

Expert Review of Selected Board Games

The following report is intended for board game stakeholders with a layman's knowledge of cognition. The report contains design recommendations based on human cognitive functioning, explained in plain terms.

Table of Contents

0. Background & Introduction

- Aim of the report – p. 3
- Glossary – p. 4
- Overview of reviewed board games – p. 5

1. Expert Review of *Haven*

- In-depth expert review based on core cognitive design principles – pp. 6-36
 - 1.a. Game Board – pp. 9-16
 - 1.b. Battle Area – pp. 17-22
 - 1.c. Tokens – pp. 23-28
 - 1.d. Hand and Cards – pp. 29-32
 - 1.e. Player Aid – pp. 33-36

2. Expert Review of *Tang Garden*

- In-depth expert review based on core cognitive design principles – pp. 37-79
 - 2.a. Game Board and Tiles – pp. 40-47
 - 2.b. Player Board – pp. 48-57
 - 2.c. Characters and Character Cards – pp. 58-69
 - 2.d. Tokens – pp. 70-73
 - 2.e. Decorations – pp. 74-79

3. Expert Review of *Photosynthesis*

- In-depth expert review based on core cognitive design principles – pp. 80-112
 - 3.a. Game Board – pp. 83-88
 - 3.b. Sun Segment – pp. 89-94
 - 3.c. Player Board – pp. 95-102
 - 3.d. Playable Elements – pp. 103-108
 - 3.e. Tokens – pp. 109-112

4. References

- Sources and literature backing the claims of the report – pp. 113-117
- Links to relevant rule books – p. 117

Aim

The purpose of this report is to propose design changes for three modern board games. The recommendations are made with the intent of enhancing ease of learning and gameplay, with the aim of reducing the barrier to entry.

All recommendations are based on scientific findings and design principles pertaining to human cognitive functioning. As such, the report aims to keep the inherent complexity of each of the games, while changing the way the player interacts with the game and is presented with information.

The structure of the report takes up predicted issues one at a time and treats them in isolation. As such, the compatibility between design suggestions will vary.

Glossary

The following reviews are intended for a **lay audience**. Scientific terms are therefore kept to a minimum. All relevant references are included.

A few key **cognitive science** terms, along with some **board game**-specific terms will be used. Each is introduced here.



Working Memory

Temporary memory for briefly holding and manipulating information (Baddeley, 2010; Binder et al., 2009).



Cognitive Load

Relates to the limited capacity of a person's working memory. If load is high, a lot of effort and resources are used cognitively (Sweller, 2011).



Flow States

A pleasurable experience of acting with total involvement, in which one action follows the other without the need for conscious intervention (Csikzentimihalyi, 1975).



Affordance

Has to do with the use or purpose that a thing can have, perceived by a person based on the way they can interact with it (Gibson, 1977; Nye & Silverman, 2012).

Upkeep

Primarily an economic mechanic, upkeep represents maintenance and is typically performed between rounds, in which players gain or lose resources, resolve ongoing effects, or perform other maintenance requirements (Levan, 2014).

Token

A component, typically made of cardboard, representing something relevant to the game, such as resources or points.

Player Aid

A reference card which provides reminders of game rules such as turn structure or available actions (Kinne, 2022).

Overview of Reviewed Board Games

Haven

(Seegert & Laukat, 2018)

01

Tang Garden

(Testini et al., 2019)

02

Photosynthesis

(Hach & Miramon, 2017)

03



01

Haven

(Seegert & Laukat, 2018)





Summary:

In Haven (Seegert & Laukat, 2018), players fight for control of a mystical forest. One player plays as City and machines, fighting for control over the forest, while the opponent plays as Forest and creatures, defending their home.

*Classification according to BGG database
(BoardGameGeek, n.d.):*

Weight/Complexity Rating: 2.27/5

Player Count: 2 players

Type: Strategy

Mechanisms: Area Majority / Influence, Enclosure, Hand Management, Push Your Luck, Set Collection

Overview of Game Areas

a) - Game board

The game board includes areas for card decks and sections that players can interact with using certain tokens, c1).

b) - Battle area

The battle area is set up by the players on the surface of the table. The area is made up of cards in play and certain tokens, c2), directing the game.

c) - Tokens

Tokens in the marked areas are up for grabs and are worth points when claimed.

d) - Hand (cards)

Player hand made up of cards from the three decks on the game board, a).

e) - Player aid and scoring sheet

Double-sided sheet which specifies turn actions and final scoring.

f) - Victory point cards

Specifies scoring criteria for end-game bonuses.



a) Game Board

The following pages contain suggestions for redesigns of the main *game board*, including:

- Predicted issues
- Problem descriptions and root causes
- Recommendations for redesign

The core game is kept unaltered, while game pieces and layout may be subject to suggested alterations.



ISSUE 1 – affordances for placement

Predicted issue: Placement of certain tokens on designated areas of the board may be performed hesitantly or incorrectly.

Problem description and **root causes**:

- Nodes (i.e. *shrines*) on the board are meant for placement of specific tokens on them. However, no visual clues suggest or signify this (Ware, 2004).
- As both size and shape varies between the two, the board establishes no meaningful grouping between *shrine tokens* and nodes/*shrines* (Palmer, 1999; Wertheimer, 1938).
- The irregular shapes of the nodes come with a risk of them being perceived as purely aesthetic, rather than having a common functionality between them (Johnson, 2021b).

CURRENT DESIGN



shrine token placed
on node/*shrine*

unoccupied node/*shrine*
on which *shrine tokens*
can be placed

RE-DESIGN

ISSUE 1 – affordances for placement

Predicted issue: Placement of certain tokens on designated areas of the board may be performed hesitantly or incorrectly.

Recommendations for **redesign**:

- Make the area for placement shaped and sized similarly to the token that the rules permit placement of, thus making the two appear grouped (Palmer, 1999; Wertheimer, 1938).
- Adhere to standards (Yablonski, 2020) of games with tile placement mechanisms by outlining areas where tiles can be placed corresponding to the tile size. This creates affordances (Nye & Silverman, 2012; Ware, 2004) for placement.
- The increased size of the nodes make them visually pop (Johnson, 2021c; Katsuki & Constantinidis, 2014). The distinct visual suggests to players that the nodes are there for reasons other than aesthetics.

similarly shaped token and placement area



the numbers start from 0,
indicating that something might
be special for the first element

ISSUE 2 – attention-grabbing elements

Predicted issue: The numbers and symbols at the left-side edge of the board may cause confusion, since they provide limited to no functional use for the gameplay.

Problem description and **root causes**:

- The color of the symbols at the left-side edge makes them pop and stand out against the green background (Johnson, 2021c, 2021b; Katsuki & Constantinidis, 2014).
- Since the symbols and numbers provide no functional use in standard games of Haven, and only limited use in advanced variants, their toll on attention adds to the overall cognitive load of players (Sweller, 2011), without an associated benefit in understanding or ease of play.
- Conventionally, numbers suggest that something is to occur sequentially (Dehaene, 2011), which is not the case for these elements.
- A base-zero counting system is rarely used outside of programming. This deviation from the norm may further cause players to believe something special is attributed to symbol 0, which is not the case.

