

The First Blitzkrieg NOTES

Table of Contents

I. Design Notes

II. A/I Design

III. Tips on Play - Panzer School 101

IV. The Scenarios

V. Selected Bibliography

I. Design Notes

Introduction

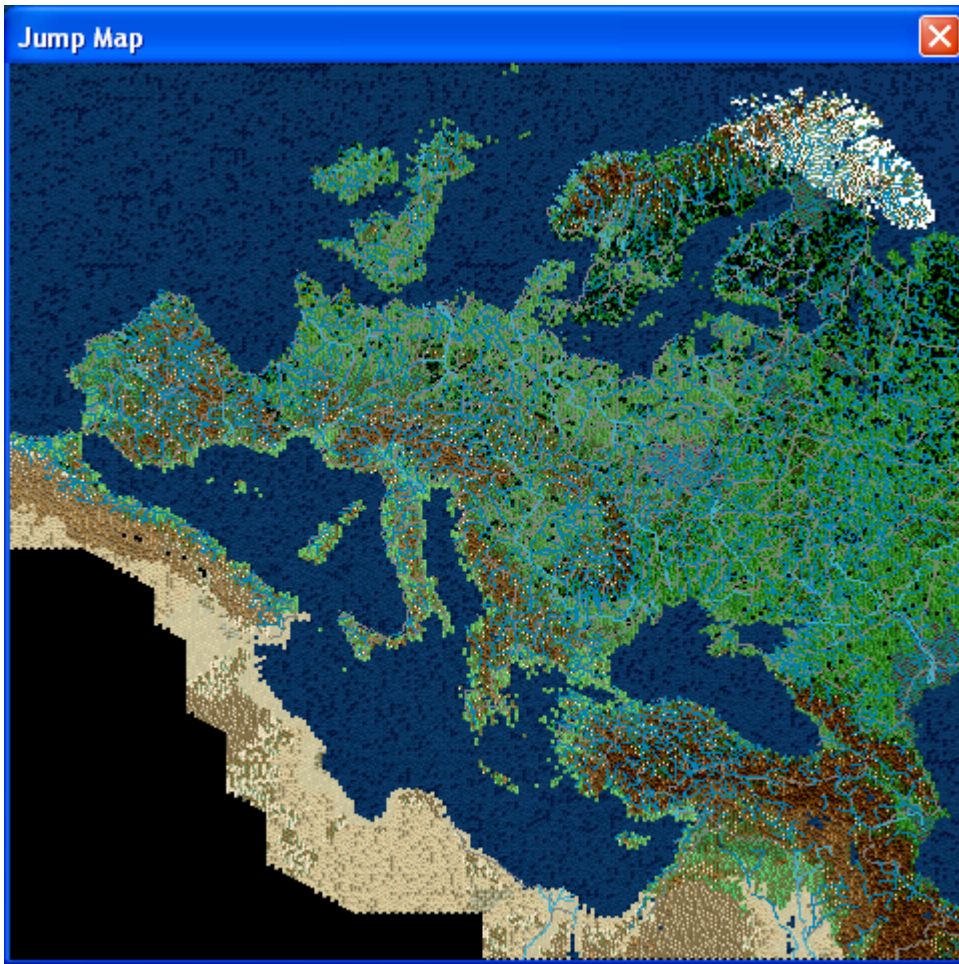


The First Blitzkrieg (TFB) is the first of what will be a series of games called **Total War in Europe**, and will focus on the early years – Poland, Norway, France and a hypothetical invasion of England in the fall of 1940. I am sure I speak for most of the development team when I say that the seeds of this go back to the day when I first set up my SPI board game War in the West which went on to become War in Europe when combined with the East Front.

The idea to make the game came from our Programmer and Developer John Tiller who for a number of years like to think of this project as his Hobby project – something he would work on as time allowed. The project really got going late in 2000, after of few people who had collaborated on the early Panzer Campaigns were invited into the project after got to know us and what each of us could bring to a project of this scope.

The Master Map

While this first installment of the series comes with several small maps, the Total War in Europe Master Map was the first step. This map is a monster! Encompassing the whole of Europe and parts of North Africa and Asia with a 10 kms per hex scale the complete map has over a quarter million hexes. The map also incorporates a 30-degree tilt to the east to allow us to fit it in a rectangular shape. The chief map maker on this project was Dave 'Blackie' Blackburn, an experienced map maker responsible for many of the Panzer Campaigns and Squad Battles Maps.



Like the Panzer Campaigns, the map was created using a proprietary Map program where a source map is scanned in pieces and assembled into a massive bitmap map. For a typical Panzer Campaign this bitmap can easily be over 100 MBs, however for this project the bitmap had to be cut into eight smaller bitmaps each 50 to 80 MBs in size because the PCs and Video cards of the day just would not support loading the entire map at once.

The master map will be used to generate smaller maps for the various games in the series, but only be released as a single large map in the final game, which will encompass the total war from 1939 to 1945. In "The First Blitzkrieg", the maps include Norway, Denmark, Poland, Germany, France, the Low Countries and England, with portions of other countries as well. Anyone familiar with making new scenarios for John Tiller games will be pleased to know the same submap feature used in other series is available here. This enables players to develop their own scenarios on smaller sections of the maps provided in the game.

The submap feature allows many smaller scenarios to be developed using the scenario editor with your own size map from the game maps and using the detailed units provided in the game Order-of-battle which covers all the nations in this early part of the war.

Many hours went into the map making and we trust you will be as pleased as we are with the results.

Not your old boardgame here

Despite the seed growing from the War in Europe (WIE) board game and perhaps the similar appear of the Map, you will find that this game is not a an attempt to port the board game to the PC. The scale is a very different in as compared with the WIE.

The WIE had a ground scale was 33 km per hex and a timescale of one weeks per turn. This game is 10 km per hex and 2 days per turn. Therefore, as an example, in WIE the distance from Dunkirk to Sedan 10 hexes and the period we cover in our France 40 campaigns would last only 3 to 6 game turns. By comparison with The First Blitzkrieg the distance from Dunkirk to Sedan is 25 hexes and the France scenarios last between 12 and 21 game turns.

But the difference doesn't stop at scale. The combat model was first developed in early 2001 and goes far beyond the simple Attacker vs. Defender odds ratio with a die roll.

Combat Resolution in TFB is intended to represent two results: the attempt of the attacker to cause casualties to the defender and a corresponding attempt of the defender to cause casualties to the attacker. These results are modified to take into account varying armor and anti-tank abilities of the units involved. This results in armor associated with the attackers and defenders possibly playing a higher or lower role in the results than they would by default. Each ground unit has 5 values which affect combat results in the game: attack value, defense value, armor value, anti-tank value, and anti-air value. Each combat result consists of two types of losses: losses to strength points and losses to effectiveness. Each combat result also affects both sides of the combat, attacker and defender.

Unit ratings in TFB based on a fairly complex set of calculation utilizing actual weapons counts. The first calculation is for unit strength. One point is given for each Infantry Platoon and an equivalent amount of vehicles or major weapons. The game ratings are based on the number of weapons of a given type multiplied by a weighting factor (different weightings are applied for each game factor (AF, DF, Arm, AT, and AA). The product for all weapon types (there are 182 of them) are then added together and then divided by the unit strength. This final number is then adjusted by a Quality factor (ranging from 1.0 for super elite troops to 0.4 for the REALLY bad) and this last part is the only place where judgment comes into play.

