_{238}, with 0.72% U_{235} and traces of other isotopes. Enriched uranium, which is used as reactor fuel, has a higher proportion of radioactive U_{235} in its isotope mix, and it is produced by removing U_{235} from a large amount of normal uranium and concentrating it in the enriched material. Once the enrichment process is complete the normal uranium only has 0.25% U_{235} left, so it is now called depleted uranium. Depleted uranium is still mildly radioactive, but unless it is somehow ingested or it gets into a wound it is not a significant radiation hazard for its operators.

The US Army chose to make penetrators out of depleted uranium for several reasons. First, it was cheap. The Americans had thousands of tons of it lying around as a result of their nuclear industry, so material costs were minimal, unlike tungsten which was significantly more expensive. Second, it was dense. Uranium alloys weigh about 18.6 grams per cubic centimeter, which compares well with tungsten alloys. Third, it was pyrophoric. When small fragments of uranium are exposed to air they burst into flames spontaneously, creating a useful incendiary effect inside target vehicles.

The fourth (and most important) reason had to do with the way uranium acts under pressure. When it is alloyed with small amounts (0.75%) of titanium, depleted uranium becomes susceptible to adiabatic shear, which means it forms very narrow bands of weakness under pressure and shears off along those lines. As a result, the front of a depleted uranium rod tends to flake off in small fragments during penetration, always leaving a pointed chisel-like tip to face the oncoming armor. Tungsten alloys, on the other hand, do not fail by adiabatic shear (despite millions of dollars spent trying to make them do so). Instead, the front end of a tungsten alloy rod squashes out into a broad mushroom shape during penetration, much like the mushroomed head of a lead bullet. Since the tungsten alloy rod forms a wide nose, it has to force a wide crater into the armor, but the narrow nose of a depleted uranium rod makes a narrower, more energy efficient crater. Thus, a depleted uranium rod can make a narrower deeper hole in the target than a tungsten alloy rod can with the same amount of kinetic energy.

The US Army currently has two 120 mm APFSDS rounds in service. The M829A1 entered service in 1990, just in time for the Gulf War, where it served alongside the

earlier M829 and earned the nickname "Silver Bullet" for its outstanding performance against Iraqi armor. The M829A1 is a long heavy round, with a 4.9 kg penetrator that is 78 cm long from tip to tail. The heavy penetrator and long heavy sabot make the M829A1 rather slow, with a muzzle velocity of only 1575 m/s. Nonetheless, its high l/d ratio of 33:1 and its depleted uranium construction give it excellent penetrating power. The M829A1 is still the front-line round for American tanks in overseas hot-spots like Bosnia and Korea.

The M829A2, which entered service in 1993, uses essentially the same penetrator as the M829A1, but the M829A1's long aluminum sabot has been replaced by one made from carbon fiber. This lightweight sabot design, which reduced the sabot mass by 30%, was combined with an improvement in the propellant to produce a dramatic rise in muzzle velocity. The M829A2 comes out of the muzzle at 1680 m/s, despite the fact that its penetrator is marginally heavier than the M829A1's. The new sabot did cause a few problems at first, such as an increase in corrosion and an occasional tendency to swell in humid conditions, but these problems have been corrected. The M829A2 is not stored overseas, and it is only shipped from America on an as-needed basis, so sudden crises will have to be dealt with using the older ammunition.

The M829E3 (which will become the M829A3) is the advanced successor to the M829A2. It is reported to have a kinetic-energy precursor to deal with heavy reactive armor, and an advanced propellant load for increased velocity. The M829E3's development program has dragged on for many years, and although it is currently scheduled for production in 2002 this may slip again.

Russian APFSDS for the 125 mm 2A46 gun uses a distinctly different design than APFSDS rounds manufactured in the West. When the Russians first started making 100 mm and 115 mm APFSDS in the 1960s, they used steel penetrators rather than dense materials like tungsten or uranium. Since the Russians needed vast quantities of APFSDS ammunition (they produced some 20,000 T-62 tanks alone), manufacturing considerations played a very strong role in their ammunition designs. Steel was strong, easy to machine, readily available, and quite economical, so it made sense to use it for the penetrator. Although steel penetrators were not as effective as denser metals, they performed well enough if they could be fired at high velocities. (Steel has a density of only 7.8 g/cm^3.)

To ensure high muzzle velocities the Russians chose a very lightweight sabot design, called a "ring sabot". This resembled a narrow disc around the center of the penetrator, and it weighed much less than the "spool" designs now in use in the West. The light rounds could be accelerated to very high speeds, and muzzle velocity was an unmatched 1800 m/s for early 125 mm rounds. However, using the ring sabot design meant that the penetrator's tail-fins had to touch the barrel walls, to keep the projectile properly aligned while it was in the gun. These wide fins cause large amounts of drag, and Russian APFSDS rounds all slow down quite quickly, lowering their penetration at long range.

The other factor affecting Russian APFSDS design is the fact that the 125 mm gun uses two-part ammunition. The projectile and main propellant charge are stored separately, and loaded into the gun one after the other by a mechanical autoloader. This means that Russian APFSDS rods can only be as long as the stowage cells in the autoloader. On the T-72 the ammunition hoist doors are only long enough to let a 70 cm object through, so long projectiles like the M829A1 (78 cm long) simply cannot fit. This is the fault of the tank, not the gun, and is the price the Russians have paid for a compact autoloader system.

The Russians fielded a large number of 125 mm APFSDS projectiles, including the BM9 (1969), BM12 (1970s), BM15 (1970s), BM17 (1970s), and BM22 (1979). These are no longer in front-line service with top Russian units, but some may remain in storage, and many were exported or licensed to client states. Iraq, for instance, was still manufacturing BM-15s in 1991.

The BM32 had entered service by the late 1980s, although it was not shown to the outside world until it was offered for export in 1993. The BM32 is made of depleted uranium, unlike all previous Russian rounds, and it has an enlarged redesigned ring-sabot. The round is quite short, only 49 cm from tip to tail, and the penetrator weighs about 4.5 kg. The BM32's 1700 m/s muzzle velocity is good, but the wide fins will slow this down fairly quickly, so long range performance will suffer.

The BM42 is part of the same generation as the BM32, with a very similar rod shape and sabot. It was also revealed in 1993, although it was already in service by the late 1980s. The BM42 uses a tungsten alloy core, but this particular alloy is too weak to form the entire rod, so the tungsten is sheathed inside a strong steel casing to keep it intact.[4] The projectile is longer than the BM32, at 57 cm, but its mixed steel and tungsten construction means its performance is worse. The BM42 has a 1700 m/s muzzle velocity, but its wide fins slow it rapidly, just like the BM32.

The next generation of Russian APFSDS is the BM44, which is radically different from all other Russian APFSDS because it uses a spool shaped sabot and has narrow fins, like typical Western designs. The penetrator uses a longer one-piece tungsten alloy body, but few other details have been released so far. Deliveries of the round were supposed to begin sometime in 1998-99, but the state of the Russian economy may have delayed this.

TANK AMMUNITION - HEAT TECHNOLOGY

HEAT (High Explosive Anti Tank) rounds are a type of shaped charge, and use the force of an explosion at the target to create their armor piercing effect, rather than relying on the kinetic energy generated by a gun. As a result HEAT rounds have the

[4] The Americans and Germans had to use the same method with their first tungsten APFSDS rounds, the M735 and the DM13, for the same reason.

same power at all ranges, and they do not have to be fired at extremely high velocities like APFSDS. HEAT rounds are the most effective type of ammunition for piercing extremely thick steel armor, but the widespread use of compound armor from the 1970s onwards, and the introduction of reactive armor in the 1980s, has forced HEAT rounds into a secondary role against modern MBTs.

HEAT warheads, at their most basic level, are a cylinder of high explosive. The front face of the cylinder has a conical cavity carved out of it, and a thin conical metal liner (typically made of copper) is fitted tightly against the walls of the cavity. The cylinder of explosive is detonated from the rear, causing a high pressure shock wave to rush forward towards the liner at speeds of about 8,000 m/s. When the explosion front passes along the liner it forces it to collapse inwards, starting from the narrow tip of the cone. As the walls of the collapsing liner slam together, they generate pressure so far above the yield strength of the liner material that the metal flows in a fluid fashion, even though it is still well below the melting point, and a long jet of liner material squirts forward through the open end of the cone. This narrow jet is moving so quickly (around 10,000 m/s at the tip) that its impact pressure forces any armor it strikes to flow to the sides, opening a long narrow crater in the path of the jet.