CURRENT DESIGN



secret bonus cards for end-game scoring can be laid out as an "advanced variant" of play

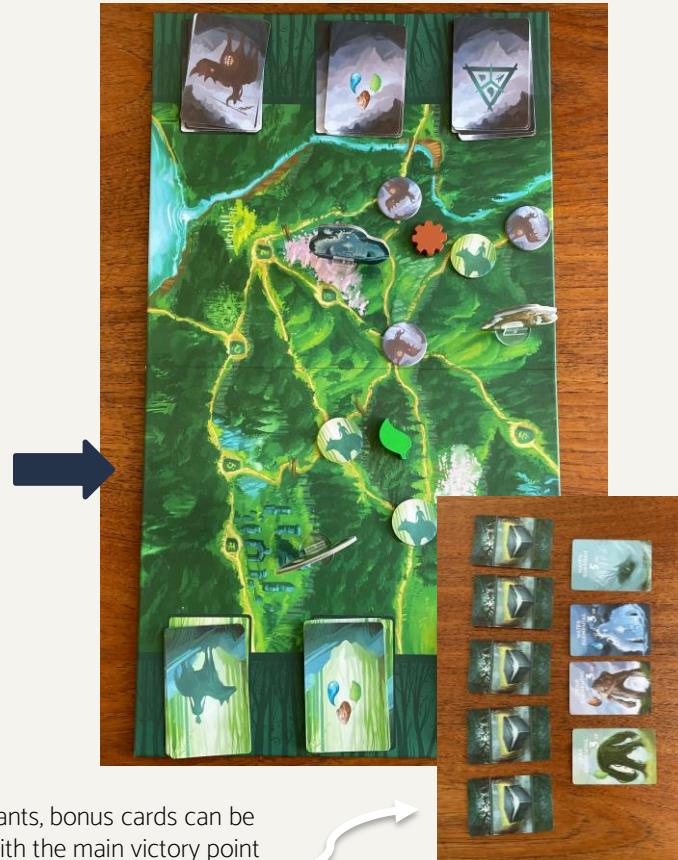
RE-DESIGN

ISSUE 2 – attention-grabbing elements

Predicted issue: The numbers and symbols at the left-side edge of the board may cause confusion, since they provide limited to no functional use for the gameplay.

Recommendations for **redesign**:

- Remove the symbols and numbers for a less cluttered and attention-grabbing player experience (Katsuki & Constantinidis, 2014; Lavie et al., 2014).
- The lack of special placement areas marked on the board will allow for the advanced variant bonus cards to be grouped (Palmer, 1999; Wertheimer, 1938) with the victory point cards off to the side.



for advanced variants, bonus cards can be placed together with the main victory point cards at the side of the table

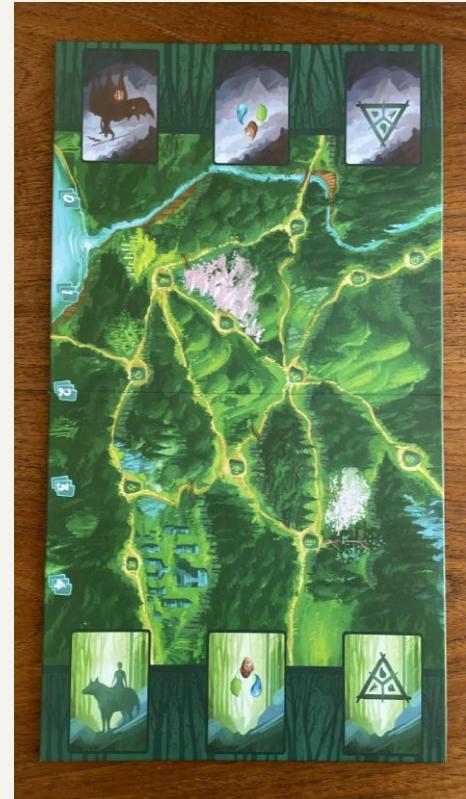
CURRENT DESIGN

ISSUE 3 – lack of overview

Predicted issue: Players risk mixing up the rules and actions that can be taken on the game board and may have to repeatedly look up rules.

Problem description and **root causes**:

- Players have to remember all placement rules off the top of their head when needing to interact with the board. Since these interactions occur infrequently, i.e. once between rounds, and are mixed in with more frequently applied rules, players may find it hard to correctly remember which outcome entails which action on the board (Robertson, 2012; Sweller, 2011).
- If players are not able to remember the placement rules between rounds, they are forced to skim through the rule book. If this happens repeatedly, it might interrupt the playing experience (Csikzentimihalyi, 1975; Elias et al., 2012a).

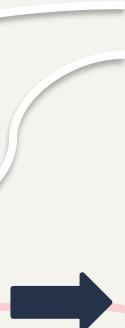


ISSUE 3 – lack of overview

Predicted issue: Players risk mixing up the rules and actions that can be taken on the game board and may have to repeatedly look up rules.

Recommendations for **redesign**:

- Add a visual aid of correct placement actions in order to let players free up some of their cognitive resources (Baddeley, 2010; Miller, 1956).
- Adhere to standards (Yablonski, 2020) of modern board games by incorporating visual aids of upkeep and actions into the main board such that they are visible to all players at all times, making them more likely to be used (Norman, 1998; Rekhi, 2018).



build-in overviews similar to the suggested redesign are found in popular board games such as *Terraforming Mars* (Fryxelius et al., 2016) and *Parks* (Audubon, 2019)



RE-DESIGN

Game Board Design Elements To **KEEP** ✓

- An aesthetically pleasing visual design improves the interaction experience and makes players more forgiving in terms of usability issues (Kurosu & Kashimura, 1995).
- Marked areas at the top and bottom of the board guide players in keeping the three unique decks of cards stacked separately to one another (Nye & Silverman, 2012; Ware, 2004).
- Mirrored design of marked areas for card deck placement between players. This may help players keep track of what their opponent is doing at a glance, since they do not have to allocate cognitive resources for mentally flipping or rotating it (Guillot et al., 2012; Sweller, 2011).
- Each side of the board is colored according to the player who owns the cards, making them appear meaningfully grouped (Johnson, 2021b).



b) Battle Area

The following pages contain suggestions for redesigns of the components of *battle area* as a whole, including:

- Predicted issues
- Problem descriptions and root causes
- Recommendations for redesign

The core game is kept unaltered, while game pieces and layout may be subject to suggested alterations.



CURRENT DESIGN

ISSUE 1 – incorrect groupings

Predicted issue: The numbers and weapons marked in the top left corner of cards played into the battle area risk being understood by players as grouped, despite having different game consequences.

Problem description and **root causes**:

- The numbers (i.e. *lore value*) and weapons (*arrows* or *swords*) may appear grouped due to their close proximity to one another (Palmer, 1999; Wertheimer, 1938).
- For cards where the number and amount of weapons are equal to one another, the risk of players perceiving them as grouped increases due to the associative correspondence between them (Johnson, 2021b; Vickery & Jiang, 2009).



RE-DESIGN

ISSUE 1 – incorrect groupings

Predicted issue: The numbers and weapons marked in the top left corner of cards played into the battle area risk being understood by players as grouped, despite having different game consequences.

Recommendations for **redesign**:

- Move the numbers and weapons away from each other to make them appear as separate entities (Johnson, 2021b; Palmer, 1999; Wertheimer, 1938), for instance by placing them in each of the top corners.



ISSUE 2 – lack of congruence between associated areas

Predicted issue: The outcome of having the most weapons may be unclear for players.

Problem description and **root causes**:

- While the numbers on the cards add up to compete towards the numbers on the tokens in the middle of the battle area (meaning that there is congruence between the two), no visual or associative clue suggests what the weapons are for, making the basis for forming a correct mental model uncertain (Gentner, 2001).
- Because the outcome of having the most weapons is resolved in another area of play, i.e. at the nodes of the main game board, players are forced to overtly shift their attention in order to connect the two, which is cognitively costly (Schubert, 2023).

CURRENT DESIGN

numbers on cards are associated with numbers on the *lore tokens*



no congruence or visual aid helps suggest that weapons are associated with nodes/*shrines*

ISSUE 2 – lack of congruence between associated areas

Predicted issue: The outcome of having the most weapons may be unclear for players.

Recommendations for **redesign**:

- Add a visual element that seems to connect the weapons and the nodes/*shrines* found on the game board. This could be in the form of a backdrop for the weapons in the shape of the nodes, making them appear grouped due to their similarity (Johnson, 2021b; Palmer, 1999; Wertheimer, 1938).
- Alternatively, the weapons could be added on the nodes/*shrines* on the game board for a similar effect.

rough sketch of weapons backdrop and node/*shrine* having the same shape



RE-DESIGN



Battle Area Design

Elements To **KEEP**

- Congruence between the numbers on the played cards and the numbers on *lore tokens* (depicted in the middle row) makes them seem grouped (Vickery & Jiang, 2009).
- The lack of a board or player mat lets players place components without having to hit a small or precisely sized target (Fitts, 1954), resulting in less time spent on placement.



c) Tokens

The following pages contain suggestions for redesigns of the *tokens* and similar loose pieces, including:

- Predicted issues
- Problem descriptions and root causes
- Recommendations for redesign

The core game is kept unaltered, while game pieces and layout may be subject to suggested alterations.