For example, below is some of the raw numbers used to arrive at values for a medium Artillery Btl" composed of 12x 105mm Artillery pieces. The ratings are calculated as follows:

Strength = squads + weapons (ex ATR's and LMG's)/10 = 0 + 12/10 = 1
 AF = sum (weapons * wpn AF factor)/Str * class = 12 * 4 / 1 * 0.9 = 43
 DF = sum (weapons * wpn DF factor)/Str * class = 12 * 0.25 / 1 * 0.9 = 3
 Arm = sum (weapons * wpn Arm factor)/Str * class = 12 * 0 / 1 * 0.9 = 0
 AT = sum (weapons * wpn AT factor)/Str * class = 12 * 0 / 1 * 0.9 = 0
 AA = sum (weapons * wpn AA factor)/Str * class = 12 * 0 / 1 * 0.9 = 0



There are 183 different Squad and Weapon types (each with their own set of factors) so the calculations get complicated when units have more than one weapon type. I use a Microsoft Access database to do the calculations. Class is the only factor that is subjectively applied and it

varies from 1.0 (fanatic) to 0.4 (despicable).

The game comes with a fully developed Order-of-Battle (OOB) for the period covering the early years of the war and includes 13 separate Nations which combined makes for 360 possible types of ground combat units and 87 types of air units. Using the scenario editor along with the maps provided and this master OOB, any other historical or hypothetical scenarios can be developed. Other nations with different units covering different periods of the war will be included as parts of later games in this series.

The AI

In 2003 John Tiller began work on an generation A/I – a project for the Department of Defense STTR Program entitled: Adaptive Artificial Intelligence for Next-Generation Conflict Simulation. In this project John Tiller was assisted by the program manager for the Air Force Office of Scientific Research, Dr. Robert Barker.

The proposal was to design and development of a challenging, adaptable, and extendible A/I system for use in state-of-the-art computer-based wargames. The development would result in a 3rd generation computer wargame and the ability to apply the technology developed for this project in other wargames. The approach was to use state-of-the-art A/I technologies programmed into A/I components which through well-defined interfaces allowed for a plug-and-play A/I system. This provides for unlimited future development and enhancement as well as provides a challenging A/I opponent developed from this proposal.

TFB is the first wargame to utilize this new system and from that point, a colleague of John Tiller, Dr. John Rushing, University of Alabama in Huntsville began the detailed building the A/I for the TFB Game. Dr. Rushing had this to say about the A/I Design.

Click here to go to the next section on [II. A/I Design](#)
or here to return to the [Welcome](#) to Notes Table of Contents

II. AI Design

by John Rushing

Overview

The Artificial Intelligence (AI) component of Total War in Europe consists of a series of layered behaviors based on the Evaluate, Plan, Execute (EPE) model. The behaviors are organized into two modules: a defender AI and an attacker AI. These modules share some behaviors, but each module has a different flow and uses the behaviors in different ways. The behaviors are mostly independent of each other, but some behaviors use information produced by others for the sake of efficiency. Each behavior has a specific well-defined task to accomplish, and a set of constraints under which to operate. Some behaviors are also controlled by parameters that are specified in the scenario files, so scenario specific tuning of the AI is possible.

Evaluate, Plan, Execute (EPE) Model

Each of the behaviors in the Total War in Europe AI has an evaluation, planning and execution component. The evaluation component constructs an assessment of the current situation and gathers the information required for the planning and execution phases of the behavior. The planning component formulates an overall approach for accomplishing the goals of the behavior and makes high-level decisions about what actions should be taken. The execute component of the behavior performs actions on the game counters including moves and attacks.

Defensive AI Flow

The defensive AI executes a series of behaviors in a fixed order. The ordering is important since some behaviors use information produced by others. Also, the order determines the priority of the behavior, as units used by one behavior may not be available for subsequent behaviors. The defensive AI flow goes as follows:

Reconnaissance Behavior	Fly recon missions
Deployment Behavior	Deploy reinforcements and replacements
Port Assault Behavior	Garrison ports and attack enemy held ports
Garrison Behavior	Establish at least minimal defensive lines
Withdraw Behavior	Rescue units in danger of being overrun
Reinforcement Behavior	Strengthen weak spots in the front
Counterattack Behavior	Attack targets of opportunity
Migration Behavior	Move units from the rear area toward the front
Air Attack Behavior	Soften up enemy ground units near the front
Interdiction Behavior	Inhibit enemy movement

Defensive AI Behaviors

Reconnaissance Behavior: The reconnaissance behavior executes reconnaissance missions using all of the available reconnaissance aircraft. Targets are chosen essentially at random, with 75% of missions being flown behind enemy lines near enemy forces, and 25% of missions being flown at or near enemy held objectives.

Deployment Behavior: The purpose of the deployment behavior is to deploy reinforcements and replacements. The AI currently does not have much to do in this regard as the locations where the reinforcements arrive are determined by the scenario.

Port Assault Behavior: In some scenarios, defensive reinforcements arrive at sea far from any port and it is up to the player or the AI to decide where these reinforcements should be deployed. The purpose of the port assault behavior is to deploy these reinforcements. The port assault behavior attempts to garrison any friendly ports that might be subject to attack, and recapture as many ports captured by enemy forces as possible.

Garrison Behavior: The purpose of the garrison behavior is to establish lines of defense that prevent the attacker from achieving objectives. The evaluation component of the behavior determines where the front lines currently are, and the relative strengths of the attacking and defending forces at each point on or near the fronts. The planning component determines which portions of the current lines should be held, and chooses a series of control points, or locations to station forces. The hold decisions are based on the value of the hex in terms of objectives in the vicinity, the suitability of the defensive terrain, the relative strengths of the forces, and the ability to bring up reinforcements from the rear. The planning component attempts to distribute forces along the front to roughly match the forces facing them. The planning component makes extensive use of the path finding routines (described later) to determine which hexes are reachable by which units. It also considers the types of units, and attempts to stack support units such as artillery and engineers with strong units like infantry or armor. The execute phase of the garrison behavior is responsible for actually performing the moves determined during planning.

The garrison behavior also takes a parameter: the hold radius. If this parameter is not set, the garrison behavior will attempt to hold as much territory as possible. In some scenarios, this is not a good idea because the defensive forces will be spread out too thin, and the attacker will easily break through the front lines. If the hold radius is set, the garrison behavior will only attempt to hold hexes within that number of hexes of an objective. In other words, the hold radius will tell the defender to establish pockets of resistance rather than a single cohesive front.

Withdraw Behavior: The purpose of the withdraw behavior is to move units that are in danger of being overrun or surrounded to safer locations, preferably where they can actually do some good. The withdraw behavior makes use of the evaluation generated by the garrison behavior. Units that are in areas outside of the garrisoned region are considered to be at risk. These units will be moved as far as they can towards the nearest (in terms of path cost) control point. If units can be moved into defensive positions, the evaluation produced by the garrison behavior is updated to reflect that.

Reinforcement Behavior: The purpose of the reinforcement behavior is to move any units that can reach the front lines into defensive positions. The reinforcement behavior uses the evaluation produced by the garrison behavior to determine which portions of the front are most in need of reinforcements. This is primarily determined by the ratio of known friendly and enemy forces in the area, and is also influenced by terrain. The weakest areas of the front get the highest priority in terms of unit assignment.

Counterattack Behavior: The purpose of the counterattack behavior is to execute counterattacks against the attacking forces to retake objectives, destroy weak units, or cut lines of supply. The evaluation component of the behavior determines the locations of enemy lines and their weak points. The planning component of the behavior determines for each weak point

whether it is possible to launch a counterattack with sufficient likelihood of success, without depleting the defensive garrisons. It uses the path finding algorithms to determine which units can move into attacking positions. The execute component of the behavior moves the units and executes attacks. Note that the counterattacks do not follow any global strategy, but rather look for attacks of opportunity where the enemy defenses are weak.

