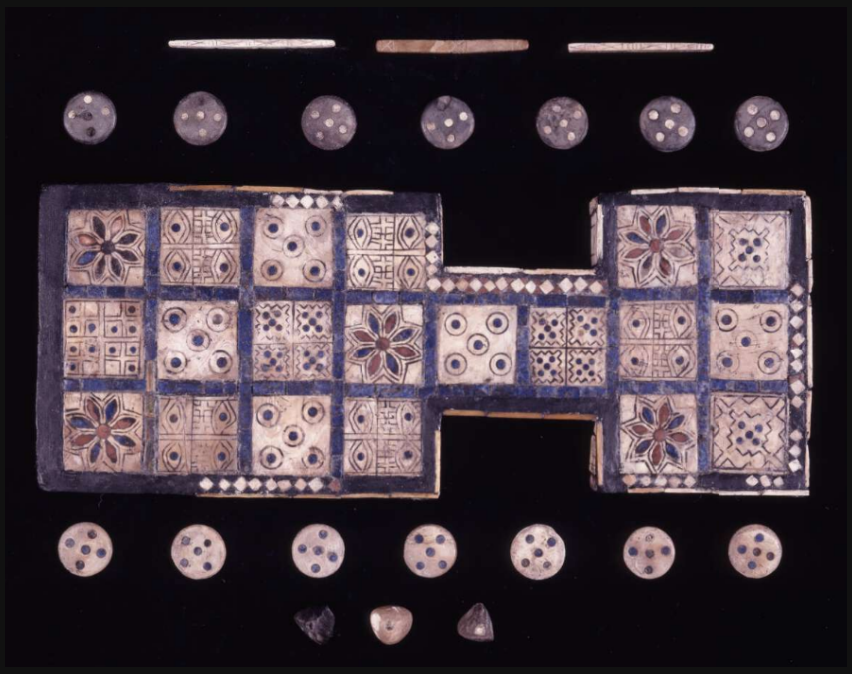
Combo to Win:
Mancala - Tetris - Bejeweled

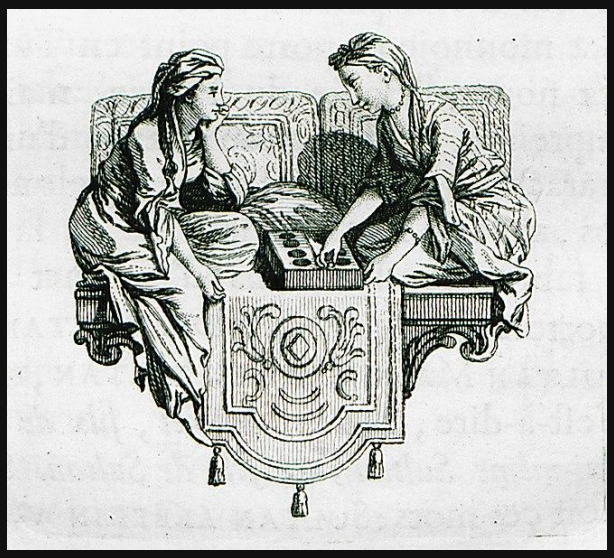
Bee Nix



The Royal Game of Ur. *The British Museum*.