ISSUE 1 – discernability

Predicted issue: Perception of the shape of the symbols may be difficult for some players.

Problem description and **root causes**:

- The low contrast in color between the shapes and background of *lore tokens* makes the shape difficult to discern (Johnson, 2021c; Mahjoob & Anderson, 2019; Treisman & Gelade, 1980).
- People who rely more on shape-matching than color-matching heuristics may therefore be at a disadvantage.
- A lack of consistency is present between the three types of *lore tokens*, in which the one for stone (shown at the bottom) is well-contrasted to its background color, compared to the others. A lack of consistency may be cause of confusion or slowed learning (Johnson, 2021a).

the shapes on *offering* cards should be easily matched to the shapes on the *lore tokens*



CURRENT DESIGN



the greater contrast for the stone token makes it more easily discernably than the leaf or water tokens – this becomes evident when blurred

ISSUE 1 – discernability

Predicted issue: Perception of the shape of the symbols may be difficult for some players.

Recommendations for **redesign**:

- Increase the contrast between the background and the foreground to make the symbols more discernable and letting them appear to pop out against the background (Mahjoob & Anderson, 2019; Treisman & Gelade, 1980).
- Keep the overall theme and color scheme, ensuring that the backgrounds differ from the shape such that the tokens remain discernable from one another at a glance (Johnson, 2021c).

RE-DESIGN

current design shown for side-by-side comparison



heightened contrasts between
background and symbols

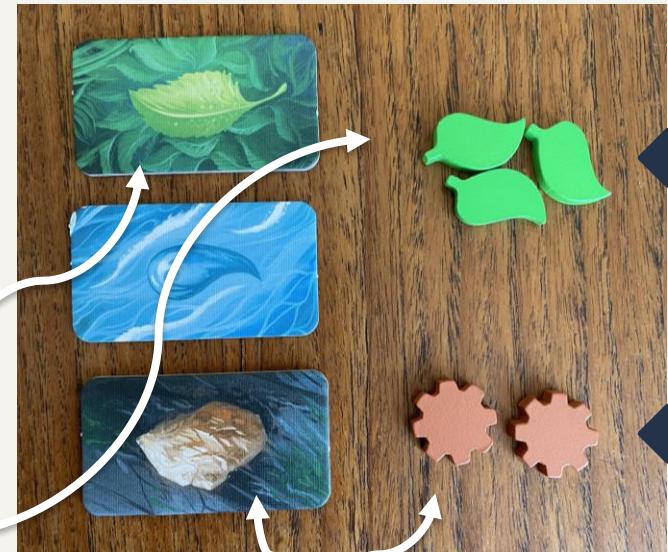
ISSUE 2 – incorrect groupings

Predicted issue: The *haven tokens* (i.e. leaves and cogs shown on the right) risk being understood by players as grouped with the leaf and stone symbols (left), respectively.

Problem description and **root causes**:

- The *haven tokens* (right) match the colors of the symbols of the *lore tokens* (left). Additionally, the leaves also match the shape of the leaf symbol to the left. Objects of similar shape and color tend to be perceived as belonging to the same group (Palmer, 1999; Wertheimer, 1938).

CURRENT DESIGN



similar colors

ISSUE 2 – incorrect groupings

Predicted issue: The *haven tokens* (i.e. leaves and cogs shown on the right) risk being understood by players as grouped with the leaf and stone symbols (left), respectively.

Recommendations for **redesign**:

- Consider changing the colors and/or shapes of the *haven tokens* to make them be perceived as unrelated (Palmer, 1999; Wertheimer, 1938) to the symbols of the *lore tokens* (left).
- The thematic division between nature and machine can be kept true while changing the shapes of the tokens as shown in the suggested redesign. Alternatively, standard shapes with colors corresponding to the otherwise established (Johnson, 2021c) player colors could be considered.

RE-DESIGN



squirrel borrowed from the
board game Everdell (Wilson
et al., 2018)

Token Design Elements To **KEEP** ✓

- Tokens of different functionality are shaped and sized differently, making it clear that they do different things and belong to their own unique groups (Johnson, 2021b; Palmer, 1999; Wertheimer, 1938).



d) Hand (Cards)

The following pages contain suggestions for redesigns of the *hand*, i.e. the cards as the players draw them before being put into play. Suggestions include:

- Predicted issues
- Problem descriptions and root causes
- Recommendations for redesign

The core game is kept unaltered, while game pieces and layout may be subject to suggested alterations.



ISSUE 1 – card types mixup

Predicted issue: Players may experience confusion as to which cards on their hand stem from which of the three decks.

Problem description and **root causes**:

- The three types of cards may be difficult to relate to their associated decks due to a lack of congruence and similarity between the illustrations on the back of the cards and the illustrations facing the players (Johnson, 2021b; Palmer, 1999; Wertheimer, 1938).
- In order to confirm which deck type a card belongs to, players may need to look at the back of the card. This forces them to keep the information in working memory while planning the next move, which increases the cognitive load (Baddeley, 2010; Sweller, 2011).

CURRENT DESIGN



the three card types and what they look like facing the player. In a regular game, the hand is made up of a combination of the three

ISSUE 1 – card types mixup

Predicted issue: Players may experience confusion as to which cards on their hand stem from which of the three decks.

Recommendations for **redesign**:

- Add the same illustration on the back and front of the cards, making them visibly grouped with their corresponding deck (Johnson, 2021b; Palmer, 1999; Wertheimer, 1938).
- By hinting to the type of the card while facing the player, i.e. in their field of vision (Rekhi, 2018), working memory resources are freed up (Baddeley, 2010; Miller, 1956).

the same illustration from the back of the cards, re-used on the front

RE-DESIGN



Hand (Cards) Design

Elements To **KEEP** ✓

- The layout between the three types of cards differs, suggesting to players that they are grouped accordingly (Johnson, 2021b).



e) Player Aid

The following pages contain suggestions for redesigns of the *player aid*, including:

- Predicted issues
- Problem descriptions and root causes
- Recommendations for redesign

The core game is kept unaltered, while game pieces and layout may be subject to suggested alterations.

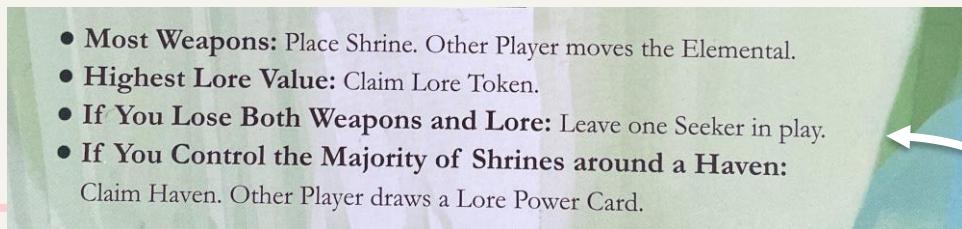


ISSUE 1 – arbitrary names in “resolve”-section

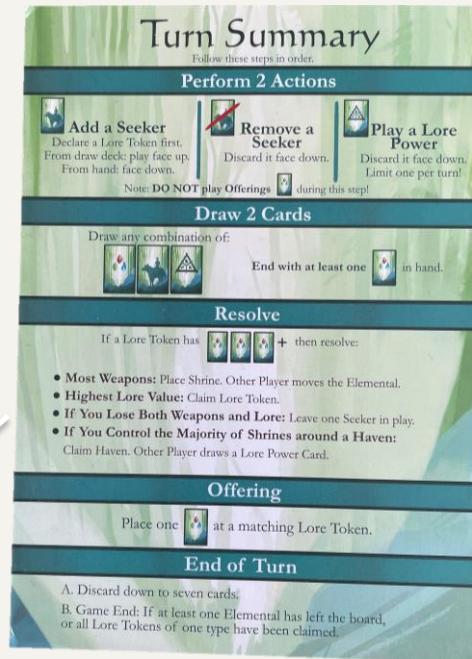
Predicted issue: Players may not know which game components the player aid refers to.