Migration Behavior: The purpose of the migration behavior is to move units that are in the rear area towards an area where they are needed. The evaluation produced by the garrison and reinforcement behaviors is used to indicate whether there are any weak points remaining in the front lines. If so, units will migrate towards the nearest weak point. If not, units will migrate towards the nearest front line control point. These points are the targets of the migration process. The planning component of the migration behavior constructs navigation meshes, which indicate for each hex on the map the direction and distance to the nearest migration target. There are actually two meshes constructed, one for rail movement and one for ground movement. Units that are very far from the front will move towards rail lines, and if they begin a turn on a rail line, will use rail movement to move towards the front. Units that are closer to the front will simply move using normal ground movement.

Air Attack Behavior: The purpose of the air attack behavior is to soften up attacking units near the front. The evaluation component of the behavior identifies potential enemy targets and determines how strong their air defenses are. Enemy stacks with strong air defenses will not be attacked. The planning component ranks the remaining targets in terms of value, with strong enemy stacks near weak friendly stacks receiving priority. The execute component then attempts to execute attacks against the targets in rank order using any air unit with ground support capability.

Interdiction Behavior: The purpose of the interdiction behavior is to inhibit enemy forces from moving. Currently the AI chooses interdiction targets mostly at random (it will not fly against invalid targets). Any air units capable of interdiction will be used to fly interdiction missions.

Attacker AI

The attacker AI executes a series of behaviors in a fixed order. The ordering is important since some behaviors use information produced by others. Also, the order determines the priority of the behavior, as units used by one behavior may not be available for subsequent behaviors. The attacker AI flow goes as follows:

Reconnaissance Behavior*	Fly recon missions
Deployment Behavior*	Deploy reinforcements and replacements
Sea Assault Behavior	Amphibious and port assaults
Attack Behavior	Plot axis of advance, carry out attacks
Garrison Behavior	Protect flanks of the advance
Rail Repair Behavior	Repair rail lines
Mobile Supply Behavior	Move mobile supply units
Migration Behavior	Move units from the rear area toward the front
Air Attack Behavior*	Soften up enemy ground units near the front
Interdiction Behavior*	Inhibit enemy movement

* Behaviors that are exactly the same as defensive behaviors. Not described below.

Attacker AI Behaviors

Sea Assault Behavior: The purpose of the sea assault behavior is to establish beachheads for the attacking units in scenarios that involve sea invasions. In general, amphibious units start near their landing beaches in all of the scenarios that are in "The First Blitzkrieg". The implication for the AI is that there is not much leeway in deciding where these units land, and therefore there is not much logic devoted to this purpose in the AI. Amphibious units will assault the nearest beach. Other units arriving at sea will assault any enemy held ports within range, or if there are none, they will land at the nearest friendly port.

Attack Behavior: The purpose of the attack behavior is to execute the primary attacks for the attacking side. The evaluation component will identify groups of mobile units (clusters) to move in a coordinated fashion, and identify objectives for these units. The planning component will plot routes from the current location of the units to the objectives. Both the grouping and assignment of objectives are determined by AI objectives if present. AI objectives are hints placed in the scenario file that determine an overall attack plan. If AI objectives are not present, the AI attempts to group units by clustering and assign each group an objective based on the values of the objectives and their distances.

The execution component will actually carry out the attacks in sequence. One important factor is that the results of one attack will determine what needs to be done on successive attacks. The execute component will attempt to gain at least 3:1 odds in its favor before attacking if it can. It will use air strikes against the target if necessary to soften it up before attacking. It will attempt to make at least one attack on each axis of advance each turn, even if the best odds achievable are only 1:1.

Garrison Behavior: The purpose of the garrison behavior is to protect the flanks of the attacking forces from counterattacks. The evaluation component of the behavior determines where the front lines currently are, and the relative strengths of the attacking and defending forces at each point on or near the fronts. The axes of advance and supply routes determine the areas that need to be protected. The planning component chooses a series of control points, or locations to station forces. The planning component attempts to distribute forces along the front to roughly match the forces facing them. The planning component makes extensive use of the path finding routines (described later) to determine which hexes are reachable by which units. It also considers the types of units, and attempts to use slower units to protect flanks while faster mechanized and motorized units advance. The execute phase of the garrison behavior is responsible for actually performing the moves determined during planning.

Rail Repair Behavior: The purpose of the rail repair behavior is to repair rail lines to facilitate unit movement and supply. Rail repair units will be moved to the nearest friendly controlled damaged rail line. They will move along the damaged line until an enemy zone of control is encountered or until all of the damaged rail along the line is fixed. Rail repair units will avoid moving into enemy zones of control.

Mobile Supply Behavior: The purpose mobile supply behavior is to move mobile supply units into positions where they can supply the advancing units without endangering themselves. Mobile supply units are assigned to advancing groups. The supply units will be positioned between the spearhead of the advance and the nearest supply source.

Migration Behavior: The purpose of the migration behavior is to move units that are in the rear area towards an area where they are needed. The group assignments produced by the attack

behavior are used to determine which axis of attack a particular unit will move toward. The furthest extent of the advance is the target of the migration, unless that hex is full. As the hexes fill with units, the migration target moves back towards the rear area.

Path Finding

The path finding algorithm used by the AI is based on the standard A* algorithm. This algorithm uses a heuristic to prune sub-paths that cannot produce a minimum cost path. The path finding algorithm uses a cost function to determine the cost of the possible moves for the unit that is being moved. Different cost functions are used in different circumstances. Many of the differences deal with treatment of enemy zones of control. There are cost functions that only allow legal moves, those that allow legal moves based on known enemy units, and those that allow moves through enemy zones of control. (The last one is used for plotting an axis of advance, where it is assumed that there will be no clear path from the attacking units to the objective).

Tools Applied

The AI for "The First Blitzkrieg" (TFB) is defined primarily as a series of behaviors, each consisting ultimately of a set of heuristics or rules. The rules are similar to those found in typical expert systems, in that they have sets of conditions that govern when the rules are applicable, and actions taken when the rules apply. This portion of the AI could have been implemented as a set of productions using an expert system shell. However, the rules are just as easy to specify in C++, and doing so improves speed of execution and makes it unnecessary to translate game information from its native representation in C++ classes into a form usable by an expert system. Based on previous experiments with expert systems shells and other similar toolkits, it was determined that the widespread use of such systems would produce unacceptable delays in the response of the AI. The amount of overhead required to send information to and from these toolkits was of particular concern.

The behaviors also made use of other AI tools to accomplish specific tasks, most notably clustering, image dilation, navigation meshes, and path finding algorithms. Clustering algorithms were used in the attacker AI to identify groups of units that should operate together to accomplish a goal. It was assumed that mobile units starting close to one another constituted logical groups, and that these groups of units were typically meant to follow the same axis of advance and try to take the same objectives. Image dilation was used in the attacker AI to compute areas of support required for the axis of advance. A skeleton was constructed consisting of supply routes from the spearheads of advance to their nearest supply sources, and friendly objectives and rail lines. This skeleton was expanded using a standard image dilation algorithm to yield that area where flank support was required.

Navigation meshes were used in cases where large numbers of units were being moved to a small number of common destinations. The most notable example is defensive unit migration, where all rear area units migrate towards the nearest weak point in the front. A navigation mesh was constructed as an overlay to the hex grid. For each hex, the direction and distance to the nearest weak point was computed. Separate meshes for rail and non-rail movement were constructed, and rail movement was used when appropriate (distance to the front was large, and rail capacity was not exceeded). Path finding algorithms were used throughout the AI in all aspects of planning and execution. A standard A* algorithm was used, with an external cost function. Different cost functions were used for finding different types of paths. For example, in some cases it was necessary to find legal single turn moves considering known enemy units. In other cases it was necessary to find the best path to an objective (in terms of terrain and distance) for an advance regardless of how long the path was, and allowing transitions of

enemy zones of control. Other cost functions were required for rail movement, sea movement and rail repair movement (which allows movement over damaged rail lines).