Shaped charge jets erode at their tip as they penetrate, rather like APFSDS rods, gradually getting shorter as they pass through the armor, and this means that the length of the jet determines how deeply it can penetrate. In general, larger liners make longer jets, but this is complicated by the fact that the jet's length is not constant. When the jet is formed its tip is moving several thousand meters per second faster than its tail, so the entire jet stretches as it moves forward, and it eventually breaks up into a series of metal particles. The deepest penetration will occur when the jet has the time and space to stretch out as long as it can without breaking up into separate pieces. Therefore, ammunition designers try to put the impact fuse of HEAT ammunition as far forward of the liner as possible, to give the round the standoff it needs to form a long efficient jet. Standoff is usually measured in cone diameters (CD), for ease of comparison. (A warhead with its fuse 160 mm in front of an 80 mm wide liner would have a standoff of 160 / 80 = 2 CD.) Optimal standoff distances vary from one design to the next, but they are usually in the region of 4 to 7 CD for modern HEAT warheads. This makes it nearly impossible to build optimal standoff into large warheads, and small liners can sometimes outperform larger liners, simply because they have better relative standoff.

In addition to manipulating the standoff of the warhead, designers can also vary the shape of the liner to get improved performance. Liners with long sharp conical shapes produce thin high-velocity jets that penetrate deeply, but have reduced behind-armor effects. Liners with short broad conical shapes produce slower wider jets with less penetrating ability, but more damage causing potential. The way in which the liner collapses can be manipulated by inserting a wave shaper (made of inert material such as polyethylene, or a slow burning explosive) into the main charge. This temporarily retards the front of the advancing detonation wave, turning the curved wave-front into a flat wave-front which causes improved liner collapse.

Differences in liner thickness, liner alloy, and even the way the liner was machined and processed, all have significant effects on jet penetration, and high manufacturing tolerances are essential for high performance.

The US Army and the German Army field the same 120 mm HEAT round, which is called DM12 when it is produced to German standards, and M830 when it is produced to American standards. Although there are modest differences in fusing, safety features, and other details, the two rounds are essentially identical in terms of performance. The DM13 and M830 use a copper liner with a wave-shaper, and have a standoff of about 2.25 CD.

The Russians, on the other hand, have a series of HEAT rounds for the 125 mm gun. The current standard HEAT round is the BK18, which replaces the earlier BK12 and BK14. The BK18 uses a copper liner with a wave shaper, but its outer walls are thicker than the M830's, so the actual liner is smaller. However, the BK18 has a better standoff distance (3 CD) than the M830, and the liner has a longer sharper cone shape, so the BK18 has slightly deeper penetration than the DM13 / M830. The BK29 is similar to the BK18, but it has a strengthened nose designed to pierce light reactive armor before the warhead detonates. This prevents the jet from being disturbed by the reactive armor.

The Russian BK21B is an unusual HEAT round, because its liner is made of depleted uranium instead of copper. Depleted uranium is over twice as dense as copper, and a jet made of such dense material would, in theory, penetrate over 40% deeper than a similar copper jet, simply due to the increase in kinetic energy. However, dense liners collapse more slowly than light liners for a given warhead size, so the actual performance advantage is closer to 20%. The dense material is also more efficient at penetrating ceramic armors, and the uranium will have its normal pyrophoric effects as an added advantage. The BK21B is not in widespread issue at this time.

Tank Ammunition - Other ammunition.

Although tanks have traditionally carried HE (High Explosive) shells, the Germans and Americans do not field anything but APFSDS and HEAT for their 120 mm guns. As a result, all anti-personnel work has to be done with HEAT rounds, which have inferior blast and fragmentation patterns compared to HE rounds of the same caliber. The Russian tanks, on the other hand, have always fielded HE rounds, and they form the largest proportion of each tank's ammunition load. (The current 125 mm HE round is the OF26.) This means Russian tanks are far better equipped to tackle infantry, especially in urban conditions, than any of the NATO armies. The Swedish Army has a similar ammunition doctrine to the Russian army, and they field a 120 mm HE round on their Leopard 2s. The 120 mm and 125 mm HE rounds are fast enough and heavy enough to cause catastrophic damage to lightly armored vehicles, like APCs and some IFVs, and even MBTs cannot ignore the damage a direct hit can do to the running gear and optics.

Other ammunition types, like flechette, canister, and smoke rounds, were all produced for rifled tank guns of previous generations, but they haven't been fielded for most 120 mm and 125 mm systems. The US Army is currently developing a 120 mm canister round for its Abrams tanks, but experiments with an Israeli prototype of a flechette round proved to be a failure. Smoke rounds simply haven't been considered important enough to be developed yet.

The US Army has fielded an anti-helicopter round, known as the M830A1 HEAT-MP-T, or MPAT (Multi Purpose Anti Tank), since 1992. This small saboted HEAT round has a muzzle velocity of 1,410 m/s, to enable it to reach distant targets quickly, and it has a proximity fuse to detonate it when it passes near an airborne target. When the proximity fuse is switched off, the round can be fired at ground targets, but the small size of the MPAT warhead means penetration is less than the basic M830. Since there are no helicopters in the Steel Beasts simulation, MPAT is not included among the available ammunition types. The US Army partly developed a top-attack round for the Abrams, called the XM943 STAFF, but the program was canceled before the round reached production. Work is continuing on another ambitious smart round program called TERM, but it will not produce rounds before 2007 at the earliest.

AUTOCANNON AMMUNITION

The small high velocity autocannon mounted on modern IFVs have a nasty sting for their size, and an IFV firing at the flank or rear of an MBT at close range may be able to kill it. Even if the IFV cannot kill the tank, the high rate of fire of the autocannon means that damage to optics, running gear, and other external fixtures is almost a certainty. The small shells of autocannons lose velocity rapidly, compared to tank guns, and the useful range of the autocannons is only one or two kilometers.

The Rh202 20 mm autocannon mounted on the Marder IFV is the smallest and oldest of the autocannons in the game, and its AP round set the standard for the frontal armor on the Russian BMP-1. The DM43 API round fires a small (111g) projectile at 1,100 m/s. The shell is an APCR (Armor Piercing Composite Rigid) design, with a small tungsten carbide core carried inside the steel shell body and covered with an aluminum windshield. Although the round can penetrate about 60 mm of vertical steel armor at point blank range it is very inefficient when penetrating angled armor, and its velocity and penetrating power decline rapidly with range. The DM43 was superseded by the DM63 APDS (Armor Piercing Discarding Sabot) round, which carries a short bullet-shaped tungsten penetrator completely inside a plastic and aluminum sabot. After the round is fired (at 1,150 m/s), the sabot breaks apart and is discarded, and the small dense penetrator continues downrange, stabilized by spin like a normal bullet. The DM63's performance isn't any better than the DM43's at point blank range, but it is much better against angled targets, and it loses velocity much more gradually giving it superior long-range performance. The DM81 HE-I (High Explosive Incendiary) round provides the Rh202's soft-target capability, but 20 mm HE rounds have tiny bursting charges, and their explosive effect is minimal.

The M242 25 mm Bushmaster is the very capable cannon mounted on the Bradley. Its best armor piercing round is the M919 APFSDS round, which fires a tiny 96 gram depleted uranium long-rod penetrator at 1,385 m/s. This small penetrator can pierce over 90 mm of armor at point blank range, which is exceptional for such a tiny weapon. The M919 had a higher velocity (1,420 m/s) when it first entered production in 1990, but problems with excessive barrel wear caused the round to be withdrawn for several years of redevelopment. A lower temperature propellant solved the erosion problem, but also led to a loss of performance. The earlier M791 APDS round remained in service while the M919's problems were being solved. This has a velocity of 1,345 m/s, but the stubby 102 gram tungsten alloy penetrator can only defeat about 60 mm of armor at point blank range, and its performance against sloped armor is worse than the M919's. The M792 HE-I round completes the Bradley's ammunition outfit.

The 2A42 30 mm autocannon on the BMP-2 is the standard by which Western IFV armor is judged today. Its primary armor piercing round is the 3UBR6 AP round, which uses a conventional steel bodied AP projectile. The heavy 400g projectile is fired at a relatively slow 970 m/s. Its size gives it a reasonably good penetration of over 60 mm of armor at point blank ranges, but its speed and penetrating power drop fairly quickly with range, and its performance against angled armor is poor. There is also a 30 mm APDS round for the autocannon, with a muzzle velocity of 1,120 m/s, but it is much rarer than the AP round. Its point blank performance is about 70 mm of armor, and it has better performance than the AP round at long ranges and against angled armor. Soft target capability is provided by a 30 mm HE round.

ANTI TANK GUIDED MISSILES

The development of ATGMs (Anti Tank Guided Missiles) put highly accurate long-range firepower into the hands of infantry and lightweight vehicles, and modern ATGMs are still a serious threat to tanks despite advances in compound armor.

The earliest ATGMs were simple rocket propelled airframes, with large fins, excruciatingly slow flight speeds, and a guidance system that was no more sophisticated than a soldier with a joystick and a pair of binoculars. The soldier had to watch both the missile and the vehicle he was aiming at, guide the missile onto the line of sight between him and the target, and manually fly the missile all the way to a successful impact. This took a steady hand and a great deal of skill, as well as strong nerves to endure return fire during the long flight. This sort of guidance, known as MACLOS (Manual Command Line Of Sight), was soon replaced by a partially automated system known as SACLOS.