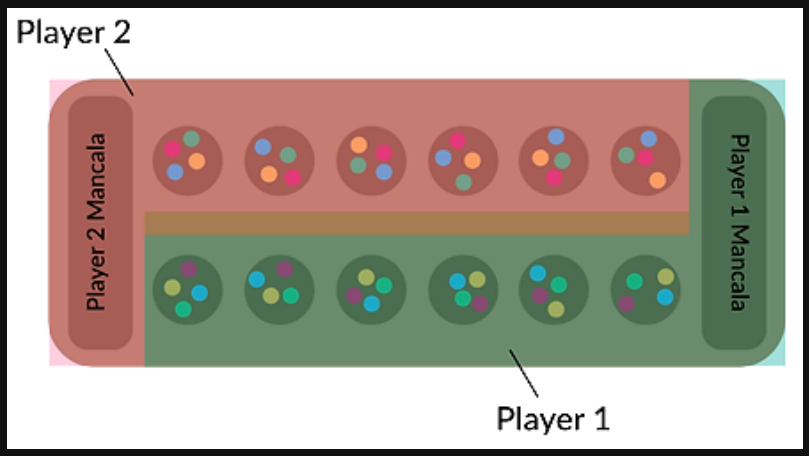
Core mechanics of a game are essential to its gameplay. They influence every moment of the game, dictate interactivity, support the creation of specific patterns of behavior and more. The mechanics of a game form some of the most fundamental components of a player's gameplay experience. Focusing on board games, many of the oldest ones, such as *senet* (3500-3100 BCE) and *The Royal Game of Ur* (2600-2400 BCE) involved dice, thus naturally implementing a high element of chance. In time, strategy and skilled board games began to come into the fore with games like *Go* (around 2356 BCE), and *Chess* (around 6th century CE), also two-player board games however, the element of chance in these games was omitted and instead an extensive knowledge of the game's rules, paired with extended time of play/practice, becomes required. This significant change from luck to skill, with additional constraints of how to play, obviously manifests a drastic change in gameplay experience: it completely changes the style of game. When comparing older games with few mechanics to one another, like senet and Chess, the similarities and evolution is rather easy to take note of. Modern games are far more complex, often requiring the knowledge and involved practice of several layers of mechanics, dynamics, all paired with dazzling aesthetics. The majority of these layers are often created by simply expanding + combining such qualities of games that have preceded whichever game is being discussed, while perhaps adding a few unique elements to the variation(s). One of the predecessors of what would become known as "match-3" games, *Tetris*, formed itself by utilizing several long established elements from other games, such as possessing a grid-system, keeping score, and most often Tetris's history is linked to the puzzles which provided

the distinctively shaped pieces within the game, *pentominoes.* Though there are several direct comparisons of some of Tetris's key game elements that can be made for games that far predate tetrominoes, such as *mancala* style games, which are worth taking note of.



Turkish women playing mancala. *Jean-Antoine Guer.* 1746

Mancala games are among some of the oldest two-player strategy games in the world, otherwise referred to as "count and capture", "pit and pebble", or "sowing" games which reference the actions of gameplay. Mancala derives from the Arabic verb "*naqala*", which means "to move". The oldest mancala board discovered dates back to the Neolithic age and was found in Ain Ghazal, Jordan, though where this style of game first originated is unknown. Mancala boards vary from culture to culture, usually adjusting the amount of rows and holes the board has, the size of the board, as well as creating their own title for their version of the game. In general the board is somewhat flat, around a foot long (30cm) and within two hands wide.



Mancala. *Savannah African Art Museum.*

The most played modern mancala board is a 2 by 6 grid of "holes", with a trench on either side of the board, one for each player, which is called the "Mancala". The goal of mancala games are always the same: when the game is over, you want to have more pieces collected than your opponent has. To begin the game, one player sits at the North of the board, one player sits at the South and 4 game pieces (seeds/stones/shells) get placed in each of the 12 holes. Mancala games are turn-based and the word refers to a family of turn-based games that are considered "combinatorial games", meaning that gameplay is sequential with each player having perfect knowledge about the game and that the first player who can no longer make any moves loses the game. There is no randomization or element of chance after the roll of a single die to determine which player gets to make the first move. This lack of chance and emphasis on mathematical strategy makes mancala games "solved" games, meaning that the outcome of the game (win, lose, or draw) is determinable at nearly any moment of the game.

To start a mancala game, once the first player is chosen, that player can choose a hole from their side of the board and pick up all the pieces it holds. Then one-by-one the pieces get dropped into the holes around the board in a counter-clockwise direction, placing a single piece in one's own Mancala but not an opponent's. This dropping of pieces around the board is called "sowing". As a player is sowing they can attempt to "capture" pieces from their opponent's side of the board by landing their last dropped piece in an empty hole on their own side of the board. If a player is able to do this, that single piece + the piece(s) opposite it on the other side of the board get captured (or one could say "cleared") and placed into their own Mancala. Should a player's last dropped stone land in their own Mancala, they get a "free turn" enabling them to make another move. This free turn mechanic is one of the earliest examples of a sequential game enabling a player the ability to make a combination of moves within a single turn to attain higher scores, moves that ultimately are necessary to win the game. The game is over if one of the two players no longer has pieces to move, and the winner is the player with the most pieces kept which includes all the pieces captured in their Mancala, as well as all the pieces still held in holes on their side of the board.

