Volo: Bird Flight in a Game

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This article describes the development of the board game Volo, based on the natural beauty of bird flight (il volo in Italian). It shows how a natural phenomenon can serve as an inspiration, and how a chosen theme can promote and influence creativity during the design process.

1 Introduction

In the summer of 2010 I was working on a game design which would further exploit the *ordo manoeuvre*. This is the connected movement of aligned pieces used in my game Ordo,[1] which in turn was based on the phalanx movement in Robert Abbott's classic Epaminondas [1].

For example, Figure 1 shows an ordo manoeuvre in which three pieces in a line move simultaneously as a group. It suddenly came to mind that birds create a similar linear, dynamic formation when flying in flocks, as do sheep in herds, fish in schools, and many other types of animals.

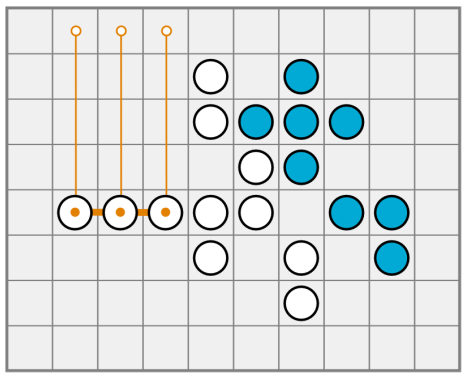

Figure 1. The ordo manoeuvre.

1.1 Inspiration

One can appreciate the way flocking birds fly near each other while simultaneously maintaining a safe distance, even if one is not a birdwatcher. Huge flocks of birds are pure beauty and leave us deeply impressed, even touched by this natural spectacle. The large number of birds, each following simple rules, results in a higher order organisation, which appears to act as a new entity, almost an organism of its own. I wanted to design a game that captured this beautiful phenomenon.

A flight formation often seen, especially for larger birds, is the V formation shown in Figure 2.[2] The straight lines followed by the birds, and their simultaneous movement with their flockmates, bore a striking resemblance to the ordo manoeuvre. So what natural rules lead to this behaviour?

Figure 2. Birds flying in V formation (photo by Henry J. Hipp).

In his classic 1987 paper [2], Craig Reynolds describes three basic rules that individual birds within flocks appear to follow:

1. *Collision Avoidance:* Avoid collisions with nearby flockmates.
2. *Velocity Matching:* Attempt to match velocity with nearby flockmates.
3. *Flock Centring:* Attempt to stay close to nearby flockmates.

From a game design perspective, it was clear that the second rule should be dropped, as incorporating velocity and timing would add undue complexity and ill fit an abstract game. The other two rules, however, were a natural fit for discrete combinatorial play. This paper describes the development of the resulting game, called Volo, based on the natural beauty of bird flight.

[1] http://spielstein.com/games/ordo

[2] 'Snow Geese Formation – Edwin Forsythe NWR, Oceanville NJ' photo by Henry J. Hipp © 2009, used with permission, from https://www.flickr.com/photos/albertovo5/4113467727/

Volo is played on a hexagonal board with 120 spaces. Two players each start with three 'birds' (pieces) in the 'nests' at the corners, then take turns either:
1) entering a new bird at an empty point, or
2) moving one or more birds grouped in a line.

The aim is to connect all friendly birds into one contiguous 'flock' of any size.

Birds may not be entered directly adjacent to other friendly birds, and may only move ('fly') to join other birds if they enlarge another friendly flock. Parts of flocks may be moved to make new groups, but groups, once formed, may never be split. Players are therefore constantly forced to enter new birds in order to progress towards the goal.

If an opponent's birds are isolated, dividing the board into multiple regions, then the trapped birds are removed at the active player's choice, such that only one single region with the opponent's birds remains. Isolated regions cannot be entered by the opponent.

2 Design

This section describes the design process that followed, starting with the basic idea of flock-like piece movement.

2.1 Board

It was immediately obvious that the rectangular grid was not suitable for creating attractive bird-like V patterns. Right angles are too regimented for such a natural movement (Figure 3).

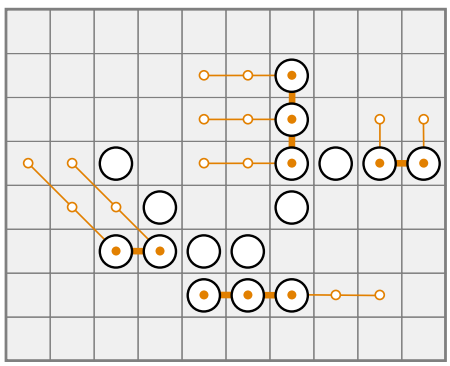

Figure 3. Ordo moves on an orthogonal board.