Other tools considered for use in the AI included other data mining tools such as trainable classifiers (neural networks, decision trees, Bayesian methods, etc.) and association rule mining methods, and also general-purpose optimization methods such as genetic algorithms and simulated annealing. However, none of those methods found application in TFB. Of those, the optimization methods seem to show the most promise, as the AI has several tunable parameters that can be optimized. Trainable classifiers have the potential to solve decision problems and could be used as a substitute for some of the game heuristics. However, these classifiers must be supplied with large numbers of cases, and the relevant information used in the discrimination process must be identified and extracted. Typically, this process is more laborious than specifying rules explicitly.

Lessons Learned

At the start of any complex development process it is difficult to know which methodologies or approaches will be the most promising for the task at hand. Many lessons were learned during the course of the AI development for "The First Blitzkrieg" (TFB).

The AI development for "The First Blitzkrieg" (TFB) was done incrementally, starting with very simple functionality and building up over time to more complex behaviors. Each behavior typically required several iterations to get to the point where it was doing what it should. Limited play testing was done throughout the development cycle, and feedback was provided to the developer. It was found that a weekly development, build and test cycle worked very well, as it allowed time to incorporate significant new features into each release while allowing rapid feedback for the developers.

Initially, it was thought that it could be useful to incorporate various external tools such as expert system shells and data mining toolkits into the AI. While this still seems like a viable approach for AI customization, there are several drawbacks to this approach. There is significant overhead in communication to and from the game engine, and this overhead can severely impact the performance of the game. Calling external tools also requires significant additional code to manage the calls to and from the tool and to format information in the appropriate way. For many of the algorithms of interest such as clustering, path finding, and dilation the bookkeeping and translation code would be significantly larger than the code for the algorithm itself. It was determined that in many cases it is easy to use the concepts and algorithms (or even source code) from various domains without the need to introduce dependencies on whole toolkits. What this ultimately means is that it is not worth introducing an external library dependency into a product unless that library provides significant functionality that is actually required.

Other lessons pertain to the interaction of the AI with the internal data model of the game. Initially, the plan was to have zero impact on the game model by not allowing the AI to alter any of the game entities. This restriction was relaxed in order to allow the AI to annotate game entities with information that is only relevant to the AI, without changing any parts of the data structures used by the game engine. This allows the AI to store state information on game entities without having to mirror those entities in AI specific data structures. This saves significant overhead and eliminates the potential for synchronization errors between the structures while adding very little in the way of coupling or risk to the core data model.

The Evaluate, Plan, Execute (EPE) methodology seems to work well in the context of TFB.

Initially, EPE was applied at the highest level, but was later pushed down to the level of individual behaviors. This is due mostly to the nature of the game. What a particular unit should do depends at least in part on the outcome of previous battles fought on the same turn. For example, an infantry unit with supporting artillery may make an attack on an enemy stack. If the attack succeeds, armored units can be moved through the gap to exploit the opening. If it fails, it may be desirable to bring up additional infantry and artillery to try to break through again. Some behaviors require low-level re-evaluation and re-planning during their execution even though the overall plan and objectives may not change.

The use of independent behaviors each with well-defined goals turned out to work well. The principles of modularity and limited coupling are well known in the discipline of software engineering, and their benefits are obvious. Due to the complexity of the problem, it is not easy to define the entire AI without decomposing it into subtasks. The drawback to this approach is that because the behaviors are independent of one another, it is possible that one may inadvertently undo the work of another if care is not taken. This means that at least some limited communication between behaviors is required. Annotations on game entities were used for this purpose. For example, units used in constructing defensive lines were marked as such and not used in subsequent behaviors such as counterattacking. By sequencing the behaviors in appropriate order, it was possible to assign priorities to actions based on their importance. Different strategies can be composed by reordering the behaviors or by altering their parameters.

One of the goals of the AI development was to use as little scripting as possible. This would make the AI more able to cope with changing situations, and would also require less manual effort on a per-scenario basis. The entire defensive AI was done without any scripting, but the attacker AI ran into trouble in the highest-level planning. In order to do this planning well, high-level concepts are required. For example, there were scenarios where Axis forces were poised to encircle Allied forces by coordinated movement of different groups of mechanized units. It was difficult to make the AI grasp this intent on the part of the Axis war planners from the initial troop dispositions alone. In order to address this difficulty, a limited form of scripting was introduced in the form of AI objectives. An AI objective is an objective that is invisible to the user and does not count towards victory conditions, but is seen by the AI to mark an important hex. The AI objectives can be ordered so that priority can be assigned. These objectives allow human knowledge about the plan of attack to be incorporated into the AI with a minimum of effort. The AI objectives were added using the same graphical editor that was used to design the scenarios. Adding objectives for a scenario typically took between 5 minutes to half an hour depending on the complexity of the scenario.

Future Plans

It's been said that an AI for a game is never really done. The truth is that most wargame AI's do not come close to the level of proficiency of human players, so there is always room for improvement. The TFB AI is certainly not an exception to this rule, and there are several areas where improvements will be explored.

There are several issues related to migration of attacking units towards the front. In many scenarios, large numbers of units are operating in a relatively small area, and stacking limits become important. Traffic jams can result, especially for the attacker, and units moving towards the front can be forced to queue up behind the spearhead. Changes need to be made to divert these units that become stuck into a more useful purpose such as broadening the breaches in the enemy line.

Another related issue is the depletion of the spearhead units. As units fight, they lose strength

and eventually become less and less effective. Depleted units in the spearhead of the advance need to be cycled out and used only for flank protection, and fresh units need to be brought in to take their place. Also, the attacking AI needs to be more careful with armored units, using them primarily to exploit breaches in the enemy front and sparing them from fighting whenever possible.

The defensive AI also needs to have more awareness of the distinctions or unit types and their purposes. Currently, the defensive AI constructs front lines by balancing forces based on their combat strength ratings without regard to the types of units involved. Awareness of unit type distinctions should speed the balancing process and yield better results.

Currently only the attacker AI is aware of AI objectives. There are several cases where it could be useful to add AI objectives for the defender. For example, one might want to add event triggers so that the defender would counterattack when the attacker reaches a certain point. Or one might want to have the defender retreat when the attacker takes a particular point. Support for AI objectives for the defender AI code and support for linked AI objectives would need to be added.

The AI can also be modified to make better use of naval and rail movement. These types of movement are currently only used in specific circumstances such as reinforcement moves and migration towards the front. They could be used more widely than that to rapidly redeploy forces. For example, the defensive AI could use rail movement to deploy forces directly into front line defensive positions.

Good human players are able to force defending units to retreat in the direction that they want them to. The attacking AI currently does not consider direction of retreat when positioning units for attack. Sometimes the AI makes several attacks on the same stack of units on the same turn when one attack could be sufficient to move them out of the way of the advance.

Parameter tuning and strategy optimization is one area that still needs to be investigated. General-purpose optimization methods such as genetic algorithms and simulated annealing can be used to tune the performance of the AI. In order to do this, modifications would need to be made to the game engine to allow for direct AI vs. AI play with no intervention. Victory conditions could serve as a cost function, and these are already in place. It may be possible to make small improvements simply by optimizing the parameters used to control the AI. Larger gains may be possible by exploring different strategies by changing the behaviors used and their priorities.