SACLOS (Semi Automatic Command Line Of Sight) guidance uses a computer to fly the missile, and allows the operator to devote all of his attention to tracking the

target. The computer typically observes a flare carried on the missile's back end, and then compares the position of the flare to the line of sight between the launcher and the target being tracked by the operator. If the missile (and its flare) is flying below the line of sight the computer commands it to climb, and if it is above the line of sight the computer commands it to dive. Similar corrections are made if the missile is drifting left or right. As a result the missile flies a slightly corkscrewing path along the line of sight, and as long as the operator keeps that line of sight aligned with the target, the missile should make a successful impact. The steering commands are usually sent along fine wires that are paid out behind the missile, although some systems use infra-red or radio command links. Battlefield experience has shown that hit rates of 90% or more can be achieved in combat by using SACLOS guidance systems, even at extreme ranges. However, SACLOS ATGMs still have difficulty functioning at shorter ranges, before the missile has been fully acquired and steered onto the line of sight by the automatic tracking system. During that time the ATGM is little more than a large expensive rocket-launcher.

ATGMs rely on HEAT warheads to kill enemy AFVs[5], and heavy ATGMs carry large warheads with outstanding penetrating power. However, the performance of the whole ATGM on the battlefield will usually fall below the maximum performance of the warhead under laboratory conditions, and the enormous penetration figures claimed by some manufacturers can be somewhat misleading. Laboratory shots can be conducted at the ideal standoff distance, to obtain maximum warhead penetration. However, the standoff allowed by the fusing arrangement on the missile is usually much shorter, greatly reducing the missile's actual penetration. Furthermore, when the missile is in flight it is almost always flying with an angle of attack, either to generate lift or to generate turning forces, and this means that the warhead is not pointing directly along the flight-path. This introduces an off-axis velocity component to the jet, forcing it to carve a slightly wider crater than normal, which results in a measurable decline in penetration.

American ATGMs currently include the heavyweight TOW, the man-portable Dragon, and its replacement, the Javelin.

TOW (Tube launched Optically tracked Wire guided) is an aging system, first introduced in the early 1970s and regularly upgraded ever since. TOW was one of the first missiles to use flare-tracking SACLOS guidance, and the steering commands are transmitted from the launcher to the missile along a wire command link. The missile is ejected from its launch tube by a fast-burning boost motor, and once it has traveled to a safe distance from the launcher, its flight motor ignites, burning for 1.6 seconds and accelerating the missile to a maximum speed of 330 m/s. After the motor burns out, the missile glides towards its target, steering with its tail-fins and gradually slowing down. TOW has a minimum range of only 65 meters, but it takes nearly 22 seconds to fly to its maximum range of 3750 meters.

[5] Exceptions include TOW-2B (EFPs), Malkara (HESH), and several high velocity prototypes, such as LOSAT, that use KE penetrators.

TOW-2A (BGM-71E), which is the fifth version of the missile[6], was introduced in 1987. It carries a front mounted 152 mm HEAT warhead, with a spring loaded telescoping nose-probe that extends after launch to give the main warhead a standoff of about 3.3 CD. The probe also contains a tiny precursor warhead, which is designed to detonate reactive armor prematurely so it cannot interfere with the jet from the main warhead.

TOW-2B (BGM-71F), the sixth and final TOW variant, entered service in 1992. It is an overflight top attack missile, and it does not impact directly on the target to destroy it. Instead, it flies about one meter above the target and fires two warheads downwards into the weakly armored roof of the vehicle. This strategy allows the missile to completely bypass the heavy frontal armor of modern tanks, and achieve reliable kills from any direction.

The missile carries a completely redesigned warhead section, which contains two EFP warheads that face downwards. EFPs (Explosively Formed Projectiles) are a type of shaped charge, but they use a shallow dish shaped liner rather than a deep conical liner like a HEAT warhead. When the EFP warhead detonates, the liner collapses into a compact slug, which is hurled towards the target at speeds between 2,000 and 3,000 m/s. The EFP slug cannot penetrate as deeply as a HEAT jet, but it doesn't need to in this application because it is only facing weak roof armor. When it does penetrate, the EFP makes a much larger hole than a HEAT jet and causes more damage to the inside of the tank.

Since it doesn't strike its target directly, the TOW-2B uses a dual mode proximity fuse to detect its target. The fuse includes a magnetometer, to find large masses of metal, and a tiny laser altimeter to measure the shape of the terrain under the missile. The warheads are detonated when the laser detects a shape that matches typical armored vehicles, and the magnetometer confirms that the shape is made of metal. Unfortunately, the system cannot tell the difference between friend and foe, or active tanks and wrecks. Any armored vehicle the missile overflies will be attacked, regardless of nationality or status. TOW-2B can also attack soft targets, like trucks or field fortifications, by using a backup impact fuse, but it has no worthwhile armor piercing capability in this case.

Dragon (FGM-77 series) is the infantry-portable ATGM that the US Army fielded at the same time it introduced TOW, and it uses flare-tracking SACLOS guidance and a wire command link, just like TOW does. Unfortunately, the resemblance ends there. Dragon does not have a flight motor to boost it to high speeds, and it does not have fins to maneuver with. Instead, it uses a series of tiny one-shot solid fuel rocket motors to push the missile in the proper direction and keep it airborne. When it is fired in windy conditions or used against maneuvering vehicles, Dragon can actually run out of steering motors before it reaches its target. Furthermore, the system is fired from the shoulder of a sitting soldier, and every twitch, flinch, and

[6] Earlier versions were the TOW, TOW-ER, ITOW, and TOW-2.

breath of the soldier is transmitted to the Dragon as an unwanted steering command.

Dragon launches are easy to detect, since the missile's ejection charge kicks up a lot of dust, and each little steering motor produces a bright spurt of flame when it fires. The missile seems to bounce downrange in a series of bright eye-catching flashes which are sure to draw unwanted attention. Dragon only has a range of 1,000 meters (and it takes a slow 11.5 seconds to get there), and the missile's penetration is unremarkable, even in the Dragon II version which added an improved warhead. With its many disadvantages and lack of any redeeming features, it is no surprise that Dragon has a very poor reputation. (The only good thing about Dragon is that it now comes with a small thermal imager, which can be detached and used for observation.)

Javelin is a sophisticated fire and forget missile that began replacing Dragon in 1995. The Javelin missile locks onto its target before it is fired, using a built-in imaging infra-red seeker in the missile's nose, and once it is launched it is completely autonomous. Javelin climbs under power to a height of 150m, and then glides towards its target, maneuvering with fins as it dives to attack the weak upper surface of its prey. (Javelin can also fly a level attack profile to strike targets hidden under overhead cover.) The missile has a range of over 2500 m, and carries a 127 mm main warhead and a large precursor warhead, enabling it to kill reactive-armored targets. Javelin is quite expensive, and is still rather rare. Only 2585 pieces have been delivered to the US Army by the end of 1999.

German ATGMs include the HOT and Milan systems, both made by the Euromissile consortium of Germany and France. Since HOT is a specialist heavyweight system used by helicopters and dedicated tank destroyers it is not simulated in Steel Beasts.

Milan is an infantry-portable ATGM, using flare-tracking SACLOS guidance with a wire command link. It is easily the most successful infantry ATGM of the last three decades. Milan is fired from a low stable tripod and operated in the prone position, but it can also be fired from a mount on the turret of the Marder. Milan missiles steer by deflecting their rocket exhaust gases with movable vanes, rather than using drag-producing aerodynamic fins. As a result, the flight motor is designed to burn throughout the entire flight to provide turning power. This gives the Milan good cornering ability at all ranges and a relatively constant speed, at the expense of a heavier motor and a more pronounced smoke trail than boost-glide missiles like TOW. Milan reaches its maximum range of 2,000m in 12.5 seconds, and can even strike targets as close as 25 m away.

Milan 2 entered service in 1984, introducing an improved 115 mm warhead with a short fixed probe giving a standoff of about 2.5 CD. The Milan 2T was introduced in 1993, with a further improved warhead with a standoff of 4 CD. The lengthened nose probe contains a small precursor warhead to detonate reactive armor prematurely, and prevent it from interfering with the jet from the main warhead. The improved warhead is heavier than that on the Milan 2, and the missile's range dropped to 1920m as a result. The Milan 3, with the same warhead and an

improved guidance package, was unveiled in 1995, but so far it has not been adopted by the German Army.

Russia is the most prolific ATGM producer in the world, and has fielded at least 15 different types of missile, most of which have several variants. During the Cold War Russian missiles were each assigned a code name and number, such as the AT-3 “Sagger”, since NATO was not always aware of the proper designations. The Russians actually use Industrial Index numbers for the entire ATGM system (9K11) and its various missiles (9M14, 9M14M, 9M14P, etc.), as well as giving the system a code name.

The AT-3 "Sagger" series (9K11 “Malyutka”) was the last of the manually steered Russian ATGMs. This compact wire-guided missile flew to a range of 3000 meters at the sedate speed of only 115 m/s, steered by deflector vanes in its rocket exhaust. Like all manual systems it had a large minimum range, and wasn't much use against targets closer than 500m. It entered service in 1961 as a man-portable system, and was soon deployed on tank destroyers, helicopters, and IFVs like the BMP-1. SACLOS versions began entering service on tank destroyers in 1969, and a variety of upgraded warheads were introduced in the following decades. The “Sagger” is now obsolete, but vast quantities were made and low readiness units kept them well into the 1990s. The last of the widely issued “Sagger” missiles was the 9M14MP1, which had an improved warhead with a probe mounted fuse for better standoff. Although later “Sagger” versions have been made for the export market, they did not enter widespread Russian use.