Problem description and **root causes**:

- Some of the game components referred to in the player aid have no apparent link between their name and their function, category, or looks. This means that the player aid may not successfully guide players to perform legal actions, since players cannot rely on their mental models (Gentner, 2001).
- The lack of symbols or illustrations as cues means that there is an increased demand to memorize the terms, which takes up cognitive resources (Baddeley, 2010; Miller, 1956).



CURRENT DESIGN



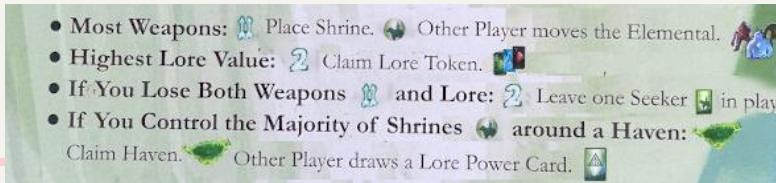
the bullet points contain no symbols
but lots of in-game terminology

ISSUE 1 – arbitrary names in “resolve”-section

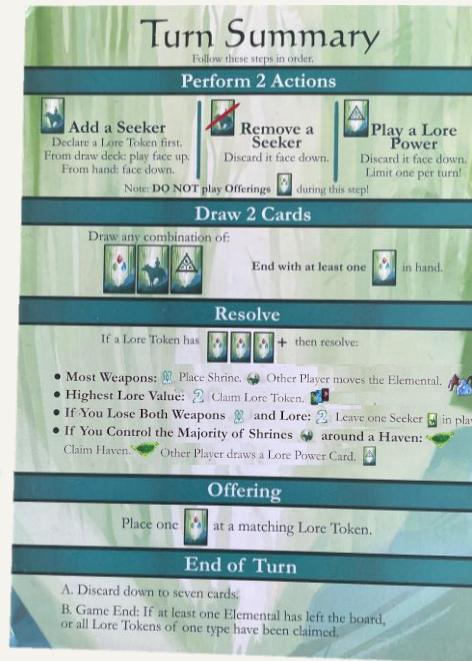
Predicted issue: Players may not know which game components the player aid refers to.

Recommendations for **redesign**:

- Add symbols associated with the components that the names refer to. Doing so will free up the reliance on storing and retrieving the terms from memory (Sprevak, 2019).
- Additionally, by providing the depictions of the components, internal consistency (Johnson, 2021a) of the player aid is provided, helping letting the player know what to expect.
- Stakeholders could consider splitting up the text and symbols to avoid visual clutter, which could cause increased cognitive load (Sweller, 2011).



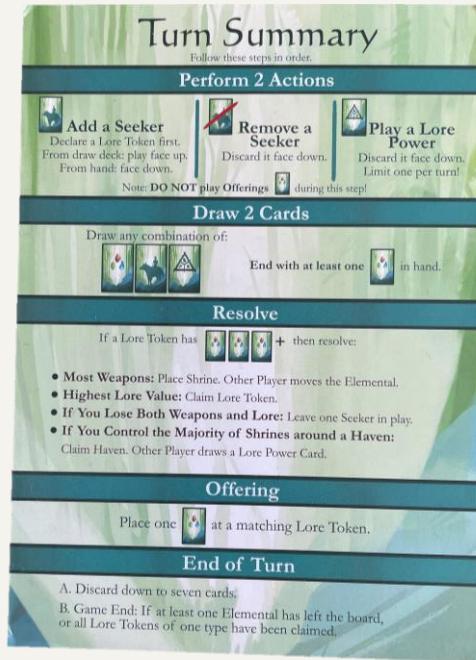
RE-DESIGN



Player Aid Design Elements To **KEEP**



- The player aid generally makes use of illustrations, which help give the player a quick overview without having to read full texts (Elias et al., 2012a; Sousa, 2005; Sprevak, 2019).
- A visual hierarchy is established, guiding the player in their search for information (Johnson, 2021d).
- Broadly speaking, the existence of the player aid should be kept as it frees up working memory resources (Baddeley, 2010; Sprevak, 2019).



02

Tang Garden

(Testini et al., 2019)



Summary:

In Tang Garden (Testini et al., 2019), players compete to build the most impressive Chinese garden consisting of landscape, scenery, and panoramic views for an audience of noblemen.

Classification according to BGG database (BoardGameGeek, n.d.):

Weight/Complexity Rating: 2.61/5

Player Count: 1-4 players

Type: Family, Strategy

Mechanisms: Line of Sight, Open Drafting, Set Collection, Solo / Solitaire Game, Tile Placement, Variable Player Powers

Overview of Game Areas

a) - Game board and tiles

The game board includes areas for tile stacks in the corners and a main area for tile and decoration placement.

b) - Player board

The personal player board lets players track progress and keep track of special abilities.

c) - Characters and character cards

Characters and their corresponding cards.

d) - Tokens and coins

In-game currency and various tokens.

e) - Decorations

Various components and their associated cards, for adding decorative and point-scoring elements to the game board.



a) Game Board & Tiles

The following pages contain suggestions for redesigns of the main *game board*, including tiles. Suggestions include:

- Predicted issues
- Problem descriptions and root causes
- Recommendations for redesign

The core game is kept unaltered, while game pieces and layout may be subject to suggested alterations.



ISSUE 1 – unintentionally hidden information

Predicted issue: The vertical placement of landscape tiles into the board risks forcing players to heavily rely on memory.

Problem description and **root causes**:

- Due to the placement areas of the game board each having tiles vertically facing their own way, players have to physically move around to see the layout of the landscape tiles. This forces them to rely on memory, which takes up cognitive resources (Baddeley, 2010; Miller, 1956), or to interrupt the game by moving around, possibly disrupting concentration and the potential for flow states (Csikzentimihalyi, 1975).

examples of game relevant information found on the landscape tiles that are hidden from view



CURRENT DESIGN

landscape tiles placed correctly in the slits of the placement area



indent/slits in the game board in which landscape tiles can be placed vertically

ISSUE 1 – unintentionally hidden information

Predicted issue: The vertical placement of landscape tiles into the board risks forcing players to heavily rely on memory.

Recommendations for **redesign**:

- Remove the slits for vertical placement and replace them with outlines of the landscape tiles. The outlines suggests to players that the landscapes tiles can be placed on the outlined spots (Ware, 2004).
- By letting the landscape tiles lie flat, visibility is ensured, which frees up cognitive resources (Baddeley, 2010; Miller, 1956).
- The tiles themselves can be altered such that their shapes “fit together”, or stakeholders can choose to add spacing between them, while keeping a close proximity.
- Make sure to keep the landscape symbols printed on this area of the game board to further make affordances for correct placement (Nye & Silverman, 2012; Ware, 2004).

RE-DESIGN



outlines on the board mark
legal landscape tile placement
spots

ISSUE 2 – symbol discernability

Predicted issue: The placement symbols on tiles may be difficult for players to spot. Some spots risk going unnoticed.

Problem description and **root causes**:

- Due to the low contrast between symbols on tiles and the background drawing on the tiles, the symbols do not appear to pop out against the background (Johnson, 2021c; Mahjoob & Anderson, 2019). Instead, they blend in.
- Since humans have quite poor peripheral vision, the risk of the symbols going unnoticed is high (Stewart et al., 2020).



CURRENT DESIGN



close-up of some of the symbols

ISSUE 2 – symbol discernability

Predicted issue: The placement symbols on tiles may be difficult for players to spot. Some spots risk going unnoticed.