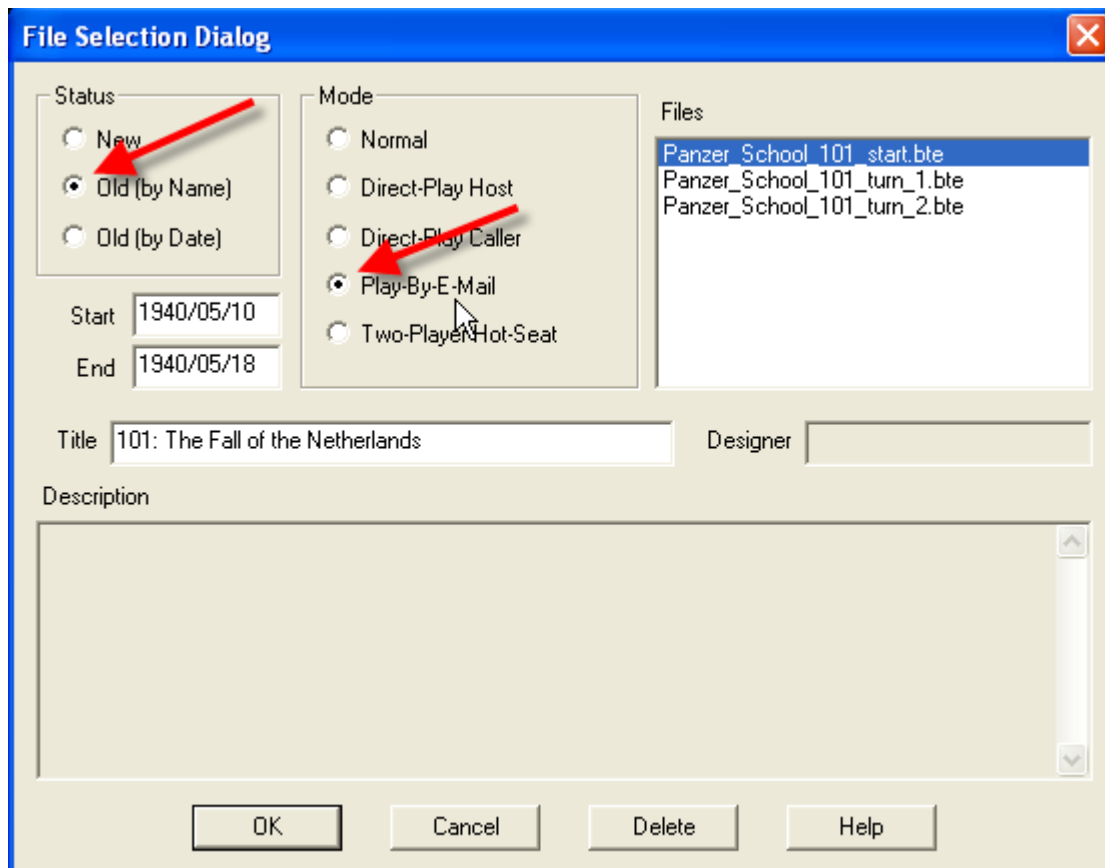
Finally, the AI may need modifications to deal with speed and scalability issues as the scenarios become larger and more complex. It is desirable for the AI to be able to complete a turn in a few seconds if possible.

[Click here to go to the next section on III. Tips on Play - Panzer School 101](#)
or here to return to the [Welcome to Notes Table of Contents](#)

III. Tips on Play - Panzer School 101

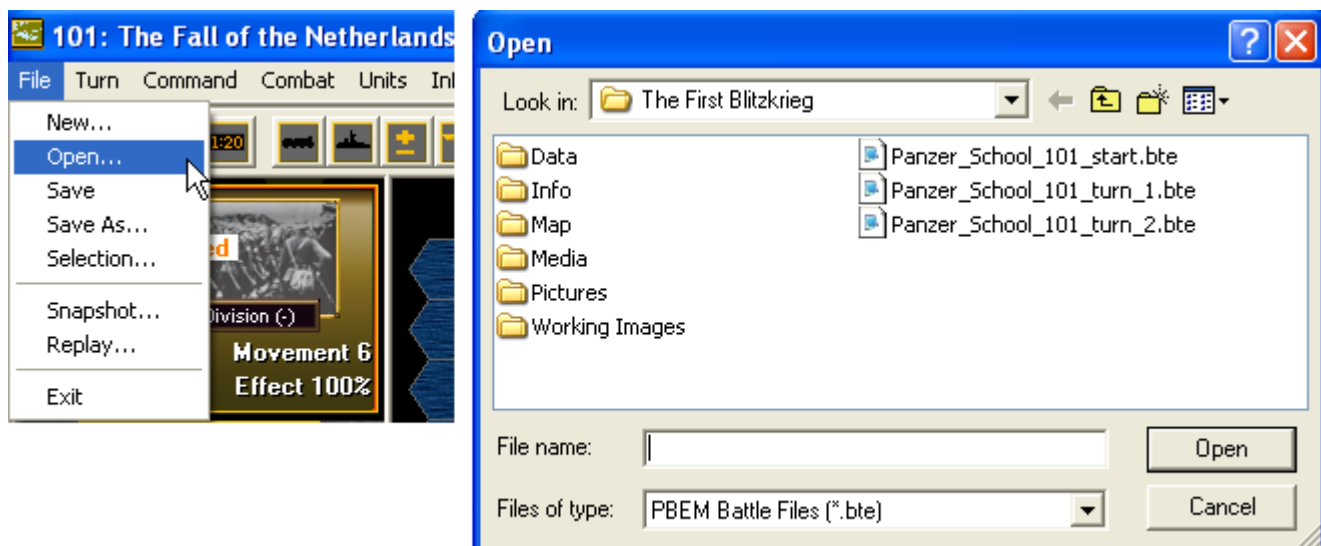
Welcome to Panzer School 101 – this is a follow on scenario to the the Started.scn, using the German attack on the Netherlands as a brief introduction to the art of the blitzkrieg. The game includes some saved Play-by-email game turns that can be loaded for the purpose of viewing the replay where a rather effective attack is shown.

If you have not yet played the Game Introduction – the STARTED.Scen, you should load the #100-Started.scn and click the link here to launch the [The First Blitzkrieg Getting Started](#)



Start your game or if you already have your game running, pick File | Selection. This will bring up the "File Selection Dialog shown that the right. As shown by the arrows, select the "Old (by Name)" option in the "Play-By-E-Mail" mode and you will see the three Play-by-E-Mail files which came with the game and the file "Panzer_School_101_start.bte" file at the top of the list highlighted. Press the OK button.

You'll be presented the game map and for illustration purposes we have left Fog-of-War OFF so you can see the full picture as this battle develops. Normally you can't see all the defending units like this. The Dutch war plan called for the defense of Holland to be a gradual delaying action while the defenders fell back to a line of forts termed "Fortress Holland" which is bounded in the south by major river obstacles. What the Dutch were not prepared for was the speed of the German breakthrough or the use of airborne troops to pave the way for the swift advance.



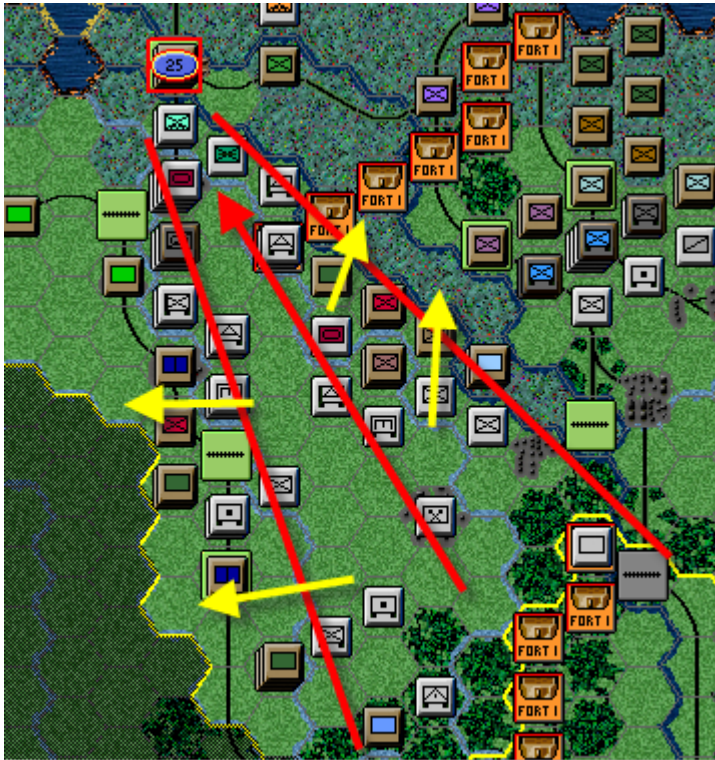
At your convenience, open the turn 1 play-by-email (or BTE) files as seen here in the image. Press the Yes button when prompted to view the Axis battle replay and watch how the player goes about cutting a swath like hole through the Dutch lines. Many of the principles being illustrated here are discussed below this in point form.