The AT-5 "Spandrel" (actually called the 9K113 “Konkurs” missile system) is a conventional flare-tracking fin-steered SACLOS missile with a wire command link, much like TOW or Milan. It entered service in 1977, and forms the ATGM armament of the BMP-2, as well as some tank destroyers. The system offers a significant jump in capability over the “Sagger”, due to its shorter flight time, semi-automatic guidance, reduced minimum range (75 m), and longer maximum range (4000 m). The basic missile (9M113) was superseded by the AT-5b (9M113M), which appeared in the 1990s, and has an extendible nose probe for improved standoff and a precursor warhead to defeat reactive armor.

Russian infantry have several man-portable ATGMs, including the AT-4 "Spigot", which has a very strong resemblance to the Milan, and the AT-13 (9K115-2 Metis-2) system. This fires a canard-steered missile (9M131) and uses flare-tracking SACLOS guidance with a wire command link. The AT-13 missile (9M131) can reach a range of 1500 m in 9 seconds, although it becomes unguided after 1000 m, and it has a powerful 130mm HEAT warhead with a precursor charge. The missile is fired from a low tripod, but it is light enough to be fired from the shoulder if necessary. The earlier AT-7 "Saxhorn" used the same type of launcher system, but with a much smaller and lighter missile carrying a 94mm HEAT warhead. The AT-13 shows what Dragon could have been if it was done right.

The Russians have developed four missile systems that can be fired from tank guns. The AT-11 "Sniper" (9K120 “Refleks”) is the 125 mm missile system built into

modern versions of the T-72 and T-80. It uses a short bullet-shaped missile and a special low strength propellant charge which are stowed in the autoloader and loaded like normal 125 mm ammunition. The propellant charge ejects the missile from the barrel at low velocity, and the flight motor accelerates the missile to supersonic speeds once its fins have deployed. The missile is quicker than most western designs, and can reach a range of 4000 m in about 13 seconds, compared to about 23 seconds for a TOW-style missile. Since the AT-11 can reach targets as far away as 5000 m, it can threaten all Western ATGM platforms, and its high speed allows it to engage nimble targets like helicopters with a reasonable chance of success. The AT-11's warhead has a good standoff distance (3.3 CD) without the complication of a nose probe, because the warhead is mounted behind the rocket motor and maneuvering canards. The initial missile (9M119) was supplemented by the 9M119M in the late 1990s, which has a precursor charge to defeat reactive armor.

The AT-11 missile system uses a guidance technique called laser beam riding, which allows it to travel along a wide laser beam projected from the gunner's sight towards the chosen target. Each missile has a rear mounted laser detector that looks back towards the tank that launched it and tracks the projected laser beam. The missile measures its position inside the beam, and calculates and executes steering commands that will move it closer to the beam's center. All the gunner needs to do to ensure a hit is to keep the center of the beam aligned with the target. Laser beam riding missiles do not need a wire between the missile and the launcher, allowing them to travel faster and further than a wire-guided missile, and the launching tank can move while the missile is in flight without breaking guidance wires.

The earlier AT-8 "Songster" (9K112 “Kobra”) is the 125mm system built into the T-64B and T-80B. It is stowed in the autoloader and fired much like the AT-11, but it uses conventional flare-tracking SACLOS guidance rather than laser-beam riding guidance. The AT-8 system avoids the hindrance of guidance wires by transmitting its steering commands over a UHF radio data link, and the missile is fast (maximum speed 400 m/s) and long ranged (5,000 m) as a result. The HEAT warhead is mounted frontally, and it does not have the same good standoff as the later AT-11.

Infantry Anti-Tank Weapons

Infantry are not helpless targets, and they carry a number of lightweight anti-tank weapons that can be used to attack tanks and other AFVs. Although the HEAT warheads on these weapons are usually too small to penetrate the frontal compound armor of modern tanks, they can easily pierce the thin sides and rear of a careless MBT that gets too close. Infantry anti-tank weapons are most severely limited by their fire control, which is based on the hasty judgment and shaky shoulder of the operator, and they have an effective range of a few hundred meters at best. Miniature computerized fire control systems are beginning to appear that will improve the situation dramatically in the future.

American infantry carry the AT-4, a shoulder fired recoilless launcher with an 84 mm HEAT warhead. The AT-4 has a muzzle velocity of 220 m/s, giving it an effective range of 100m and an extreme range of 300m. The warhead is reasonably effective, but it cannot penetrate modern tanks from the front. The AT-4 is a one shot weapon, and once the round is fired, the empty tube is discarded.

German infantry use a larger and much more sophisticated system called the Panzerfaust 3 (or PzF 3), which entered volume production in 1990. This is a shoulder fired rocket launcher with a recoilless launch system. The basic rocket is the DM12A1, which has a large 110 mm HEAT warhead with a probe-mounted fuse to give it a reasonable standoff distance of 2.5 CD. The over-caliber warhead is much larger than the 60 mm rocket body, and it does not fit inside the launcher tube. This means the system can be easily upgraded to take larger or longer warheads without changing the entire launcher. This was done in the late 1990s, when the PzF 3T entered service with a new warhead carrying a precursor charge in the enlarged nose probe, to defeat reactive armor.

The PzF 3 uses an innovative countermass system that ejects a mass of iron filings from the rear of the launcher when the rocket is fired. The recoil of the rocket and the countermass cancel out, so the gunner feels no kick, and the iron filings disperse into a harmless cloud of dust within a few feet of the launcher without causing a dangerous and conspicuous backblast. This means the PzF 3 can be fired from enclosed positions without injuring the gunner. The rocket leaves the launcher at a velocity of 160 m/s, and its flight motor quickly boosts it to a speed of 243 m/s. The system has a good optical sight, and is said to have an effective range of 300 m. The sight and trigger assembly detach from the empty launch tube after the weapon is fired, and a fresh tube and rocket are clipped into place to reload the weapon.

Russian infantry have a large number of weapons to choose from. The deadliest of the Russian systems is the RPG-29, which entered service in the early 1990s. This is a re-usable bazooka-like rocket launcher firing an advanced 105 mm HEAT warhead. The main warhead, which may have a dense liner, has an excellent standoff of 4.5 CD, and is equipped with a large precursor warhead to neutralize reactive armor. The rocket has a muzzle velocity of 280 m/s, and its normal maximum combat range is considered to be 450 m, although its effective range is less. The RPG-29 has been used in combat in Russia's internal conflicts, and it is one of the best infantry anti-tank weapons in the world today.

The reliable RPG-7, another reloadable rocket-launcher, continues to soldier on in Russian service. The RPG-7's rockets use over-caliber warheads, and this has allowed the same launcher to be regularly refitted with better warheads for decades. The PG-7L rocket carries a conventional 93 mm HEAT warhead, with much better penetrating power than the 73 mm and 70 mm warheads on earlier rockets. The rocket is launched with a velocity of 112 m/s, and accelerates to nearly 300 m/s when the flight motor ignites. Targets can be engaged at distances up to 300m, although accuracy is poor at those ranges. The best rocket for the RPG-7 is actually the PG-7VR, which is essentially the RPG-29's warhead fitted to

the RPG-7's rocket motor. It entered service in the early 1990s and was used in combat in Chechnya in 1995. Unfortunately, the heavy warhead reduces the range of the rocket to only 200 meters.

The Russians also have several one-shot disposable rocket launchers, the best of which is the RPG-27, which takes the RPG-29's 105 mm HEAT warhead and puts it into a short disposable launcher. The RPG-27 became available in 1992, and has a range of about 200 meters.

ARTILLERY

The traditional HE (High Explosive) shell is still very much in use with modern artillery batteries. HE shells are cheap and easy to manufacture, rugged enough to be fired at very high velocity, and useful against a wide range of targets, including infantry in buildings and sturdy field fortifications, which are difficult to tackle with more "advanced" ammunition. Although armored vehicles are not in immediate danger from HE shells, fragmentation damage can still strip off radio antennae, damage running gear, and disable vital optics. Furthermore, the longer an AFV remains under fire the greater its chances are of receiving a direct hit, and the crushing impact of a 44 kg (97 lb.) 155 mm HE shell on the thin turret roof is likely to destroy even the sturdiest tank. Dallying needlessly in an artillery fire zone is not recommended, even for MBTs.