Recommendations for **redesign**:

- Make the contrast between the symbol and the background greater in order to make it stand out against the background (Johnson, 2021c).
- Slightly tweak the hue to further set the symbols apart from the background and make them more easily discernable (Johnson, 2021c).



current versions for comparison



close-up of heightened contrast of the symbols

RE-DESIGN



ISSUE 3 – varying design of walls

Predicted issue: Players may miss some of the (generally) red walls due to their varying design, width, and color.

Problem description and **root causes**:

- Although all depictions of walls have the same in-game functionality, their designs vary quite widely. This may cause confusion as to whether they have the same function or it might cause players to miss some of the wall depictions entirely if their resemblance to the rest is vague (Johnson, 2021b).
- The rounded wall is especially likely to go unnoticed due to its lack of thickness, since human peripheral vision is quite poor (Stewart et al., 2020) and since it has limited “pop” that can drive attention (Katsuki & Constantinidis, 2014).

CURRENT DESIGN



the five different wall depictions have the same in-game functionality of blocking characters' line of sight

ISSUE 3 – varying design of walls

Predicted issue: Players may miss some of the (generally) red walls due to their varying design, width, and color.

Recommendations for **redesign**:

- Change the wall designs to all have the same brick-like texture, making them appear grouped (Johnson, 2021b; Palmer, 1999; Wertheimer, 1938).
- For the blue wall tile, make the outer layer of walls be red to facilitate it being perceived as belonging to the same group as the other walls (Johnson, 2021b; Palmer, 1999; Wertheimer, 1938). While doing so, keep the rest of the blue design to make it clear that it has other in-game functionalities as well.
- The semi-circle wall should be thickened to make it more similar to the straight walls and to make it pop in the peripheral vision (Johnson, 2021c, 2021b; Katsuki & Constantinidis, 2014).

RE-DESIGN



Game Board & Tiles

Design Elements To KEEP



- An aesthetically pleasing visual design improves the interaction experience and makes players more forgiving in terms of usability issues (Kurosu & Kashimura, 1995).
- Good use of continuation between tiles makes it easy for players to lay them down correctly and in legal spots (Palmer, 1999; Wertheimer, 1938).
- Good use of heuristic clues for suggesting availability or lack thereof (Ware, 2004): Face down tiles on tile stacks cannot be drawn.
- Square grid on the board affords placement of the tiles (Nye & Silverman, 2012; Ware, 2004).
- Although the slits for vertical placement of landscape tiles are suggested removed, stakeholders should keep the broad and forgiving slit design if they wish to keep the vertical landscapes. This is because a bigger target size is easier to hit (Fitts, 1954).



b) Player Board

The following pages contain suggestions for redesigns of the *player board*, including its associated game pieces. Suggestions include:

- Predicted issues
- Problem descriptions and root causes
- Recommendations for redesign

The core game is kept unaltered, while game pieces and layout may be subject to suggested alterations.



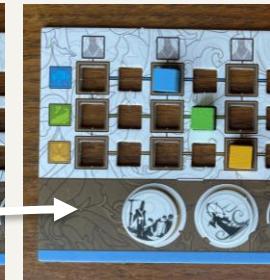
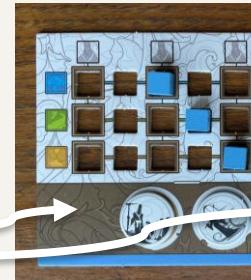
ISSUE 1 – player colors

Predicted issue: Players may accidentally match the color of the tracking cubes to the color of their player board.

Problem description and **root causes**:

- Because three of the player board colors (shown in a long line at the bottom) are identical to the tracking cubes representing water, forest, and stone elements, players risk playing with tracking cubes of their player color rather than colors representing the different elements. This may increase cognitive load (Sweller, 2011) and slow down actions when players have to track each of the elements.
- The further the tracking cubes with incorrectly chosen colors get from the left-hand side of the board, the further the player will have to move their eyes to confirm the type of element the cube represents (Stewart et al., 2020). This makes room for error.

CURRENT DESIGN



wrong and correct
combinations of tracking
cubes, respectively

ISSUE 1 – player colors

Predicted issue: Players may accidentally match the color of the tracking cubes to the color of their player board.

Recommendations for **redesign**:

- Since player colors do not show up or interact on the main game board at all, the colors on the player board should either be removed or changed to colors other than the ones used for representing water, forest, and stone. This will let players automatically arrange the cubes in the way that is most beneficial in terms of cognitive resources (Johnson, 2021b; Sweller, 2011).

RE-DESIGN



tracking colors
different to the color of
the player board

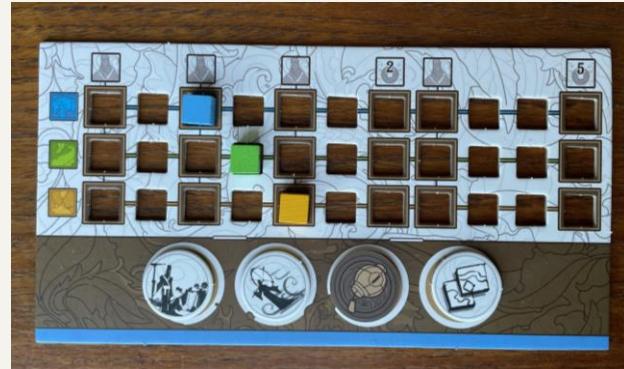
ISSUE 2 – symbol discernability

Predicted issue: At a glance, players may not notice that there are more than one type of bonus, as represented by the symbols in the top row.

Problem description and **root causes**:

- Due to the poor resolution of the human peripheral vision (Stewart et al., 2020), players risk not noticing that the symbols on the top row vary and represent different in-game bonuses.
- Because the symbols only vary beginning from the fourth symbol, players may not look directly at this symbol to see if it differs from the previous ones. This is because we generally use heuristics and best guesses from what we have learned previously (Gigerenzer & Brighton, 2009).

CURRENT DESIGN



when blurred, the symbols are very similar-looking and difficult to tell apart

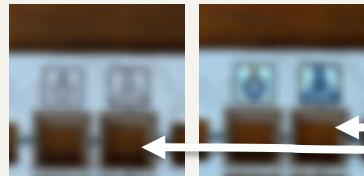
ISSUE 2 – symbol discernability

Predicted issue: At a glance, players may not notice that there are more than one type of bonus, as represented by the symbols in the top row.

Recommendations for **redesign**:

- Increase the contrast of the symbols to make them more easily discernable from one another at a glance (Johnson, 2021c; Stewart et al., 2020).
- Changing the hue or color temperature of the symbols compared to the rest of the player board makes them stand out against the background and be more easily noticed as worthy of attention (Katsuki & Constantinidis, 2014).

RE-DESIGN



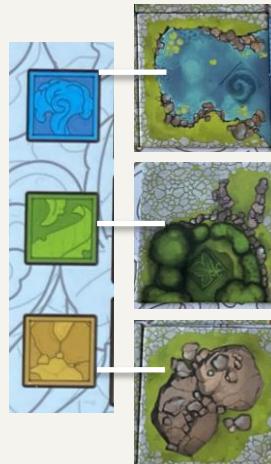
current design and
redesign next to each
other for easy
comparison

ISSUE 3 – stone symbol coloring

Predicted issue: Players may not realize that the yellow square represents stone tiles.

Problem description and **root causes**:

- Yellow is not conventionally (Johnson, 2021a; Krause, 2021) associated with stone colors and may thus not be understood correctly by players.
- The yellow-colored square and the brown stone color on the corresponding tile are not very close in hue and may therefore not be understood as grouped (Johnson, 2021b; Palmer, 1999; Wertheimer, 1938).



CURRENT DESIGN



the blue and green squares bear resemblance to the tiles they represent more so than the yellow one does

ISSUE 3 – stone symbol coloring

Predicted issue: Players may not realize that the yellow square represents stone tiles.

Recommendations for **redesign**:

- Change the color of the yellow square to better match the brown color palette of the stone areas on tiles. This will suggest to players that the two belong to the same category (Johnson, 2021b; Palmer, 1999; Wertheimer, 1938).
- Make sure to also change the color of the tracking cube such that all three match.