But my second choice of tiling – the hexagonal grid – proved to be perfect. It not only yielded attractive, natural lines for the V formation, but also allowed a sky-like circular game space (Figure 4).

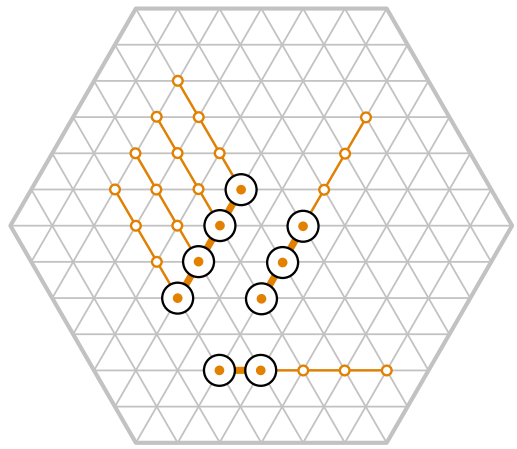

Figure 4. Angles on the hexagonal grid.

2.2 Goal

Now that the grid and basic board shape were decided, I turned to the goal of the game. The movement rules, together with the theme, pointed to an obvious choice: since flocking behaviour was the inspiration for the game, it made sense to bring the birds together into a single flock.

There were surprisingly few games at the time that featured both piece movement and a goal of gathering. One that immediately comes to mind is Claude Soucie's modern classic Lines of Action from 1969 [3]. But there were not many others, until some recent examples started to emerge such as Ayu,[3] Feed the Ducks[4] and Unity.[5] It seems that movement to cluster is a game idea whose time has come.

2.3 Start

The next step in the design process was to choose a suitable setup and appropriate movement rules. One setup option would be to start with all pieces on the board, like the games listed above. Another option would be to bring the pieces into play from off-board, either allowing them to group instantly or stipulating that they are entered at isolated points – or at least not adjacent to any friendly pieces – before the flocking takes place, as shown in Figure 5. This second option was chosen, which recreates Reynolds' first rule of flocking (Collision Avoidance), making Volo a game with piece movement.

[3]https://boardgamegeek.com/boardgame/114484/ayu
[4]http://www.nestorgames.com/#feedtheducks_detail
[5]http://www.nestorgames.com/#unitydeluxe_detail

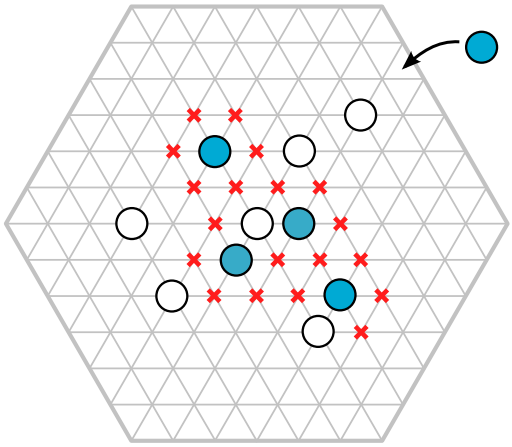

Figure 5. Entering pieces on an early Volo board.

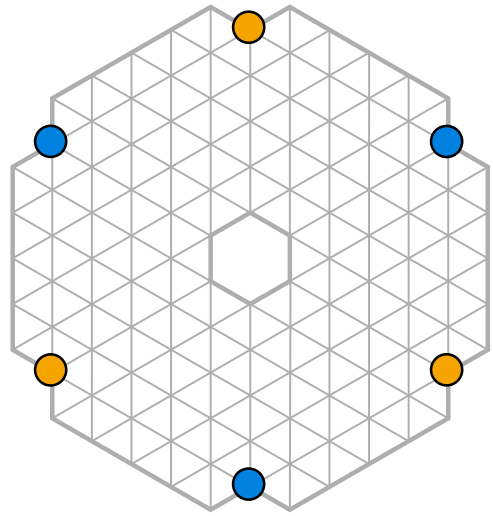

Figure 6. Final board design and setup.

At this point, board size came into play. I wanted a large board, to add more strategic action to the game, and to give the relatively expansive flocking formations some space in which to unfold. Moreover, the possibility of long lines of birds moving simultaneously and creating flock changes on a relatively large scale was appealing.