A new family of artillery shells, called ICM (Improved Conventional Munition) began to appear in the late 1960s. ICM shells carry a large number of small grenade-like submunitions, called bomblets, rather than a single explosive charge. When the shell arrives over the target a time fuse blows the back off the shell and ejects the bomblets at an altitude of several hundred meters. The submunitions spread out and fall to the ground in an elliptical pattern, causing extensive fragmentation damage over a much larger area than the fragment pattern of a single HE shell. Although early ICM bomblets caused nothing but splinter damage, current versions (sometimes called Dual Purpose ICM) have shaped charges built into them so they can penetrate the thin top armor of any armored vehicle they happen to land on. This makes ICM shells far more dangerous to armored vehicles than conventional HE, and the US Army considers its ICM shells to be about 6.5 times as deadly as a conventional HE shells. Armored vehicles caught in an ICM barrage should leave at once, while they have the chance.

ICM shells are widespread now. Examples include the Russian 152 mm 3O23 ICM shell, which carries 42 bomblets and spreads them over an area 145 m long and 90 m wide. Each bomblet is 44 mm in diameter, and can penetrate up to 100 mm of armor in ideal circumstances. The Germans have the DM642 (among others) with 63 bomblets of 42 mm diameter, and US Army fields the 155 mm M483 series (among others), with 88 smaller bomblets, each capable of penetrating 70 mm of steel armor.

ICM shells are sometimes referred to as cargo shells because they carry a payload of smaller objects, and the cargo shell principle has been extended to carry mines. The Americans pioneered this flexible, rapid reaction method of minefield delivery with a group of artillery shells called FASCAM (Family of Scatterable Mines), which carry 36 small anti-personnel mines or 9 small anti-tank mines, depending on the model. The unexpected arrival of several hundred mines on a vital crossroads or route of advance can dramatically alter the enemy's ability to maneuver and bring second echelon forces to bear, making scatter mines one the commander's most valuable tools for shaping the battlefield.

The commander can also modify the battlefield with smoke shells, generating temporary obstructions to visual sighting. Steel Beasts simulates conventional WP (White Phosphorous) smoke shells, which contain a large amount of white phosphorous and a small central explosive bursting charge. White phosphorous is a soft yellow-white waxy solid which burns spontaneously in the presence of air, producing a thick white smoke. When the burster charge detonates the shell ruptures, spraying small chunks of burning phosphorous in all directions and making an immediate local smoke screen. Although WP smoke does not block thermal imagers it will prevent most infantry weapons and tanks without TI from seeing through it, and it will reduce the situational awareness of tanks with TI to whatever the gunner happens to be looking at.

Smoke shells also show up in an important non-artillery role, in defensive multi-barreled smoke mortars mounted on armored vehicles. These fire a salvo of small smoke grenades that detonate in mid-air, scattering burning red phosphorous in a wide burst to make an instant wall of white smoke in front of the vehicle. The United States uses 66 mm grenades, Germany uses 76 mm grenades, and Russia uses 81mm grenades, but they all have much the same effect. The most modern grenades add components including carbon particles or metallic flakes, to generate large hot smoke particles which will block IR wavelengths and foil thermal imagers.

APPENDIX C: ARMOR TECHNOLOGY

by Paul Lakowski [7]

BASICS

Modern AFVs. are rated in three important areas; firepower, armor and mobility. Mobility is often the most important capability viewed from an operational context but armor and fire power determine success and failure on the modern tactical battle field. Historically the battle between projectile and plate has determined the outcome of most tank battles. It's probably true that fire power is the more important of the two, but often it's the level armor that becomes the 'rate determining step'.

In order to keep pace with gun penetration, designers were forced to focus more armor to the front at the expense of flank protection. To combat this, gun designers resorted to high tech ammunition, and the battle went on. After WW-II, Soviets and Americans both experimented with ERA equipped tanks, while the Americans experimented with the silica ceramic armored T-95. These technologies offered potential but were too costly and the main solution adopted was to increase the weight. The main battle tank went from 20—30 tons in WW-II to 35—48 tons in the fifties. In other words, this year's heavy tank turned into next year's medium tank just by changing the name.

In the '60s & '70s the dramatic rise in the potential of the ATGM forced another evolutionary step. The British resorted to the 'heavy tank' with 16 inches of armor called the Chieftain, while the French opted for a medium tank, and the Americans developed the M-60 which was a cross between the M-48 & M-103 designs. The German solution was the Leopard 1, a 40 ton hybrid tank with the turret armored like a heavy tank while the hull was a medium tank – a smart solution. The Soviets developed the T-64, their own version of the Leopard. In some respects this was still the heavy tank of the 40s & 50s as the armor of the T-64 was on the same level of the Chieftains in most places but in other places it was medium tank armor. The Soviet armor solution was similar to the German solution, just arranged differently.

The '80s saw the introduction of western Chobham armor to counter ATGMs (Anti Tank Guided Missiles), while the Soviet solution was to add ERA (Explosive Reactive Armor) to the T-64—80 tanks, but the gun designers were able to keep pace. By the 90s even these armors were obsolete and required upgrading to compete against the latest warheads. The current solutions are dU (Depleted Uranium) armor for the M-1s and Challengers, "Wedge armor" for the Leopard 2A5, and K-5 for the Russians. The one thing in common here is that the new heavy armor only covers about ½ the front profile. So the first solution in the ever increasing upward

[7] This version has been editing for the manual. An unedited electronic version is part of the Steel Beast installation.

need for more armor is to transfer armor mass to the most vulnerable sections of the tank at the expense of the less exposed vehicle areas. In addition special materials have been relied on increasingly to help boost armor levels at some cost to the design.

ARMOR MATERIALS AND COMPOSITION

STEEL

Rolled Homogenous Armor (RHA) appears in three forms; armored steel (RHA), semi hardened steel (SHS) & high hardness steel (HHS). Armored steel is most often found in thick armor and can appear as cast or rolled; all modern tanks feature rolled plate. High hardness steel offers about 30—34% more resistance than armored steel, but its costly (twice the price of RHA), difficult to weld, and can only be manufactured in thin rolled plates. Often this armor has to be bolted on to the main armor wall The Leclerc tank and German Leopard 1A3 feature this armor layered with RHA and SHS, it's assumed Leopard 2s also featured triple hardness steel. Layered steel – as in the Leopard 1A3 – should offer an average hardness of 18% higher than RHA.

ALUMINUM

The post WW-II period saw a number of special armors developed to enhance armor resistance to shaped charge warheads including ERA, aluminum and ceramic armor, to name a few, but all these were too expensive except for aluminum. At one third the density of steel, aluminum was an attractive alternative to steel, especially in the construction of light AFVs and support vehicles. Unfortunately along with the lighter construction comes a corresponding weaker resistance, AL5083 (M113, M2/3 and LTVP-7 AFVs) offers only 60% of the resistance of RHA (against API shot).

TITANIUM

An interesting alternative to aluminum is titanium, which has a density of only 4.5 g/cm^3 and offers resistance of 80-90% of RHA (against APFSDS). However, titanium is many times the price of aluminum which itself is twice as expensive as RHA. Titanium is known to be used in select items of the M-1's armor to reduce weight and may be used in the modern version of BDD armor in Russian tanks.[8]

HONEYCOMB STRUCTURE & FUEL CELLS.

Tests on thick honeycomb aluminum structures sandwiched between thin aluminum plates reportedly offered ~ 70% of the resistance of RHA, when the same resistance

[8] See: Int. J. Impact Engng. Vol. 20, pp. 121—129

of solid Aluminum should be 47% of RHA; that's 1.5 times better. Apparently this kind of construction is quite cheap compared to modern layered armors and is already in wide spread use in industry…always an important consideration.

The fuel cells mounted around the driver of the M-1 tank are reported to feature honeycomb structure to increase resistance in the front hull.[9] In addition, Diesel fuel has been shown to be a reasonable armor, and by integrating it into the armor, it further increases protection.

COMPOSITES

Many lightweight materials, like Fiberglas, have also been tested in an effort to replace part of the dependence on heavy steel in AFV design. Usually these composites involve fiber material that is suspended in a medium for reinforcement and stiffening. The mediums can be Epoxy, Thermoplastics, Vinylester, Polyester or some Phenolic type material. These also boost the density of the material and allow it to change from *cloth or fabric* to *panels*.[10] Steltexolite is an example of a lightweight Russian Fiberglas that uses glass cloth. It's known to be used extensively in Russian tank armor. Steltexolites material compares well with aluminum' in terms of resistance vs. KE projectiles and is slightly better vs. shaped charges, this despite the fact that it is just 2/3 the density of aluminum.[11]

SPALL LINERS

The effect of spall is like a small grenade going off inside the AFV. With the addition of *spall liners* this is reduced to a shot gun blast. Kevlar is a common composite material used in the west as spall liners in tanks, like the British Chieftain, but is also used as backing material for ceramics in armor like the M-1 Abrams. Kevlar offer less resistance to AP shot compared to Fiberglas but comparable figures for APFSDS and HEAT. Not as good as Steltexolites but lighter at just ¾ of the density, it's a good solution as a spall liner. (50% reduction in particles and blast cone). Newer materials like Spectra Shield and Dyneema achieve the same effect but at 2/3 the weight of Kevlar. Dyneema is of note as being the liner in German AFVs, and has comparable resistance to Fiberglas at 1/3 the density.[12]

CERAMICS

By far the most common special armors studied to increase AFV protection are ceramics. Ceramics are also assumed to be the main component in Chobham armor. Ceramics are light, but very hard, materials -- over 4 times as hard as the hardest steel at only half the weight. This combination of light weight and high

[9] See: Int. J. Impact Engng Vol. 19 pp. 361—379.