RE-DESIGN



ISSUE 4 – lack of overview

Predicted issue: Players risk mixing up the rules having to do with tracking and tile placement.

Problem description and **root causes**:

- Players have to remember the rules having to do with bonuses for tile placement off the top of their head. Since the actions are very similar, this heavily increases cognitive load, and players may find it difficult to tell the rules apart (Sweller, 2011).
- If players are not able to remember the placement rules between rounds, they are forced to skim through the rule book. If this happens repeatedly, it might interrupt the playing experience (Csikzentimihalyi, 1975; Elias et al., 2012a).

CURRENT DESIGN



ISSUE 4 – lack of overview

Predicted issue: Players risk mixing up the rules having to do with tracking and tile placement.

Recommendations for **redesign**:

- Add a visual aid specifying consequences of placement actions in order to let players free up some of their cognitive resources (Baddeley, 2010; Miller, 1956).
- Adhere to standards (Yablonski, 2020) of modern board games by incorporating player aids into components that players have lying in front of them, making the information easily accessible (Norman; 1998; Rekhi, 2018).



RE-DESIGN



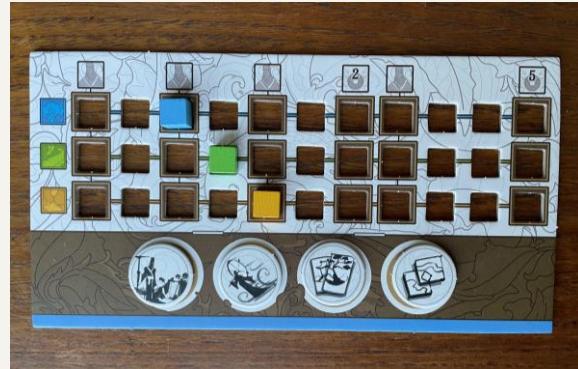
build-in overviews similar to the one suggested are found in popular board games such as *Terraforming Mars* (Fryxelius et al., 2016) and *Parks* (Audubon, 2019)



Player Board Design Elements To **KEEP**



- The square holes slightly larger than the cubes make for targets that are easily hit. This means that the action of moving the cubes requires less effort compared to having smaller sized holes or no holes at all (Fitts, 1954).
- Congruence between the colors of the left-side square symbols and the cubes make them appear as belonging to the same group (Palmer, 1999; Wertheimer, 1938).
- The use of horizontal lines in the grid helps suggest to players the direction of movement (Ware, 2004).



c) Characters & Cards

The following pages contain suggestions for redesigns of the *characters* and their associated *character cards*, including:

- Predicted issues
- Problem descriptions and root causes
- Recommendations for redesign

The core game is kept unaltered, while game pieces and layout may be subject to suggested alterations.



ISSUE 1 – eye gaze direction

Predicted issue: Players may find it difficult to see in which direction characters are looking.

Problem description and **root causes**:

- Due to the miniature figures being quite small and having dynamic poses, the directionality of where the heads are facing may be difficult to assess.
- The above observation could result in erroneous decision making or may interrupt the flow of the game if players have to regularly assess it by taking a closer look (Csikzentimihalyi, 1975).

CURRENT DESIGN



ISSUE 1 – eye gaze direction

Predicted issue: Players may find it difficult to see in which direction characters are looking.

Recommendations for **redesign**:

- Add a visual clue to the base of the characters that players can look for when assessing eye gaze direction. This makes for faster identification of eye gaze direction because players will know what to consistently look for despite variations in the design of character (Katsuki & Constantinidis, 2014; Ware, 2004).
- Make sure to let the visual clue pop, making it easy to visually search for (Johnson, 2021c).
- By indicating character directionality with the use of clues on the base plate, the game adheres to standards found in games with similar mechanics (Yablonski 2020).

example of base plate from Monster Hunter World: The Board Game (Hart et al., 2022) with indications of figure directionality



RE-DESIGN



ISSUE 2 – identification of certain characters

Predicted issue: Players may experience trouble identifying the characters on their card among the miniature figures on the board.

Problem description and **root causes**:

- Due to the similar color ranges and hue for some of the characters, they are likely not easily discernable from one another (Duncan & Humphreys, 1989).
- The circles on the cards and the circles on the base plate of the miniature figures vary in color between each other. With incomplete color matches between the two, searching for and identifying the characters is made more difficult (Reijnen et al., 2007).



supposedly recognizable as different character identifying colors



supposedly recognizable as the same character identifying color

CURRENT DESIGN



ISSUE 2 – identification of certain characters

Predicted issue: Players may experience trouble identifying the characters on their card among the miniature figures on the board.

Recommendations for **redesign**:

- Make the colors less similar in hue. Do this by leaning into the brown and nude color, respectively, to set them apart from the orange.
- Make the colors that are supposed to be identical more similar to each other in hue.

current design next to
suggested redesign of
colors



CURRENT DESIGN



ISSUE 3 – visibility of obsolete bonuses

Predicted issue: Players risk accidentally planning for or performing special ability bonuses that are no longer valid.

Problem description and **root causes**:

- The special abilities of characters are only valid when the character's miniature figure is not placed on the game board. However, the design of the character cards does not help suggest this to players.
- Because players keep character cards in front of them regardless of whether the associated character has been placed on the main board or not, the depictions of the character skill is always visible to players – regardless of whether it is valid or not. This visibility wrongly suggests to players that the skill is available and applicable (Ware, 2004).
- Since players have been gaining the special ability bonuses of their card from the start of the game, the action pattern becomes part of their routine while playing the game. As such, the game should make an effort to disrupt this routine behaviour to make players attend to and deliberately adept to the change (Kahneman, 2013).

CURRENT DESIGN



illustration depicting the special ability/character skill

ISSUE 3 – visibility of obsolete bonuses

Predicted issue: Players risk accidentally planning for or performing special ability bonuses that are no longer valid.

Recommendations for **redesign**:

- Add a token to the game which can be used to cover up the special ability the moment it becomes obsolete. As such, players are not confronted with outdated information when inspecting their cards. Instead, the token and covered-up skill suggests unavailability (Norman, 1998; Rekhi, 2018; Ware, 2004).
- By letting players perform an action of covering up the special ability of their character, the game design will force them to actively consider and dwell on the fact that the skill is no longer in use (Kahneman, 2013). This decreases the likelihood of them accidentally performing obsolete routine actions.
- In covering up actions that are no longer applicable, the game will furthermore adhere to standards of well-received modern board games such as Everdell (Wilson et al., 2018).



token covering up action in
Everdell (Wilson et al., 2018)

RE-DESIGN



ISSUE 4 – incorrect groupings

Predicted issue: Players may not understand which of the two illustrations has to do with sight preferences.

Problem description and **root causes**:

- The eye symbol depicting sight preference for the characters is placed in the middle between character skills (top row) and sight preferences (bottom row). Because of the similar distance and proximity to each row, players may not realize which one it should be associated with (Palmer, 1999; Wertheimer, 1938).



CURRENT DESIGN



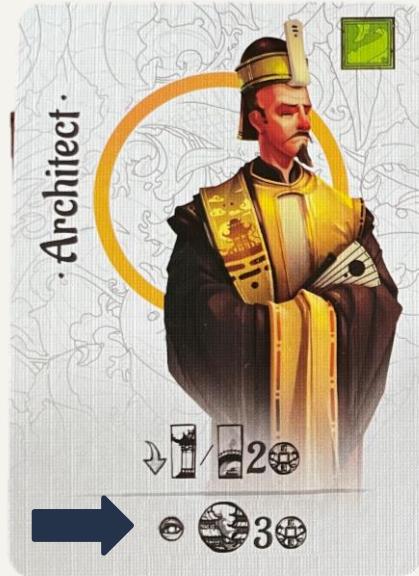
ISSUE 4 – incorrect groupings

Predicted issue: Players may not understand which of the two illustrations has to do with sight preferences.