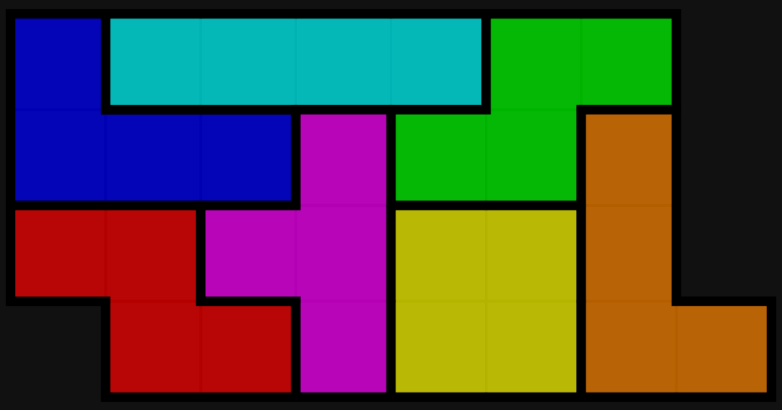
Mancala game mechanics fundamentally demand mathematical prowess paired with a strategic mind that can plan ahead in order to both take pieces/points away from their opponent and simultaneously set up to try to make combo moves to greatly increase their own score. A player must also continuously be able to interpret their opponent's moves, that is of course only if a player cares to win. Mancala game mechanics make them easy games to begin playing but take time to master which

instills a rather competitive dynamic between players. These games are mind sports. With the simplicity of mancala games, their beginner friendliness, the arena of the mind they establish for competitive play for those who journey towards mastery-- it's no wonder that mancala games spread around the world for thousands of years and are still played to this day. Naturally, mechanics which define mancala games, such as the ability to make combo moves in order to attain the highest score(s), would go on to influence other games and become a part of their defining mechanics, like Tetris.

Tetris, first version screenshot. 1984.

In 1984 Moscow, *Tetris* was created by AI researcher, Alexey Pajitnov. Tetris is a combination of the words "tetra" and "tennis", references to the game piece shapes and Pajitnov's favorite sport. Starting as a single player PC game, Tetris boomed across Russia and became the first entertainment software to be exported to the USA from the USSR. Originally Pajitnov focused on pentomino shapes, which are polygons made of 5 equally sized squares connected at the edges. Figuring that the 12 total pentomino shapes would be overly complex, Pajitnov switched to using "tetriminos", which are polygonal shapes made of 4 equally sized squares and have a total of only 7 variations (O, I, T, L, J, S, Z). The first version of Tetris made the digital cells (each square) of the tetromino shapes visible on the computer monitor by using a set of closed brackets " [ ] ". Twenty cells high and 10 cells wide, Tetris's game generates a vertical rectangle grid called the "matrix", and within the matrix is where the game play

happens. As a single player problem-oriented game within a mathematical system, Tetris is a "combinatorial puzzle" and unlike most two-player combinatorial games it is not considered a solved game because the end results are highly indeterminable and the randomization of pieces gives Tetris an element of luck. Since Tetris is a computational game, constraint logic is used to categorize the game by placing it within a complexity class. Tetris has been determined as being within the computational complexity class of NP-complete, due to having quickly verifiable correct solutions.



All 7 one side tetrominoes in a 7x4 shifted rectangle.

Tetris begins with an empty matrix, a random tetromino descending from the middle of the horizontal line atop the matrix called the "skyline", and as the piece descends the player is able to rotate the tetromino piece 90 degrees, move it left to right, or accelerate its speed. A player cannot, however, stop a piece from descending, implementing the pressure of time. When a piece lands on either the bottom of the matrix, or on top of another piece, it gets "locked down" becoming immobile and a new tetromino begins its descent from the skyline. If a player is able to fit the tetrominos in a way that creates a horizontal line without any gaps, that initiates a "line clear": the squares within that horizontal line are removed from the matrix, all the pieces above drop a single cell row and the player is rewarded a specific amount of points. Tetris uses a "bag system" for its randomization, wherein all seven tetrominoes get put into a digital "bag" and one by one get selected at random and dropped until the bag is empty before the process starts again. This adds a fairly small but significant amount of information to a player, however, even after the "queue" was added to later versions of Tetris, wherein the piece(s) a player is about to next receive gets shown vertically on the side of the matrix in order, the game remains incalculable. To proceed to the next level (of which there were originally 29+ with each level increasing in speed) a certain amount of points need to be collected or a specific amount of lines need to be

cleared. Clearing lines is also imperative to keep playing the game because, like any other combinatorial game, if a player no longer has pieces to move the game is over. The conditions in Tetris that keep a player from having pieces to move is if a tetromino gets "blocked-out" (a new tetromino piece is blocked by an old one and cannot enter the matrix) or "locked out" (when a tetromino piece gets locked down over the skyline).