[10] See M. Szymczak in: DREV paper Sept'95.

[11] See Int. J. Impact Engng. Vol. 17; pp. 751—762

[12] See: M. Szymczak in: DREV paper, Sept'95

hardness offers resistance to KE warheads comparable to RHA and, more importantly, resistance to shaped charge warheads up to twice the amount RHA offers. While this makes them good armor material, there are several drawbacks to using ceramics in tank design.

First, ceramics lack mechanical strength and can't be used as support structures. Furthermore, to be most effective they must be encased in metal, therefore diluting some of the weight and performance benefit. While the most basic ceramic, Alumina [AL_2O_3] is about as expensive as Aluminum or hard steel (twice the price of RHA), the really mass-efficient ceramics can be up to 10 times the cost of Alumina.

The second major drawback of ceramics is that they shatter on impact because the mechanical strength can't survive the shock waves bouncing off the free tile edges. In tests, the resistance of a shattered steel-ceramic target ranges from 95% vs. AP shots to 80% vs. APFSDS. In addition, test on AP impacts of sloped ceramic-steel targets show that resistance is less than the LOS value, when the slanted resistance of RHA is more.

SPACED ARMOR

One of the first methods to enhance the armor of tanks was the spaced plate arrangement. It was discovered that the combination of air gap and plate detonated shaped charges before impact on the main armor. Where the air gap was large enough, the standoff of the shaped charge helped to defeat the warhead. This is because shaped charges have an optimum detonation range. If the standoff distance is too little or too much, this reduces the jet efficiency. All modern tanks have spaced armor somewhere over their design, like the rear hull and turret or the skirts over the side hull.

In addition, the spaced plates themselves also help to defeat the shaped charge by erosion. Test on thin spaced plate's show that the collapse of the plate flows into the path of the jet, leading to a large disrupted zone. Since the jet has little strength, it too is disrupted and the plate will offer a resistance 2—3 times the LOS thickness.

If the spaced plate arrangement is layered, the disrupted zone and shaped charge loss of penetration is larger. A steel–aluminum–steel arrangement offers a resistance 7 times the LOS thickness of the plates. The *wedge armor* added to the Leopard 2A5 seems to be of this construction with several plates of steel, probably of different hardness (triple hardness steel?)[13]

Sufficiently large enough spaced plates can also offer increase resistance to kinetic energy attack (APFSDS), increasing plate resistance ~10% as well as 10% for slanted impact.[14]

[13] See: Int. J. Engng. Sci. Vol. 20, pp. 947—961

[14] See: Int. J. Impact Engng. Vol. 5, pp. 323—331

If the layer includes an elastic material the plates will bulge at considerable speed [200—500 m./s], increasing the effectiveness of the plate in much the same way ERA works (see below). These kind of arrangements could offer ~10 times the LOS thickness against shaped charges. The Israeli EKKA armor added to M113 and AAVP–7 are examples of this armor.[15]

Explosive Reactive Armors

ERA generally works in the following way: A flat layer of explosive is sandwiched between two steel plates, mounted some distance from the main armor wall. When this array is struck by a sufficiently large enough force (HEAT jet or KE penetrator), the explosive is detonated and the *flyer plates* are driven apart. If this impact occurs at angle, the expanding movement of the plates will cut across the path of the jet or rod, thereby eroding it. When a rod interacts with the flyer plate, it will suffer enhanced erosion and magnify its yaw resulting in 10—20% loss of penetration per plate. The effect on HEAT jets is similar to rod shaped projectiles, but since the jet is already weak the disruption can be massive. In addition, tests on asymmetrical sandwiches show that, even at normal impact, the HEAT jet is seriously disrupt. Thin plates offered 7—10 times the resistance at normal impact.[16]

Kontakt-1 ERA

Late model Soviet tanks mounted 1st Gen Kontakt armor . These 5 x 8 inch blocks work as follows, inside the box, two plates lined with explosives underneath, stacked one on top of the other, explode outward in the same direction. Test show that outward propelled plates offer more resistance than inward propelled plates (2 times compared to 1.7 for the retreating plates vs. APFSDS).[17] Kontakt is thought to be 10 times as effective as RHA plates vs. shaped charges, but the ERA coverage over the front and side of Soviet tanks is reported to be only 60%, while the glacis is about 80%.

Kontakt-5 ERA

The patent for K-5 shows a box with K-1 type plates inside. The outer 25mm plates hardly move at all and are fixed in place but there are 2—5 inner plates [similar to K-1] with no more than 2 layers active and the others inert. It might be that, since the active layers are in segments themselves, it might be reusable! Since only a

[15] See: Int. J. Impact Engng. Vol. 21, pp. 294—305

[16] Int. J. Impact Engng. Vol. 23, pp. 795—802

[17] "Principle Battle Tank" pp. 59, Arsenal books & Kontakt 5 Patent

maximum of 2 of the 4-7 plates are flyer plates, the variation should be only about ±10% [instead of ±30% in K-1] .[18]

Non Explosive Reactive Armor NERA

A variation of this theme is Soviet BDD or Brow armor. This is a thick armor added to the front turret and glacis of older tanks. The bulk of the thickness is rubber with a few thin (5mm) mild steel plates mounted freely. When this is struck, the kinetic energy of the rod or jet is re-transmitted through the rubber to the mild steel plates, which bulge. The T-55 BDD glacis thickness is 150mm with 30mm RHA casing and alternating layers with 4 x 5mm mild steel sandwiched in between 100mm rubber.

Layering

Test of AP shots on various aluminum–steel combinations has revealed that if the less dense layer is on top, the array offers as much as 15% more resistance than the other way around. Tests on APFSDS seem to show this same effect. Test on ceramic with backing plates show resistance changes with the backing material. The Ceramic/Aluminum, offering much less resistance than the same Ceramic mounted on RHA. In addition, the same ceramic mounted on tungsten plate offers more resistance still. In the case of aluminum, this is less dense than the ceramic and thus it fits into the above model. The case of the Tungsten backing is of note due to the possibility that this might be a key to dU armor effectiveness.

Another way to increase the effectiveness of the ceramic /steel target is to confine (encase) the ceramic in steel. Tests of APFSDS impact have shown that a mild steel cover plate will increase the overall resistance by 12%, while SHS cover plate increases the resistance by 25%. If the backing material is SHS instead of RHA the resistance of the target as a whole goes up again. A ¼ ceramic ¾ SHS target offered 20% more resistance than SHS.

[18] See: Zaloga, Steven: "Artillery & Design Practices 1945—present", pp. 122, 124/125, 147, 436

Appendix D: Tank Tactics

By Ssnake

The Single Tank

Three major properties influence the appropriate tactics for the single tank on the battlefield,

- armor protection,
- the capability of the weaponry system, and
- mobility.

Armor Protection

Both the Leopard's and the M1's frontal armor are impenetrable to armor piercing (beyond about 1500m) and simple HEAT rounds at any distance. Extremely strong HEAT warheads of ATGMs might have a chance, though.

Even minor HEAT warheads will easily penetrate the side armor of the turret, while the hull's track skirts still may deflect at least bazooka missiles. It is unclear whether the improved turret armor is capable to protect from bomblet submunitions - it sure won't save your life from a top-attack guided missile. While both hulls can withstand simple blast mines, neither of them will deflect the HEAT explosion of a modern scatter mine like the German AT-2. So remember: It's the front that will protect your life as a tanker, and nothing else! Life can be uncomfortably short in wartime, and in most cases, the crew won't even know what hit 'em.

Both ATGM and artillery submunitions are 'unfair' in two common aspect: In most cases you won't notice that they're threatening to kill you in a few seconds, and you have very little chances to survive the impact. Some other tank simulators for PCs have shown ATGMs as small rockets with big exhaust fumes. Well, that's been a trick to give the player a chance to react (e.g. by throwing smoke, and back up - bold natures will try to kill the ATGM enemy on the fly). Unfortunately, in reality guided missiles produce very little exhaust. They're nearly invisible. You might notice a dust cloud emerging from the attacker in the moment of ignition, but after that: Ten seconds of nothing but fear. Artillery submunitions are even nastier: They fall from the sky on parachutes all of a sudden. There are no warning explosions like mortar rounds that an inexperienced arty spotter will have having fired to determine whether the gun crew behind is doing a good job. A MLRS battery will fire a single rocket, track that with radar, and blow it up in mid-air ten to five kilometers in front of the target area. That's all the info they'll ever need, and a minute later you have a strike of 3000 bomblets delivered within 20 seconds.