Recommendations for **redesign**:

- Move the symbol depicting an eye down to the illustration it is supposed to be grouped with. Placing them close together will increase the likelihood of being perceived as belonging to the same group (Palmer, 1999; Wertheimer, 1938). This furthermore makes room between the top and bottom row, making it clear to players that they are separate from one another.

RE-DESIGN



ISSUE 5 – lack of guides for visual search

Predicted issue: Players risk spending prolonged stretches of time searching for icons on the landscape tiles identical to the one on their character card.

Problem description and **root causes**:

- Due to all icons being small black-and-white depictions, having no prominent features, nothing of note helps players in guiding their visual search (Duncan & Humphreys, 1989; Reijnen et al., 2007).
- Players may not realize that the circular color behind the depiction of their character is the color they are supposed to look for when trying to identify the relevant icon on the board. This lack of understanding occurs because the colored circle and the icon for sight preference are placed at separate parts of the card and thus do not appear to be grouped (Palmer, 1999; Wertheimer, 1938).

CURRENT DESIGN



ISSUE 5 – lack of guides for visual search

Predicted issue: Players risk spending prolonged stretches of time searching for icons on the landscape tiles identical to the one on their character card.

Recommendations for **redesign**:

- Add a circle in the correct color around the symbol, letting plays know what to look for amongst the many black-and-white icons. Having the color be right next to the icon makes it clear to players that they are grouped (Palmer, 1999; Wertheimer, 1938).



RE-DESIGN



Characters & Cards

Design Elements To **KEEP**



- The iconography at the bottom of each card helps players remember what the special abilities and sight preferences of their characters are and alleviates the toll on working memory (Baddeley, 2010; Sprevak, 2019).
- The same colors are generally used for the character cards and the corresponding base plate color, making them appear grouped (Johnson, 2021b; Palmer, 1999; Wertheimer, 1938).



d) Tokens

The following pages contain suggestions for redesigns of the various game *tokens*, including:

- Predicted issues
- Problem descriptions and root causes
- Recommendations for redesign

The core game is kept unaltered, while game pieces and layout may be subject to suggested alterations.



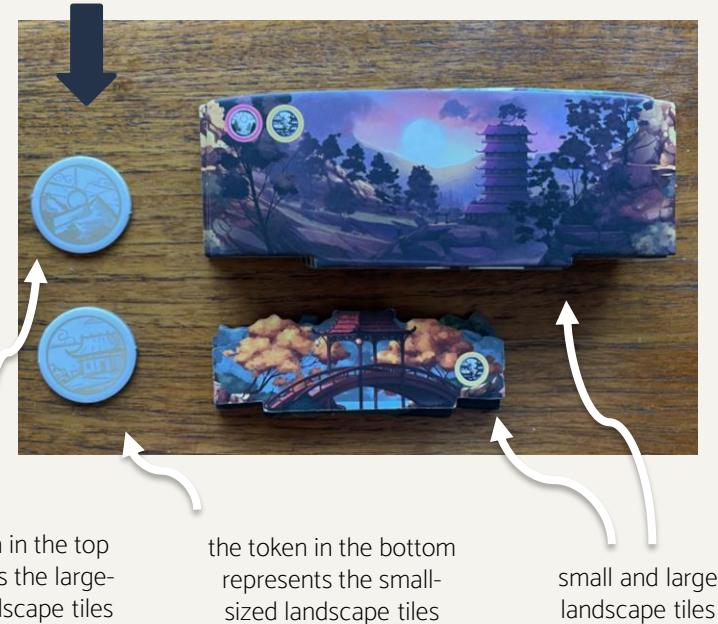
ISSUE 1 – reliance on vague associations

Predicted issue: Players risk mixing up which kind of landscape token goes with which size of landscape tile.

Problem description and **root causes**:

- The landscape tokens look very similar at a glance. Due to the poor resolution of human peripheral vision (Stewart et al., 2020), players will have to look more or less directly at the token to perceive its illustration.
- The illustrations on the tokens can be associated with their corresponding landscape tiles; mountain = large, cottage = small. However, this requires for players to make this association. Otherwise, they must rely on memory, which may increase cognitive load (Sweller, 2011).

CURRENT DESIGN



ISSUE 1 – reliance on vague associations

Predicted issue: Players risk mixing up which kind of landscape token goes with which size of landscape tile.

Recommendations for **redesign**:

- Decrease the size of the token that represents the small-sized landscape tiles. This makes the two types of tokens easily discernable at a glance (Stewart et al., 2020) and helps establish an additional layer of associations, in which; small = small, large = large (Johnson, 2021b; Vickery & Jiang, 2009).

CURRENT DESIGN



Token Design Elements To **KEEP**

- Some tokens are flippable. This decreases the cognitive load for players, since they do not have to keep it in working memory which ones they have already used (Sweller, 2011; Baddeley, 2010).
- The existence of a first-player token helps players keep track of turn-taking, which helps decrease cognitive load (Sweller, 2011).
- The existence of a placeholder token for gaining a new character likewise helps decrease cognitive load (Sweller, 2011) by allowing players to postpone certain actions without keeping it in working memory (Baddeley, 2010).
- Good use of illustrations helps aid memory recall (Sprevak, 2019).



e) Decorations

The following pages contain suggestions for redesigns of the various *decorational elements*, including:

- Predicted issues
- Problem descriptions and root causes
- Recommendations for redesign

The core game is kept unaltered, while game pieces and layout may be subject to suggested alterations.



ISSUE 1 – similar-looking symbols

Predicted issue: Players risk confusing some of the sight symbols on landscapes with one another.

Problem description and **root causes**:

- Players will likely experience difficulty if attempting to rely on verbal cues from inner speech when trying to identify some of the similar-looking sight symbols during their visual search (Lupyan & Swingley, 2012). For instance, “yellow layered building” may sound specific but could fit two different symbols.
- The similar-looking symbols are not always placed next to each other. Greater distances between the symbols comes with an increased risk of mixing them up due to imperfect visual working memory (Ricker & Cowan, 2010).

CURRENT DESIGN



similar-looking
illustrations and colors

ISSUE 1 – similar-looking symbols

Predicted issue: Players risk confusing some of the sight symbols on landscapes with one another.

Recommendations for **redesign**:

- Change the color of one of the circles, making them look less similar to one another (Johnson, 2021b).
- Stakeholders could also consider changing one of the illustrations, in order to put further associative distance between the two.

RE-DESIGN



different color hues
for the circles

CURRENT DESIGN

ISSUE 2 – visual search

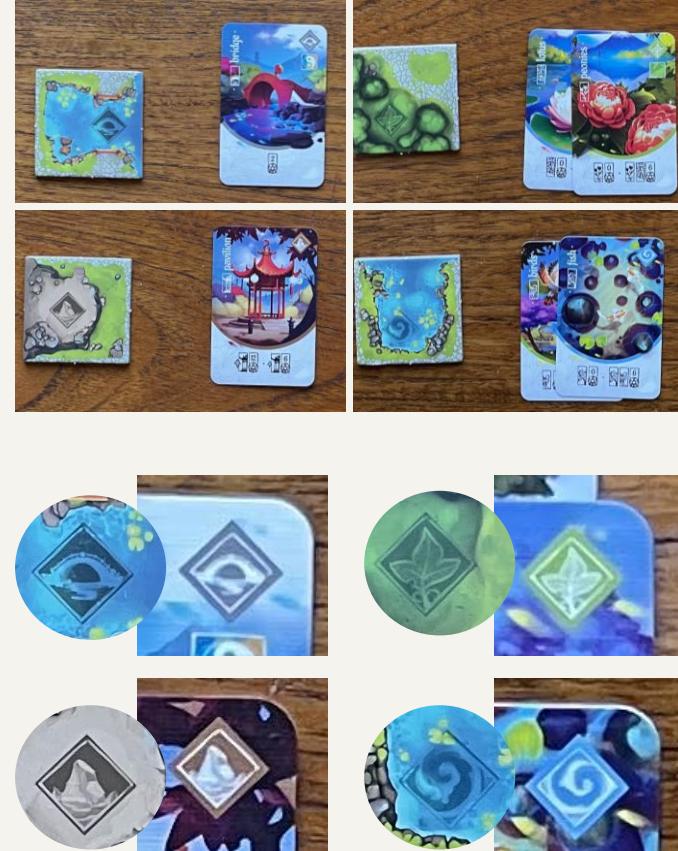
Predicted issue: Visual search may be performed slowly by players due to the symbols on the tiles not being identical to the references on the decoration cards.