The ultimate goal of Tetris is to get the highest score, so being methodical about how to clear lines will not only assist a player in keeping the "stack" of pieces from getting too high, it is imperative for a player to continue to be able to play. Though let it be clear, simply continuing to be able to play does not equate to a player reaching the highest scores. One of the signature ways of keeping the stack's height in check while attaining high scores is by setting up for combo moves. As previously mentioned, mancala game combos let a player make multiple moves within a single turn, therefore adding a lot more points to their score. In Tetris, combos occur when a player arranges the stack in a way that a single piece is able to clear multiple lines with a single move, which also substantially adds to a player's score. Combos can also occur when a player is able to clear lines using one new piece directly after another. Setting up for combos to gain more and more points is a focal point of Tetris and a large part of the addictive + competitive quality of Tetris, supporting the fact that it is the most ported digital game to date. Similarly to mancala games, Tetris is played best by those with mathematical skill and a strategic mindset that can plan ahead to get the most out of every move. Though being a combinatorial puzzle game that integrates a bit of chance while layering computational form, time pressure and difficulty structure---Tetris is a wonderfully unique game whose variation of combo moves has inspired many games since its creation. Most notably, Tetris is known for its influence on match-3 games like *Bejeweled*.

Bejeweled deluxe sc1.

Created by PopCap Games in 2001 and released for PC, *Bejeweled* has been played by half a billion people globally and has inspired more copycat mobile games than any other mobile game. It is not the original match-3 game (*Shariki* 1994), but it is the one that made it so popular. Bejeweled is a *tile-matching* game wherein a player reorders tiles according to a matching criterion resulting in the removal of the matched pieces from the board. For Bejeweled, the matching criterion is three of the same type of piece. Starting with an 8 by 8 grid filled randomly with a specific set of gems/pieces, a player can attempt to swap the position of any two adjacent pieces to try and match 3 or more of the same type of piece, thus triggering the removal the matched pieces resulting in the pieces above those removed to fall into the empty spaces as new pieces follow suit, dropping from the top of the grid. If a player attempts to swap two adjacent pieces that don't result in a match, the pieces are returned to their original positions. Pieces can only be matched either vertically or horizontally, matching more than 3 pieces together yields higher scores and, of course, so does making combo moves. Combo moves occur if, after making a match, pieces falling into place make another match when they land. This dynamic of matching, removing, with new pieces replacing those lost potentially makes Bejeweled a combinatorial puzzle within the computational class of PSPACE-complete, which indicates that for every one move there are two consequences. However, this estimate is one based on the influence that the game *Clickomania* (which is rated as PSPACE-complete) had on the creation of Bejeweled. Nevertheless, the games are distinctly different from one another on a fundamental level for when matches are made in Clickomania the matched pieces are removed and not replaced, but when matched pieces are removed in Bejeweled they are always replaced. The board in Bejeweled never has empty spaces. With the board never having empty spaces, and the pieces which replace any vacant spaces being chosen at random, Bejeweled is actually a game of chance and is not solved. Even though there are strategies of how to best play Bejeweled, such as always working down from the top, there is no calculable perfect gameplay. Just like Tetris, Bejeweled is all about getting the highest score and to continue playing the game you need to keep making matches and reaching the amount of points necessary to carry on to the next level. If attaining one of the highest Bejeweled scores is a player's pursuit, then they'll want to be mathematically skilled with a strategic mind because it is still a puzzle game, but such qualities are not exactly a requirement to reach high scores.

Digital and modern games with their many layers of complexity have enabled mechanics/dynamics/aesthetics to emerge that were not possible before digital computational systems and the advancement of entertainment technology. Though too often is the history of digital/modern games discussed predominantly within the history of technology while barely, if at all, extending the discussion to include non-digital game influences which predate even industrialization, let alone the invention of digital games. It is not so much that knowing exactly where this or that specific element of a game originated from is of the utmost importance to understanding the game, but it is undeniable that the mechanics of a game directly influence its gameplay experience so, it seems a great disservice to the research of digital games at large to primarily compare them only to themselves. There is a line of connection that can be drawn from making combo moves to attain high scores in mancala games, one of the oldest game styles in the world, all the way to the combo moves of 1984 Tetris and contemporary Match-3 games, and such connections as these should not be overlooked. It would appear also that, particularly for computational puzzle games, that digital games typically get discussed within a computer science lens (solved/unsolved, complexity levels...) more than anything else, which seems another poignant disservice to understanding games, digital or otherwise. By following the lineage of a single game mechanic, the complexity of modern games can be simplified with the analysis of gameplay experience greatly expanded to include influences that may not be easily recognized in their digital formats.

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