Weaponry

Your tank is equipped with the most modern conventional tank gun. In particular, the 120mm AP rounds will reliably hit any target within a distance of 3000m, and is most likely capable of penetrating the frontal armor plates of modern Russian tanks. However, the T-80 has up to 2000m of range MORE than you to fire its AT-11 ATGM, whose warhead is likely to penetrate anything you'll have, except **maybe** your frontal armor. You should try to find favorable ground for your combat - e.g. those areas who give you about 3000m range and the additional favor of the first shot. In times in which hit means kill, he who strikes first is likely to be the sole survivor.

Firing the gun is one thing, hitting is the other. Although the gun stabilization will help you significantly, it's still better **not** to drive at top speed (except when the terrain is exceptionally flat) but to be moderately fast when operating the gun.

Mobility

Your tank is FAST. Especially when backing up! Fast moving targets are more difficult to hit, especially if they have a more or less erratic course. While the "T-72" is as fast as the Leopard 2 when moving forwards, it is incredibly slow when going backwards.

You cannot outrun an attacking force of Russian tanks while driving in reverse, but you'll find cover much quicker, and if you have to back up for a longer distance, you're better protected, and you won't lose that much time.

High acceleration makes it easier to cover a distance in several jumps instead of moving at a continuous speed. You should sprint from hill to hill, and take some time to stand still in your new position, watching. You are easier to detect when being on the move than carefully waiting behind a hill until you can be sure that nobody is around.

Never drive forward from any position. This will expose your soft belly and throw your gun high in the air, revealing a unique silhouette - in short, it will blow your cover at once. It's better to back up for a hundred meters, and move on in a deviating course. Try to stay as low in the terrain as possible, so you don't show more of yourself than necessary. Try to "drive as the water flows."

Tank Platoons

Tank Platoons are more than assembled numbers of single tanks. At least they should be.

Formations

Aside from driving in different formations, the spacing of the units can be of interest, too.

If you're in unclear terrain you'll prefer to stay rather closely together. In open terrain, it is useful to have a normal or wide spacing, also depending on the air threat level. If you're in the field with rather weak forces, and your mission is to guard a certain sector, wide spacing is inevitable. It also may be useful to rely on wide spacing if you're expecting weak forces in a generally unclear situation.

The most common formations are line and column.

Line

The line formation gives you a maximum firepower to the front. The drawback is that your platoon's flanks are somewhat exposed. Enemy forces surprising you from unexpected positions cannot be fought very well. Keep in mind that your platoon is most vulnerable to mine fields in this formation, since all of them will more or less blow up at the same time, thus giving you almost no time to react to this new kind of threat. Line formations work best if the enemy position is known and at least half a mile away.

Column

The column formation is used mostly for marching. Moving in column will increase your speed (especially in wooded terrain), but decrease your ability to observe the terrain. Naturally, moving in column will give only the first tank a free view to the space forward of him, while he's blocking the view for the tanks behind him.

Echelon formation

The echelon formation is used mostly if you have to cross open space with known or suspected enemy to just one of your flanks. It gives you good firepower forward and either left or right to your movement direction, while totally neglecting the other flank. Moving while having the enemy at your flank is always risky !

Wedge

The wedge formation will serve you best in unclear situations. It's a good compromise between firepower, observation capability, and flank protection. Of course, a good compromise leaves everybody mad - the wedge is by no means the best solution for every situation.

Esoteric formations

These are formations which are seldom in use - the Diamond, the Vee, or splitting up the platoon in two independent groups. Except for the Diamond, you can order your platoon into these formations, too. However, about 75% of all combat situations can be solved with either the line or column formation, 15% for the echelons, and 5% for the wedge.

Tank Companies

- Concentrate your forces !
- Use the high mobility of your tanks if your combat sector is very large !
- Don't waste your energy by distributing your forces evenly all over the terrain: "He who defends everything will defend nothing in the end." (Frederick II., King of Prussia)
- As a German tank company leader, build your own reserve. Your platoons are smaller, but you have four of them in your company instead of three.

Four-Tank Platoons

Four tank platoons grant the platoon leader more flexibility. He may operate in two rather independent sections - although that's not the regular way to conduct your battle. And four tanks have a higher firepower than just three. On the other hand, you could be spotted earlier, since your platoon is 33% bigger.

Three-Tank Platoons

Although these platoons feature only 75% of the gun tubes compared to their four-tank cousins, the number of tanks in a company will still be the same. The result is a fourth platoon at the company leader's disposal. Usually, he'll use this fourth platoon as a reserve force in his battle plans, thus enhancing his flexibility.

After numerous changes back and forth, three-tank platoons are now what you get in Germany. Also Red forces will use three-tank platoons, but a Red company will have only three platoons. Therefore a Blue company will always have 30% more tanks than its counterpart - but then again, a Blue company will have to deal with a whole enemy tank battalion...

APPENDIX E: SIMULATING TANKS

By Ssnake

In case you have the illusion that you could become a real tanker if only you played a simulator often enough, read on…

HOME AND OFFICE ENVIRONMENT

Unfortunately, the comfy surroundings of your PC -your living room or maybe even your office- do not match the environment inside a tank very well. In fact, there is absolutely no resemblance at all. Therefore, a PC simulator will meet serious restraints in what it can actually simulate.

INPUT DEVICES

You can never train yourself to become an excellent gunner (or commander) on a PC because, for one thing, you are limited to using a keyboard, mouse, and joystick. To excel at gunnery on a real tank you must learn to operate the real controls while blindfolded. You can see the same effect in a simulation. Until you know all the sim controls, and how to efficiently access them, you'll be a novice sim gunner. The same is true for the real thing. Many switches in a tank are found near the gunner's right shoulder, above his head, and below his butt. You can't simulate that on a PC.

PHYSICAL STRESS

You don't have do hard labor on your PC. A tank crew member has to do a lot of manual labor. Each round weighs about 25 kilograms, and there are 42 to load into a tank. The loader will jump in and out of the tank numerous times in a day. The whole crew will probably sleep only two to four hours a day for weeks. It stinks. It's loud inside a tank. You may not wash yourself for days, and then you get some ice cubes instead of a warm and comfortable shower. The rolling motion of the moving tank might cause nausea -- somebody's barfing into a rubber boot, but the tank won't stop. Boring routine for hours, days, even weeks. Then an enemy attack, all of a sudden. And it's over even before you fully realize that there was a threat to your life!

If you care to simulate the routine day of a tanker, here's what you can do. (Take care to avoid all social contact, though, or you may find yourself under sedation in a rubber room.) Once you're alone, stop washing for a couple of days[19]. Then start

[19] OK, if it's absolutely necessary, use a bowl of ice water. Shave yourself with a blade, but no foam! Use face paint afterwards, and diesel fuel as a deodorant.

exercising by repeatedly climbing some dressers in your bedroom. Fold yourself into a locker for a few hours, and then start weight-lifting your 17" monitor. Avoid sleeping for more than three hours per day - in the locker, of course ! Use duct-tape and fix yourself to your seat.

COMMUNICATION

You cannot talk to your computer. OK, there are some programs that will allow you to translate some simple speech commands into keyboard input, but you can only give a limited set of orders that the simulator understands. Worst of all, you cannot do several things at the same time; you can only handle what's most threatening *right now*.

TERRAIN RENDERING

MONITOR RESOLUTION

Although modern PCs are far more powerful than the computers that sent the Apollo rockets to the moon, game developers still don't have enough computing power to create virtual environments that resemble reality close enough. Terrain rendering is a good example. Here you meet several restraints. Although some people call screen resolutions of 640 x 480 pixels and above as "high res", these are still very poor values in comparison to human eyes. If you don't need glasses, you can easily spot a moving tank at distances up to 3000m with the naked eye (if the terrain is favorable, and weather provides good visibility). At 3000 meters, a typical tank would subtend an angle of about 0.057 degrees (about 1 mil). To make that tank appear as just a single pixel on you monitor at a resolution of 640 x 480 means that the field of view must be reduced to about 36 degrees, far short of a human's field of view, and still the tank would appear as a single dot. Conversely, if you want to have a field of view of only 72 degrees, the tank would be smaller than a single pixel at just 1500 meters.

VISIBILITY RANGE

From high ground with good visibility and binoculars you could detect a column of tanks at a distance of 10 or 15 km. Although this is beyond the reach of your tank's main gun, you could have called artillery if you spotted an enemy tank column at such a distance.

Unfortunately, the amount of computing power needed to render the artificial landscape and perform enemy detection over such a great distance is too prohibitive. Therefore we had to limit the maximum visibility range 4500 meters - which is still comparatively large when compared to "Mech" games which typically show you no more than just a few hundred meters.

The Looks of an Artificial Environment

Computer-rendered areas still look artificial. Surfaces are too smooth, and there's probably never enough trees, leaves, and even butterflies in the air to fool you. Unfortunately, that will affect the way you deal with the terrain presented here. Disorientation is a common phenomenon in computer simulations (even in the cutting edge ones of the military) unless some terrain properties are grotesquely overdrawn. The only terrain types that can be displayed with information contents roughly equal to reality are oceans, deserts, and the arctic tundra.