The large board, reminiscent of an open, empty sky, and the expected high number of bird pieces, strengthened the decision that pieces should start off-board and brought into play over the course of the game. However, the rejected setup option left a trace: the game would begin with three 'early birds' for each player, spaced as far apart as possible in the corners of the board.

To mark these special places, six cells were removed at the corners of the board and the starting points shifted one cell inwards, resulting in distinctive positions which I immediately called 'nests'. Here again, a personal choice was made: introducing the nests gave the board a pleasing snowflake shape, similar to that of Kris Burm's YINSH,[6] which added something to the character of the game. Even designers with goals like elegance through minimalism in mind are sometimes tempted to add tiny ornaments, although not without a cause (or excuse).

Similarly, a symmetrical setup was an obvious choice to please the eye. This required another change, so that birds did not simply connect across the board to win in a few moves, which led to the removal of the central cell. It was not a perfectly satisfying decision to 'drill a hole' into the sky, but the desire for symmetry won.[7] Figure 6 shows the final board design and starting position.

2.4 End

Standard game design principles were then applied. Termination rules often need to be explicitly stated, to ensure that progress is made and that the game moves towards completion. Simple games with small rule sets often have termination rules already 'built in'. But with more complex rule sets, it is often necessary to add further rules to make the game robust.

In Volo's case, this crucial termination rule, added on a subsequent step, proved to be: *movement must always result in the creation of a larger flock*. Every move must connect to birds which are members of another separate but friendly flock.

2.5 Flocking

It is also forbidden to split flocks once they have been formed. This ensures that flocks are always growing, and that sooner or later players will run out of movement actions and be forced to release another bird into the sky. Figure 7 shows two legal moves using these rules, which create patterns reminiscent of the V formation of flying birds.

The question then arose whether to let players move entire flocks in their V shaped patterns, to reinforce the analogy of flight, rather than single-line ordo moves. I decided against this for three reasons: 1) moving two lines of pieces at once blew out the complexity of some moves too much; 2) it raised the inelegant possibility of flocks flying backwards; and 3) it just proved too clumsy to manipulate two lines of pieces in a move. It is enough that V shapes form naturally during play.

[6] http://www.gipf.com/yinsh

[7] Game designer Néstor Romeral Andrés later suggested restoring the central cell, and starting with a neutral piece enclosed by the six early birds. This worked, but was not followed up as the game had already been published.

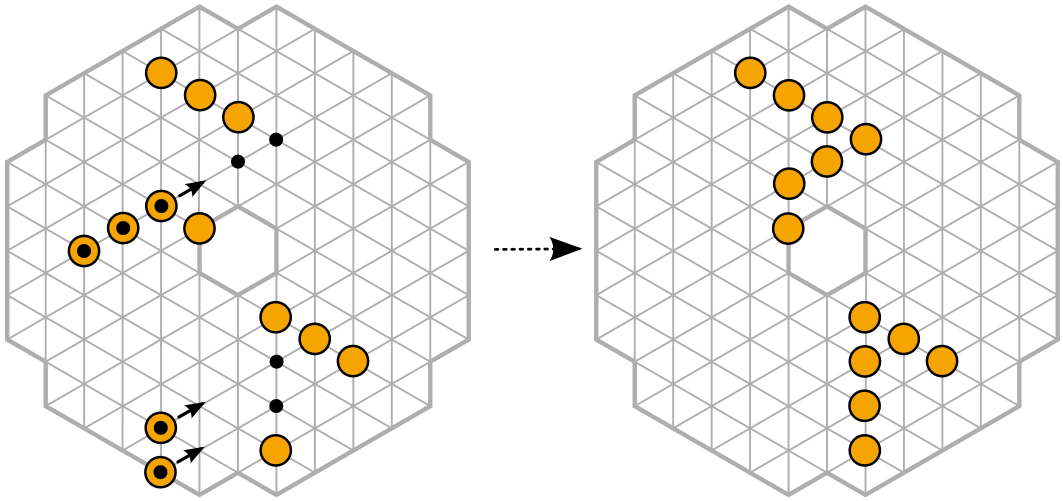

Figure 7. The movement rules create patterns similar to the V formation of flying birds (Figure 2).

Figure 8 shows a typical game position. The marked flock of three birds at the bottom left has five available moves: either 3 or 4 steps upwards, creating flocks of four or six birds, or single file to the upper right to connect with a single friend. Opponent birds block all other move options.