At the end of the replay press OK to the Command Report, OK on the Air Allocation Dialog And Air Superiority Dialog. This Game file is not meant to actually be played so do not press the SAVE button. Rather after viewing this first turn, repeat the sequence the view the second turn replay.

Now review the remaining Tips on play form the Designers and Playtesters and then return to this scenario. Play as the German Attacker. You can play it first with Fog-of-War OFF and then with Fog-of-War ON to get the feel for what techniques work best.

Now for some additional Tips on Play!

Some general rules of thumb to help you master this game.



1) As the attacker, if you face a defense line that you are able to punch a hole through, drive through and go deep! Resist the urge to double back to surround units with your armor. Use the best available support units to pin the enemy so your infantry can move up and finish them off. Keep the armor moving forward even if they might be out of supply for a turn.

Of course, as the defender, the reverse is also true, on the defense, set up a defense in depth where possible.

2) Always be aware of the possible retreat route of units you are attacking. Where possible, use your forces to "direct" the retreat as a defender will never retreat into an enemy ZOC unless it is occupied by a friendly unit. In the Netherlands scenario, the attack on The Hague is a clear example of this as the difficulty in capturing it is very much dependent on where the Dutch troops retreat when the Paratroops land. If one defender remains adjacent to the city after retreating, it opens a retreat route for the city defenders so all you have to do is attack and they will vacate the city. Note, in all tests as in this example it may not happen. But you may be able to achieve the desired result with a little air support addition to repeated ground attacks.

If you leave an enemy unit next to a stack you want to retreat (such as out of a Surrender Objective) it will have a hex to retreat to. Completely surrounding the enemy with ZOC's will not give them a retreat hex and they will have to stand and fight to the death.

3) Break-down Divisions when you need to advance (or defend) on a wider front of hexes.

Also don't move stacks if you are moving into territory which has not be covered with Air Recon missions. If you move into enemy ZOC's you will waste MP's for the whole stack. Better to move forward with one unit to discover the enemy and then decide whether to position your follow on forces to maximize your attack or go around the places where the enemy is strong.

Another approach is to find overruns with slower foot units first, starting from the rear if possible, but using units that start adjacent to enemy units as well. If you can punch a hole, the armor can pour through it. It's not always good to move rear armor first in this case until you see where the hole develops. Using a football analogy, consider how a fullback waits for his

blockers to open the hole for him.

4) There are LOTS of strong units in the game. Don't think you have to use a Division for everything. Be careful when trying to finish off a weak defender by using small attacking units, especially artillery. Even just a couple of Strength Points lost can eliminate a valuable unit, such as artillery, so try to use some infantry units in every attack.

Do not use a full division when a regiment has all the power required to carry out the task. However, try to get overrun odds without using excess units. It's all about overruns!



5) Use your artillery wisely. Yes, these units can be effective even with a strength point of 1 as they have a high combat value. Artillery is the only unit that can attack embarked units while in the water. Artillery does not have to have movement points to enter the defending hex when it attacks. Fixed-artillery units can still attack.



6) Use care in placing your engineer units. When the hexes being moved out of or into contain a Construction Engineer unit that has not moved that turn, 1 is subtracted from these costs. When a Combat Engineer unit participates in an attack, it reduces the effectiveness of any fortifications in the defending hex.

7) Air units can be critical to weakening defensive stacks for ground attacks, but the losses the air units take can be costly VP wise. You do not have to use all air units every turn. Use what you must, rest others. Sometimes an enemy stack is spotted that is without AA units that can be struck to weaken it even though it isn't a critical target. Remember that you can use interdiction to slow down enemy response to your breakthroughs, such as slowing movement toward a targeted objective.

8) Sometimes it is better to hit a hex with one big attack (like forcing a critical retreat) but sometimes a several small ones are better (like forcing multiple retreats). With time you will learn when each strategy will work best given the situation you are facing.

9) Attrition is a two edged sword due to the loss of effectiveness tied to losses. Effectiveness comes back very slowly, and reduces the combat strength of a unit further below its already reduced strength. This in combination with the stacking limit will reduce the attacker strength for the same stacking points compared to 100% effectiveness.

Avoid attacking with low effectiveness units unless the odds are good. There are times when it is better to concentrate your attacks on the critical points or the places where the attacks can succeed and rest units in other areas. Save your armor for important attacks as the loss of even a few strength points over each of several attacks will greatly weaken the unit involved after 4-5 turns.

10) Large defensive stacks can be tough to attack, as the attacker is limited to the same stacking limit as the defender. Mass units with high armor ratings, primarily the tank/panzer units, against these stacks if they are in a critical position, and don't use non-armor rated units, to maximize the attacking strength. The average armor value for the attacker plays a large role in calculating the attack strength, so adding non-armor units to the attack can actually reduce the overall attack strength due to the drop in armor value. Also, artillery units are not included in the stacking limit so the attacker should mass artillery where increased strength is needed, when necessary.

11) If you evaluate the terrain and its effects you will appreciate is how much difference the streams can make. Attacking with the same units across a stream can dramatically change the odds from attacking with the same units from a different hex with no stream hexside.

12) Remember, like retreats, you can move from ZOZ to ZOC as long as the new hex is already occupied. Therefore, always leave a chain of hexes open for advances, retreats, and for tracing supply.

13) Don't feel that you have to complete the movement of one unit before moving another. You can always move a unit, move another, and then come back to complete the move of the first unit. After retreats by the enemy or when you eliminated weaker defenders with your preliminary attacks you may be able to move your own units that were adjacent to the defenders forward as the ZOC penalty of the defender has now been removed.



14) Use the "reachable hex" button regularly!

15) Bring on your reinforcements at the start of your turn so that you understand what you have available. Move units from the rear first, if they can reach some defenders, the front line units can then move through them.

16) In scenarios with Minor Neutrals it is often worthwhile to look for ways to force a country to surrender. If you have these focus your effort on capturing those objectives if you are the attacker. To find the Surrender Objectives, look under the in the Info | Objectives menu item.

Click here to go to the next section on the [IV. The Scenarios](#) – A List and the Overviews or here to return to the [Welcome](#) to Notes Table of Contents

IV. The Scenarios

Scenario List

Getting Started: Sparks Along the Polish Corridor

- 100: Invasion of Denmark (Hypothetical)
- 101: The Fall of the Netherlands
- 102: The French Offensive in the Saare
- 103: Gamelin's Gamble (Sept '39 Hypothetical)
- 104: Hitler's Directive #6: Case Yellow in '39 (Hypothetical)
- 110: The Invasion of Poland: Case White
- 111: Poland Stands Ready (Hypothetical: stronger Poland)
- 112: Poland Stands on the Vistula Line
- 120: The Invasion of Norway
- 121: The Invasion of Norway (Allies Free Hand)
- 130: The Invasion of France and the Lower Countries
- 131: The Invasion of France & Belgium (Smaller Scale - Historical)
- 132: The Original German War Plan (Hypothetical)
- 133: Belgium - On the Dyer Line (Hypothetical)
- 134: The Breakout from the Ardennes - Panzer Country
- 140: Operation Sealion - The German Invasion of England
- 141: Operation Sealion - (More Axis Challenge)

Getting Started: Sparks Along the Polish Corridor

Along the Polish Border – 1st September 1939: The Polish Corridor, a strip of German territory awarded to newly independent Poland extending along the Vistula River to the Baltic Sea, was to provide Poland with permanent access to the Baltic Sea. However, the Corridor cut East Prussia off from the rest of Germany and was one of many points of resentment by the German people as a result of the 1919 Treaty of Versailles. Hitler demanded permission to build a road and rail connection across the Corridor, and that Danzig would come under German control once again. Poland staunchly refused, thus the Polish Corridor would become the spark to ignite the Second World War in Europe. *Designer Note: ***SEE STARTED.HLP*** "Sparks Along the Polish Corridor" is the Getting Started scenario and it should be played in conjunction with the Getting Started help file. The purpose of the scenario is to get you acquainted with the mechanics of game play.