Artificial Intelligence

The world was astounded when *Deep Blue* beat Gari Kasparov during an infamous chess tournament. Although chess has a lot of variables, it still has only 64 different positions that pieces can occupy, and a small number of moves and rules. In a simulator like Steel Beasts, each vehicle can occupy nearly an infinite number of 3D positions. (256 * 2 ^ 32, to be exact, which is over 1 trillion positions) and the rules and movements are very complex. There's simply no way to use brute-force chess algorithms in such a simulation.

The AI (more accurately, the computer control logic) for simulations invariably relies on ad hoc algorithms based on heuristics that sometimes work and sometimes don't. When they don't work, the AI units look plain stupid.

What the computer can do well is follow rather simple rules of micro management. Our computer-controlled drivers try to find hull-down positions from the very moment they make out an enemy. They'll follow your change-of-formation orders without bouncing into each other too often. They back up when being under direct fire, and try to find a different position. Our computer-controlled commanders will fire smoke grenades at the proper time. They'll ask for artillery support on their own. They'll search for the enemy in a realistic way, and hand off targets to the gunner. There's no cheating here!

But how did we train the computer to invent ingenious battle plans? We didn't. We gave up on the idea of having an imaginative computer AI create high-level battle plans, and instead rely on humans creating them. In other words, you'll have to face canned missions (although they can contain random elements in them). They're as ingenious (or as unimaginative) as the mission designers' minds. The alternative is to have an automatic scenario generator create an infinitive number of missions that all seem to play the same way.

Appendix F: Credits

Designer/Programmer	Alexander Delaney
Technical Director	Ssnake
Creative Director	Curtis Ratica
Sound, Music	SPC Edward (Volcano) Williams
Music	Dave Bakker
Additional 3D Models	Geoff Coovert
Infantry Sprites	Michael Peters
Additional Art	Matt Osborn, Ssnake
Scenario Designers	Dave Freeman, Larry Hookins, Michael McConnell, Eric Myers, John Olson, Andrew Romaniuk, John Sponauer, Ssnake, Robert Statius-Muller, James Sterrett, SPC Edward Williams, SGT Brian K. Huyler
Web Site Designers	Eric Myers, Andrew Romaniuk
Beta Testers	Geoff Coovert, Dave Freeman, Volker Holloh, Larry Hookins, Mats Lindebro, Corinne Mahaffey, Eric Myers, Peter Nilsson, John Olson, Andrew Romaniuk, Robert Statius-Muller, James Sterrett, Douglas Ure, SPC Edward Williams
Lead Multiplayer Tester	Michael "Sabot" McConnell
Multiplayer Testers	Geoff "Mekhazzio" Coovert, SSG Black6g, John Branom, Dave Chambers, Paul "KrappO" Chasse, Steve Dineen, Chris Feltault, Paul T. "Solomo" Hammerness, SSG Kolenski, Dan Polito, David "Reich" Reichard, Douglas "Phoenix" Ure, Tom "Mire" Walsh, Edward "Volcano Man" Williams
Voices	SFC Ron Cole, SFC Allen R. Palmer, SPC Edward L. Williams, Ssnake, Axl, Mats Lindebro, Peter Nilsson, Seniorsergent Johnny Jensen
Technical Consultants	SFC Ron Cole, J. Scott Cunningham, Andrew Jaremkow, Paul Lakowski

Translations	Victor Amar B. (Spanish), Francisco Sanchez Blanco (Spanish), Koen Desmecht (Dutch, French), Seniorsergent Johnny Jensen (Danish), Dirk Lemkemeier (German), Mats Lindebro (Swedish), Peter Nilsson (Swedish), Ssnake (German)
Special Thanks	Arielle Bieber, SFC Thomas Cagle, COL Chris Cardine, Maj Collins, 1ATB, Fk Feldhoffer, MekB10, CPT Fournier, 16th Cav, MAJ Gilewitch, 16th Cav, SFC Greene, 1ATB, Fk Hedberg, MekB10, SSG Howell, 16th Cav, CPT Johnson, 1ATB, Ilona Kiss, Martin Nilsson, Rhonda Paige, PAO Ft. Knox, SFC Pearson, 1ATB, André Reszöhàzy, Tomi Sarvanko, Dean Sprague, PAO Ft. Knox, Heike Strake, SFC Scott Vallie, A/5-112 AR BN, Joachim Vanderroost, Christy Van Hoof, Willy Veldeman, Jean-Pierre Wauters, Vincent Wauters, Fk Westin, MekB10
Box Photo Provided by	J.S. Cunningham

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PR Manager	Christina Ginger
PR Associates	Michelle Fortier, Kelly Ekins
Packaging and Design	Kenneth Green, Philippe Brindamour

Appendix G: Control Reference

Hot key mappings

Fire button	=	joystick button 1 or Spacebar
Lase button	=	joystick button 2 or Ctrl or right mouse button.
Palm button	=	joystick button 3 or P or middle mouse button.
Dynamic lead button	=	joystick button 3 or P or middle mouse button.
Cancel button	=	joystick button 3 or P or middle mouse button.
Mag button	=	Joystick Button 4 or N.

General Controls

Esc	Quit the game
Pause	Pause the game
F12	Time acceleration

Position Controls

F6	Gunner's position
F7	Tank commander's position
F8	External position
F9	Jump to lead tank in next unit
Shift F9	Jump to next tank in current unit and make it lead tank
F11	Jump to lead tank in first engaged unit

Platoon Controls

[	Echelon-left formation
]	line formation
\	Echelon-right formation
Shift [	wedge formation
Shift]	column formation
Shift \	vee formation
-	tighten formation spacing
+	widen formation spacing
H	Hold fire
F	Fire at will
Tab	Pop smoke
Shift Tab	Toggle engine smoke on/off
Shift Backspace	Toggle engines on/off

Driving Controls

W	Increase speed to next level (halt, slow, fast or top speed)
X	Decrease speed to next level (fast, slow, halt or reverse)
S	Halt
A	Turn left 22.5 degrees
D	Turn right 22.5 degrees
Shift A	Continuous left turn while keys depressed
Shift D	Continuous right turn while keys depressed
C	Continue on last route / proceed to next route
E	Go hull-down facing the enemy or viewing / hull direction
lase button	Drive to this point (TC or external position only.)

Gunner's Controls

F1	Gunner's primary sight (GPS)
F2	Gunner's auxiliary sight (GAS)
F3	Gunner's unity sight (M1) or vision block (Leopard)
F4	Gunner's interior view
F5	Map screen
Fire button	Fire
lase button	Lase
Palm button	Turn palm switch off while depressed (M1 only)
Dynamic Lead button	Add dynamic lead while depressed (Leopard only)
Mag button	Toggle day (M1 only) or TIS magnification in GPS
M	Toggle gun select: main / coax
T	Notify TC of target in sights (TC will stop overriding)
I	Ask TC to show you current target
Insert (Insert)	Set ammo select to Sabot (M1 only)
Delete (Delete)	Set ammo select to HEAT (M1 only)
Home / End	Set ammo select to amo #3 /#4 (M1 only)
,	Set fire control mode to NORMAL
.	Set fire control mode to EMERGENCY
/	Set fire control mode to MANUAL
~	Toggle laser return: first / last (M1 only)
R	Toggle GAS reticle: Sabot / HEAT (M1 only)
Shift ↓ ↑	Adjust GAS range setting (Leopard only)
Keypad +	Toggle TIS: on / standby
Keypad -	Toggle TIS polarity: white hot / black hot
↓ ↑ → ←	Manual-mode gun steering
0 - 9 then Enter	Type manual range entry (in GPS view)

Commander's Controls

F2	Gunner's primary sight extension (GPSE)
F3	0.50 Cal. MG sight (M1) / Normal Peri view (Leopard)
F5	Map screen
B	Button/unbutton tank
Fire button	Order gunner to fire. (Fire gun if overriding.)
Lase button	In TC eye view, drive to this point upon release. (Lase, if overriding [Leopard must be in KW mode])
Palm button*	Palm switch ON, overriding while depressed. (M1 only)
Cancel button	Cancel override, surveillance mode of peri. (Leo only)
Mag button	Toggles binos on/off (GPSE mag if overriding in GPSE.)
Joystick hat Up or ↑	Slave gun to Peri, overriding gunner. (Leopard only)
Joy hat Down or ↓	Slave Peri to gun. (Leopard only)
Keypad *	If overriding gunner, enter KW mode. (Leopard only)
Shift joy hat or Shift ↑ → ←	Order gunner to move turret to front, left, right, with respect to hull
M	Order gunner to use main gun / coax
Insert (Insert)	Order loader to load Sabot next round
Delete (Delete)	Order loader to load HEAT next round
Home / End	Order loader to load amo #3 /#4 next round (not used)
,	Order gunner to set fire control mode to NORMAL
.	Order gunner to set fire control mode to EMERGENCY
/	Order gunner to set fire control mode to MANUAL
Keypad +	Order gunner to toggle TIS (on / standby)
Keypad -	Order gunner to toggle TIS polarity (white hot / black hot)
0 - 9 then Enter	Battle sight rangeentry (M1) / manual range entry (Leo)
Backspace	Enter battle sight range entry into ballistic computer