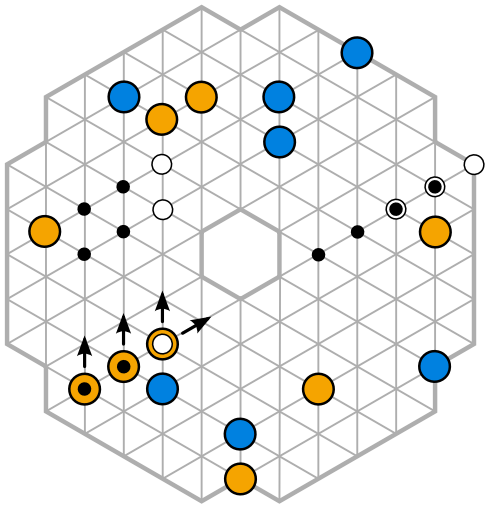

Figure 8. A typical game position.

This two-step feature of entering birds and then flocking to them leads to an interesting twist, as the player must make moves that conflict with the goal in order to progress: they must enter single birds that can only form flocks later.

This results in considerable tension, as players are repeatedly faced with the dilemma of how to enter new birds – which increase their movement potential – so as to minimise the damage to their own position. Further, the mover must also consider how much strategic information a new bird's position discloses to the opponent, as the opponent can step in to block obvious connections. On the other hand, trying to hide your plans can lead to stray birds that are hard to catch.

Figure 9 shows a board position (light player to move) that demonstrates tactical play. Moving bird A to 1 would be a decisive move for the dark player, hence the light player must enter a bird at 2 to block this move. But dark bird B can then move to 3, and the light player cannot stop the winning flight of dark bird A to 4, to create a single dark flock and end the game.

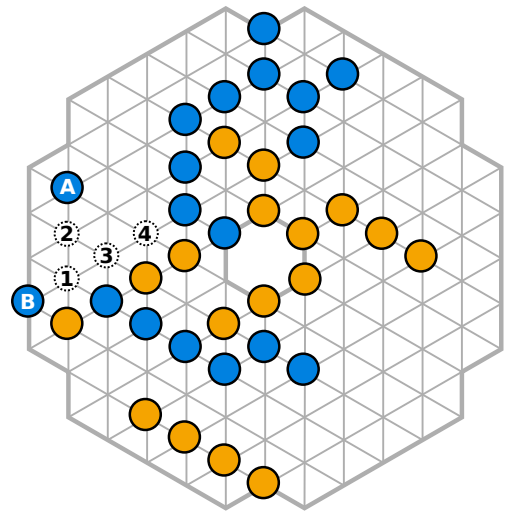

Figure 9. An example of Volo tactics.

3 Refinements

The game seemed almost complete, but a problem emerged: as more birds are entered, it is possible to isolate the opponent's birds so that they can never reach a winning position, as long as they remain trapped. The obvious fix – allowing birds to fly over occupied cells – would ruin the game, as blocking is a substantial tactical feature in Volo. Further rule refinement was needed.

3.1 Regions

This problem was solved by adding the notion of *regions* to the game. If the player creates a region containing opponent's birds who have no path to any of their friends, then those isolated birds are removed. Accordingly, players cannot enter a bird into an empty isolated region.

Figure 10 shows these rules in action. The light player has created three regions (*A*, *B* and *C*) and must choose two from which to remove all opponent's birds. If region *B* is left alive, then its single bird would give the dark player the win.

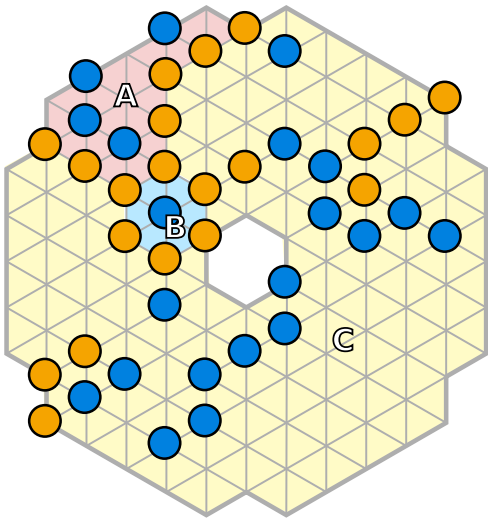

Figure 10. The region rule.