100: Invasion of Denmark (Hypothetical)

Denmark - 9th April 1940: Coincident with an ambitious plan by the Germans for the invasion of Norway, German troops also occupied Denmark. There was very little opposition by the surprised Danes as Copenhagen was captured within 12 hours with the loss of a few soldiers and members of the King of Denmark's Guards. This is a hypothetical situation using historical forces on both sides and the actual "pre set" German invasion plan. However, this scenario depicts what "might" have occurred had the Danes had the will to resist. *Designer Note: This is a beginner scenario created to familiarize players with Sea Movement. The Player should consider alternative approaches to the invasion as what appears to be the direct approach may not be the best solution.

101: The Fall of the Netherlands

The Netherlands – 10th May 1940: While much of the attention of the German assault on the Western Front was focused on the fighting in Belgium, including the first use of airborne troops at

the Forts of Eben Emael. However, little known, but significant German airborne operations were mounted to assault "Fortress Holland". This task fell to the German 18th Army and the air forces of the Luftwaffe. A large bomber force struck Rotterdam on the 14th of May, after which, the Netherlands surrendered and the Dutch Royal Family evacuated to England. Will this be a Dutch side show or can the Dutch hold out long enough to affect the battles raging in Belgium and win the Dutch a pyrrhic victory?

102: The French Offensive in the Saare

The Saare Gap region on the French-German frontier – 6th September 1939: Only a week prior to the outbreak of war, the Commander of the French Armed Forces, General Maurice Gamelin, told his government that France could not hope to launch a major offensive for at least two years. Yet two weeks later, more as a matter of honor, a token advance in support of the much beleaguered Polish Army was made in the Saare Gap region directed at the industrial center of Saarbrücken. The advance penetrated a bare six miles into Germany and no sooner had it begun, it became apparent to those in the West that the Polish situation was rapidly becoming hopeless and came to an abrupt stop. The French had no intention of forcing the Germans' hand in this early attack and, therefore, no additional support was committed. Thus a golden opportunity may have been lost as even some high ranking German officers believed a determined offensive might have carried the French through the West Wall before the Germans could have brought back formations from Poland. This scenario covers the limited focus Saare offensive by the French in 1939 with forces available and forces that could have been committed had the French had the will to do so.

103: Gamelin's Gamble (Sept '39 Hypothetical)

French-German Frontier – 6TH September 1939: With five full Armies deployed in the east, to conquer Poland, Hitler was taking a calculated gamble that the French and British would be paralyzed with indecision, and not take action in the west before events in the east were concluded. While General Maurice Gamelin, the Commander of the French Army, did launch a limited, face-saving offensive in the Saare region, a real opportunity may have been lost by the Allies. General Franz Halder, the German army's Chief of Staff, was astonished by the weakness of the French attack. He wrote, "If the French had used the opportunity presented by the engagement of nearly all our forces in Poland, they would have been able to cross the Rhine without our being able to prevent it, threatening the Ruhr with decisiveness for the German conduct of the War." *Designer Note: Unlike the Saare Offense Scenario (#102), this Scenario depicts a full scale attack by the French on Germany with all forces mobilizing to aid the Poles. However, Belgium neutrality is honored and this area on the map is marked as impassible terrain.

104: Hitler's Directive #6: Case Yellow in '39 (Hypothetical)

French-German Frontier - 26TH October 1939: Flush with success from the Polish Campaign, Hitler was beginning to look westward. Hitler intended to hold on to Germany's eastern conquests, either through intimidation of Britain and France, or by conquering them too. He put out peace feelers in early October, but was met with no response. On 9TH October, he issued a long memorandum to the leaders of his Armed Forces, explaining that Britain and France had kept Germany down throughout history, and that now was the time to strike to establish a united German Reich. On the same day, Hitler issued Directive #6, giving provisional orders for an attack in the West - Code-named: CASE YELLOW. Hitler stressed the importance of attacking as soon as possible; using the same forces that had been used in the Polish attack. However, the movement of these forces to the German-French frontier would have taken a super human effort, even for the well-oiled German military machine and was ultimately delayed 27 times. The CASE YELLOW Plan was modeled after the Von Schlieffen Plan utilized in 1914. This scenario explores the possibility that the Germans moved their forces, albeit somewhat weakened, across from east to west, and attacked using the 1914 plan.

110: The Invasion of Poland: Case White

Along the Polish Border – 1st September 1939: "A Gathering Storm" had been building in Europe, and then lightning struck in the form of the First Blitzkrieg. Hitler unleashed five Armies in a lightning attack on Poland from the north, west, and south. Air strikes crushed the weak Polish Army Aviation on the ground, as nine Panzer Divisions led the drive into Poland, quickly slicing through the Polish Army, which was made up largely of infantry units, supported by a few horse cavalry and light tank brigades. By 27th of September it was over. Warsaw had fallen and the Polish government had fled to Romania. Sir Winston Churchill called this "a perfect specimen of the modern Blitzkrieg", and the Poles were not to be the last to endure this ordeal! Can the Polish troops delay the inevitable or will the Germans surpass the historical precedent set in September of 1939?

111: Poland Stands Ready (Hypothetical: stronger Poland)

Along the Polish Border – 1ST September 1939: As the storm gathered over Europe, the Allies began to mobilize their armies, but not too quickly, lest their action repeat the mistakes of 1914. The Poles were far too complacent about the danger threatening them. Thus, when the Germans struck with a surprise attack, the thirty divisions available to the Polish Army represented only two-thirds of the troops they could have called upon had they been more vigilant. In fact, a large measure of the German plan had called for overrunning Polish railheads near the frontier before additional Polish Reserves could be called up. In this scenario, we are depicting a historical German attack upon a reinforced Polish defender, deployed, with reserves in depth to prevent rapid penetration by the panzers. *Designer Note: The additional 18 Polish Reserve divisions represent the full mobilization of the Polish Army prior to the German attack. There are also a few more Level 1 Forts for the Poles and the scenario lasts longer than the historical version.

112: Poland Stands on the Vistula Line

Along the Polish border – 1st September 1939: As the German High Command gauged the risk of launching their attack on Poland, their biggest fear was that the Poles would be able to disengage their Army and retreat intact toward the Vistula River line to reorganize their defense. And, while the Poles may have been criticized for their military incompetence, it is hard to see what else they could have done, except stand and die at the frontier as the Germans had planned. If not, much of the industrial heartland of Poland would have been abandoned, including the Silesian coal fields, not to mention the population centers, where they had planned to mobilize their reserves. *Designer Note: This scenario features historical forces but with the Polish deployment slightly back from the frontier and a defense in depth - would it have made any difference?

120: The Invasion of Norway

Norway – 9th April 1940: The confrontation between the Germans and the Allies over Norway during the beginning rounds of the Second World War in Europe is no surprise. Norway stood on Germany's northern flank and offered an opportunity to secure supply lines from which Germany could import iron ore from neutral Sweden. Therefore, the Germans launched a bold naval invasion at six points along the Norwegian coast with seaborne infantry. The landings were further supported by paratroopers. Norwegian defenses were weak and quickly overrun. Some Allied troops did attempt to intervene and, in fact, the Allies did have some success in the north. In the end, with the collapse of France, Allied troops were withdrawn and Norway was to remain an occupied country for the remainder of the war. The scenario depicts the historical setup, German invasion and Allied intervention in Norway.

