

Quantitative Analysis of Game Balance:

- **Level Design:**

- This game is designed for 2 players. In each turn, the player rolls a dice to get the number of units they have to move, then move their units, and attack the opponent units.
- The board game is a grid of size 25 x 25 squares. There are **3 capturable zones** on a diagonal of the board: 1 zone in the centre (called B) and the other two in 2 corners (called A and C), each zone has a dimension of 3 x 3 squares. The other 2 corners have **2 starting zones** for players' units (called Z1 and Z2), each of size 4 x 4. The distance from Z1 to any capturable zone is equivalent to the distance from Z2 to the corresponding capturable zone, so initially, no player is closer to a zone than the other player.
- There are **2 power ups** (called P1 and P2) on the board. Once picked up, each can be chosen to be Type 1 or Type 2 by the player's preference, and can be activated at any time. This means that there is a 50% chance of the opponent using Type 1 or Type 2 power up. The power ups are positioned symmetrically and distance from Z1 to P1 = distance from Z2 to P2, and distance from Z1 to P2 = distance from Z2 to P1, ensuring no player has an unfair distance advantage to take a power up initially.

Abilities of Type 1 and Type 2 are as follows:

- Type 1 power up allows the player to choose an unit of the opponent and deal 1 damage (taking away 1 health point) to that unit.
- Type 2 power up lets the player choose, revive one of their lost units, and put it back to their starting zone.
- We initially only allowed 2 power ups on the board, with one of them being Type 1 and the other was Type 2. However, this may create an unfair situation, for example, Player 1 use Type 1 to destroy an enemy unit that about to capture a zone and forcing Player 2 to use their Type 2 to revive it back at their starting zone, which has to go through a lot of turns again to return to the position it was killed. Therefore, we decide to let the player be able to choose their own power up to create fairer gameplay.
- **The win conditions** are either **capturing 2 zones** (and holding them for 1 turn) or **eliminating the entire opponent team**.

- **Gameplay mechanic:**

- There are 4 types of units: **Tank, Mechanic, Sniper, and Assault**. Besides the tank has **2 health points**, other types of units have **1 health point**. In each turn, a unit can fire 1 shot (Assault is a special case when it can fire 2 shots), each shot takes away 1 health point from the shot opponent unit.
The reason we choose to have most units to have only 1 health point and can deal 1 damage each shot is to make the game simple as most damaged units get removed instantly from the board after they get shot. A more complicated health point and damage system would require a counter of health points for each unit, therefore it is not suitable for a tabletop game.
- Beside the tank unit, which occupies 2x2 squares, each unit stands on a single square.
- Each type of unit can move either **Up - Down - Left - Right** to an adjacent square **twice** for each turn (except Tank as it can only move forward or backward in its current direction). They share the same speed so no unit trails behind another. The

distance from a corner capturable zone (A or C) to a starting point (Z1 or Z2) is $25 - 2 - 3 = 20$ squares, so it takes at least $20 / 2 = 10$ turns for a unit from the start of the game to reach that zone. On the other hand, the distance from the centre capturable zone (B) to a starting point is $14 - 4 = 10$ squares, which is equivalent to requiring at least $10 / 2 = 5$ turns to reach the middle zone.

- Each unit type has one unique ability:
 - The shooting range of a Sniper is 8 tiles (the longest shooting range of all units. It can shoot in **8 directions** from their current position: 4 cardinal directions and 4 intercardinal directions (like the queen unit in chess). Since 8 tiles is pretty long, counting along 8 cardinal directions makes it easy.
 - The shooting range of an Assault is 4 tiles (i.e. a path of length 4). We define a path of length 1 as moving up/down/left/right from a square to a neighboring square. If there is a path of length at most 4 between Assault and an opponent unit, then the Assault unit can shoot at that opponent unit. In Mathematical terms, if the Manhattan distance between 2 units is lesser or equal to 4, then Assault can shoot at the other.
Assault can shoot twice each turn, but can not shoot twice at a unit each turn, otherwise it would be too powerful and able to destroy a Tank unit.
 - The shooting range of an Engineer is 4 tiles (similar to Assault), and it can repair the tank if the tank is not destroyed and in distance of 1 tile away from the Engineer.
 - The shooting range of a Tank is 2x6 tiles (a length = 6 with width = 2), like a beam, in its current direction. The tank is the most powerful unit (with 2 health points and beam AOE), so we balance it by nerfing its mobility and flexibility:
 - Instead of moving 2 steps in any direction like others, it can only move 2 steps forward or backward to the current moving direction.
 - It can only shoot in its current moving direction, and it can only change its moving direction to one of 4 cardinal directions. In a turn, if a Tank wants to change its directions, then it turns and is able to move just 1 step.
- Each team has **8 units: 1 Tank, 1 Engineer, 1 Sniper, and 4 Assault**. At each turn, a player uses **an unbiased D8 dice** to get the number of units they have to move. Each time they roll a dice, they have a chance of 1 out of 8 (12.5%) of getting a number in range [1,8].
Assuming the value of the dice they get is "x", If "x" is larger than or equal to their current number of units, they have to move all units. Otherwise, the player chooses "x" units and moves them.
- **Playtesting:**
 - The win conditions encourage both players to play aggressively, either to move their units to quickly capture 2 zones, to quickly pick up power up, or to put their units to the right positions to prevent the opponent from capturing 2 zones
 - An average turn of a player lasts for about 1 minute, depending on the player's planning time. A game with a lot of thinking from both players can last for an hour. Meanwhile, a game with few tactics and a lot of pushings only lasts for around 10 to 15 minutes.