The player must leave one region alive when capturing, as total elimination would go against the peaceful ethos of the game. Capturing opponent birds was a mechanism added to clear the board as needed, and leaving one region alive gave the opponent the chance to 'fly away' and gather themselves. Introducing such a radical new concept to a game – just when it seemed to be almost complete! – must be considered very carefully, but here enhanced the overall design.

Regions are effective at breaking up misaligned, crowded positions, and can even give an inferior player the chance to catch up, as removing (possibly many) birds from the board can unexpectedly resolve a complex situation to give one player a sudden advantage. This is because the actual number of birds which form the winning flock is not defined: a single bird remaining on the board counts as a winning flock. It is never possible to remove all of the opponent's birds.

3.2 Passing

Further testing also revealed that unfortunately not all misaligned positions can be resolved by the region rule. When large regions are created, a situation can occasionally arise in which players can only enter new birds into regions they have claimed themselves. This results in a rather dull space-filling phase, in which players just fill up the board until no more moves are available.

To deal with this problem, passing was allowed. Players *must* pass if they have no available move, and *may* pass if they can only enter a new bird into a region of their own. If both players pass in succession, then the game ends as a draw. Figure 11 shows such a (rare) situation, in which both players can only enter birds into their own regions, so will both pass for a draw.

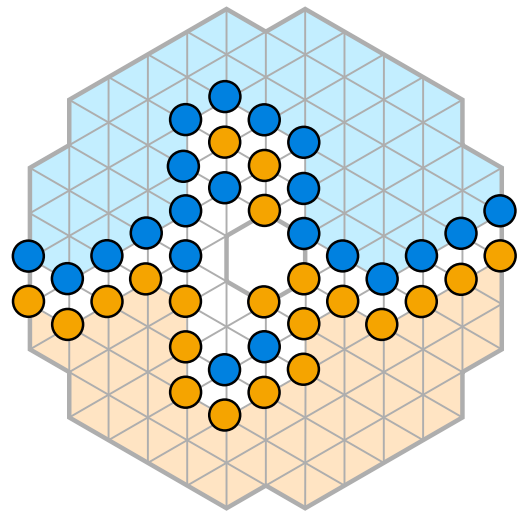

Figure 11. A draw: neither player can move.

4 Epilogue

It turned out that bird flight was not just a metaphor, but fit the core of the game precisely. Adding some backstory about the game's inspiration to the official rule sheet [4] hopefully projected some of the beauty of the natural world onto the game, to help players 'feel' what is going on as they play, and to fully appreciate Volo.

As a designer of combinatorial (often called 'abstract') games, I am often asked how I get my

ideas, how things get started. It is difficult to imagine how a game concept is developed, which on the surface may appear simple, but which offers players plenty of tactical and strategic options. I would even say that it is impossible to design a game in its whole strategic depth.

If a game designer is seen as a storyteller who creates some kind of interactive story, it seems easier to comprehend why choices are made. The lines of development regarding progress and excitement in a story are often already set up, and it is in the hands of the designer to find interesting mechanisms (i.e. rules), which match the context and fit together to create a satisfying and joyful experience when the game is played.

Like the storyteller, the game designer's goal is to give the audience an experience, but it is more difficult to find the key to the 'story' in this field. Fortunately, the game designer as a human being is equipped with experiences and knowledge of the real world, and it happens that sometimes the abstract and the natural coincide beautifully.

Some may point out that simplicity is beauty, and boils down to mathematics in the end. But it is not just pure mathematics which leads to a correct solution when inventing games; the designer needs intuition and to not fear making decisions.

5 Conclusion

This case study describes the process of turning an observed natural phenomenon, the flocking behaviour of birds, into a board game. The resulting game, Volo, is published by nestorgames[8] and can be played online at Boardspace.net.[9]

Acknowledgements

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[1] Schmittberger, R. W., 'Epaminondas and Crossings', *New Rules for Classic Games*, New York, John Wiley & Sons Inc., 1992, pp. 91–93.

[2] Reynolds, C. W., 'Flocks, Herds, and Schools: A Distributed Behavioral Model', *Computer Graphics*, vol. 21, no. 4, 1987, pp. 25–34.

[3] Sackson, S., *A Gamut of Games*, Mineola, Dover, 1992, pp. 34–39.

[4] Stein, D., 'Volo', *Spielstein – Games & Puzzles*, 2010. http://spielstein.com/games/volo

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[8] http://www.nestorgames.com/#volo_detail
[9] http://boardspace.net/english/about_volo.html