121: The Invasion of Norway (Allies Free Hand)

Norway – 9th April 1940: In a confrontation between the Germans and the Allies over Scandinavia,

the Allies sent British, French, and even some Polish troops to Norway. In the historical scenario #120, "Invasion of Norway", these Allied reinforcements arrive by sea, but adjacent to the landing points in Norway where they historically landed. In this variation, Allied reinforcements arrive by sea one turn earlier where the Allied player can move and land them in Norway at places of his choosing.

130: The Invasion of France and the Lower Countries

France - 10th May 1940: On this date, the German Army launched a massive attack on France, Belgium, and Holland. The attack was aided by massive aerial bombardments and supported by small, but highly effective, paratrooper landings. The following morning, the Allies began to execute their own pre-planned war maneuvers. On the coast, the French 7th Army began a dash toward Holland. On their right flank, the British Expeditionary Force, along with the French 1st Army on its right, advanced to the Dyle River in central Belgium. However, the German's move in central Belgium was only a feint. The bulk of the German forces were coming through the Ardennes, where they broke out over the Meuse River five days later. Thus, pinning the mobile elements of the French Army and the BEF to the coast and leaving the French with virtually no reserves to stave off disaster. *Designer Note: If players wish for historical results in Human vs. Human Play, then apply these House Rules or conditions on the Allied play - All French and British units that are not fixed, with the exceptions of the French 18th, 22nd, and 1st Light Divisions, must move into Belgium and continue moving east for three turns. Also, any unit that enters Belgium must stay north of the Meuse River.

131: The Invasion of France & Belgium (Smaller Scale - Historical)

France - 10th May 1940: According to Allied strategy, if and when the German Army attacked in the west, it would occur mainly on the plains of Belgium. As such, the Allies poured troops and resources into Belgium from the outset of hostilities, where the Allies planned to re-fight the First World War. The Allies did not anticipate or plan for strong German panzer forces to navigate the Ardennes Forest, a rough and forested area covering Luxemburg and some of the French-Belgian border. It was this area where the Germans, or more specifically, General Manstein, planned his surprise attack to outflank the Allied Armies pouring into Belgium, and pin them to the sea. Within 5 days of entering the Ardennes, the German Panzers broke out over the Meuse River and raced for the coast, creating a large pocket of French, British, and Belgian troops in what is arguably the swiftest, most decisive action of the Second World War. *Designer Note: This is a smaller and shorter version of Scenario #130. For Historical Allied play - All French and British units that are not fixed, with the exceptions of the French 18th, 22nd, and 1st Light Divisions, must move into Belgium and continue moving east for three turns. Also, any unit that enters Belgium must stay north of the Meuse River.

132: The Original German War Plan (Hypothetical)

France - 10th May 1940: On the morning of 10th January 1940, two Luftwaffe majors prepared to fly to Cologne, only eighty miles distant from the little airfield at Munster, Westphalia. One of the majors was a member of the planning staff for General Student's newly formed 7th Air Division. He knew it was expressly forbidden for members of the planning staff to fly, but knowing the long waits on the trains at the time, he had weighed up the risks and accepted the offer of the flight. Initially it went well, in glorious sunshine, and then murky tendrils of clouds started to engulf the plane. The pilot continued on, seemingly unconcerned, but when the clouds were too thick to see through, he changed course several times. He was trying to find a gap in the cloud cover to find the Rhine. Eventually he saw a winding black trail of water under the white horizon, in his mind; it had to be the Rhine. As he raised himself in the seat to get a better look, disaster struck! His hand hit the fuel cut-off switch and the engine sputtered, then died, he was too low to do anything but try to safely land the Me 108. This he did, but both men were badly shaken by the crash. It was only after being found by an old farmer did they realize the river was in fact the Meuse, and that they were in Belgium. They hastily tried to burn the Top Secret documents of Hitler's plan to

invade Western Europe. Unfortunately, border guards caught them and rescued the burning documents from the fire. Belgian Intelligence soon translated the documents and decided they were genuine. This was the course of events that led the German High Command to adopt Manstein's plan instead of the original CASE YELLOW. In this scenario, the historical CASE YELLOW plan is used for the set up of opposing forces at their approximate start positions.

133: Belgium - On the Dyer Line (Hypothetical)

Belgium – 10th May 1940: It is easy to see why from the German's Point-of-view, the best route into France lay through the Belgian plain. It was the route the Germans used in World War I with the Von Schlieffen Plan. After the First World War, the Franco-Belgian Treaty of Alliance (1920) was signed between the French and a pro-Allied King Albert of Belgium. This treaty called for Allied troops to be invited into Belgium before the start of hostilities. The reason for the advance into Belgium was two fold: First, it was to protect the industries of Northern France that were devastated in the First World War. Secondly, it was the desire of the British to remove the possibility of Germany using airfields located in Belgium from which the Luftwaffe could mount air attacks on Britain. But events were to conspire against Allies. King Albert was killed in a climbing accident in 1934 and was succeeded by his son, Leopold, who abrogated the Treaty to pursue a policy of neutrality. In January of 1940, the German's Plan for the attack through Belgium was discovered by Belgian authorities (See the overview for scenario #132) and for a period of several days the barriers on the French border were removed but no official invitation for Allied assistance came. This scenario depicts the Allied Armies occupying their "Dyer Plan" positions. The German setup is historical.

134: The Breakout from the Ardennes - Panzer Country

Northern France – 16th May 1940: British Prime Minister Winston Churchill was rudely awakened, in the early morning hours of 15th of May, by a call from French Premier, Paul Reynaud. Reynaud exclaimed, "We have been beaten, we have lost the battle!" Churchill tried to calm him down, explaining that it was only one penetration, and that they would have to slow down in a few days, this would present an opportunity to counter-attack. Reynaud responded that, "The front is broken near Sedan! We are faced with a torrent of tanks." As the 16th dawned, the extent of the disaster that had befallen the French on the Meuse became clearer. The Germans had smashed through the line and were now racing over the northern plains of France unopposed. The French tried to gather together units to counter-attack, but the French armor forces had been split into penny packets and were spread out all over the place. Desperately, the French began to throw units in piecemeal to staunch the flow of German units flooding in to the plains.

140: Operation Sealion - The German Invasion of England

The English Channel – 24th September 1940: OPERATION SEALION was the German plan to invade England in 1940. Earlier that summer, the Germans had swept through Europe, crushing France and the Low Countries and forcing the British Army to make a chaotic escape from Dunkirk. These German forces stood waiting on the Channel coast for the invasion order of England. By mid-September, the plan was in motion. OPERATION EAGLE was the Luftwaffe plan to systematically destroy RAF bases and ground support and gain air superiority prior to the invasion. The German High Command had also been busy refining "Sealion". This was done with such precision and thoroughness they were ready, after barely three months, to invade. Due to the bravery of the RAF, OPERATION EAGLE failed and OPERATION SEALION was never put the plan into action. What if OPERATION EAGLE was successful and OPERATION SEALION was launched in September of 1940?

141: 'Operation Sealion' (More Axis Challenge)

The English Channel - 24th September 1940: OPERATION SEALION was the German plan to

invade England in 1940. This scenario is the same setup for both sides but with a stronger Allied Side and a faster release of FIXED units to respond to the invasion so it can be played HTH, but may be best played as Human Axis vs. the Allied AI opponent.

Click here to go to the next section – the [V. Selected Bibliography](#) Selected Bibliography or here to return to the [Welcome](#) to Notes Table of Contents

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