Problem description and **root causes**:

- Players have to search among the tiles that have been played into the game board to find symbols matching the ones on their drawn decoration cards. This may happen slowly and inefficiently due to differences in coloring, since pattern recognition occurs faster for exact matches (Reijnen et al., 2007).

decoration cards and corresponding tiles that allow for placement of the specific decoration

zoom-in on the symbols that should be found during visual search (circles) compared to the references players will be looking for (squares)



RE-DESIGN

ISSUE 2 – visual search

Predicted issue: Visual search may be performed slowly by players due to the symbols on the tiles not being identical to the references on the decoration cards.

Recommendations for **redesign**:

- Make the symbols more similar between tiles and decoration cards by matching the colors and adding a white backdrop to the symbols on the tiles. This will make it easier for players to search for and identify the corresponding symbols (Reijnen et al., 2007).

decoration cards and corresponding tiles that allow for placement of the specific decoration

the symbols that go together are now identical to one another



Decoration Design Elements To **KEEP**

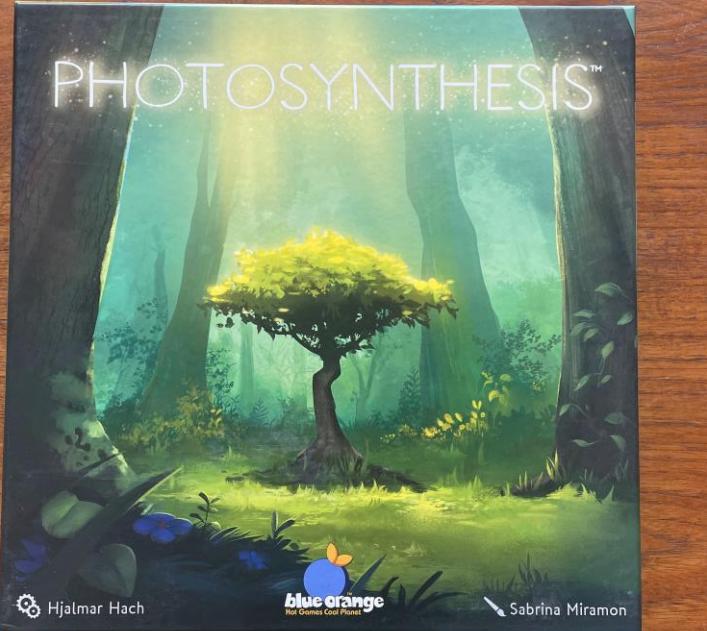
- Great use of symbols on decoration cards lets players easily remind themselves how the specific decoration type scores points (Sprevak, 2019). This reduces cognitive load (Sweller, 2011).
- A high degree of color and shape distinction between trees makes it easy for players to tell them apart (Duncan & Humphreys, 1989; Reijnen et al., 2007).
- Sturdy and tactile components may add to the experience (Elias et al., 2012b).
- Small-sized decoration cards make them appear to have other effects from the large-sized character cards (Johnson, 2021b; Palmer, 1999; Wertheimer, 1938).



03

Photosynthesis

(Hach & Miramon, 2017)



Summary:

In Photosynthesis (Hach & Miramon, 2017), players sow crops and grow trees based on shifting directions of shadows and light from the sun.

*Classification according to BGG database
(BoardGameGeek, n.d.):*

Weight/Complexity Rating: 2.26/5

Player Count: 2-4 players

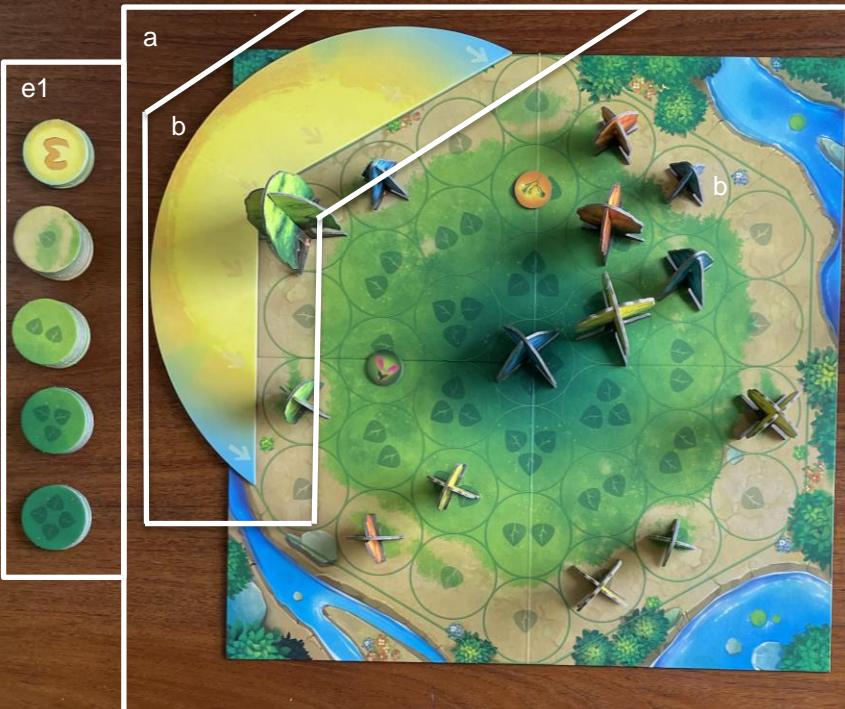
Type: Abstract, Family

Mechanisms: Action Points, Area Majority / Influence, Bias, End Game Bonuses, Hexagon Grid, Income, Progressive Turn Order

Overview of Game Areas

a) - Game board

The game board includes areas for placement of game components and the sun segment.

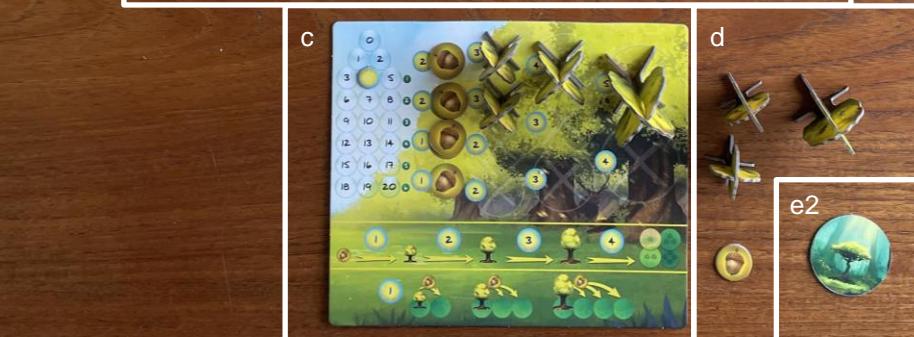


b) - Sun segment

The sun segment moves freely around the hexagonally marked edge of the game board.

c) - Player board

The personal player board lets players track currency and functions as a store for the playable components. Additionally, costs and actions are illustrated at the bottom of the board.



d) - Playable elements

Playable components that are ready to be put into play are set up by the player in their area.

e) - Tokens

Various tokens for scoring and upkeep.

* The board depicts a 4-player game: Note that player areas are only shown for two of the four players.



a) Game Board

The following pages contain suggestions for redesigns of the main *game board*, including:

- Predicted issues
- Problem descriptions and root causes
- Recommendations for redesign

The core game is kept unaltered, while game pieces and layout may be subject to suggested alterations.



ISSUE 1 – the marking for sun revolutions may be missed

Predicted issue: Players may not notice the small marking meant for keeping track of the revolutions of the sun component.

Problem description and **root causes**:

- Since the yellow spot is small and placed in the periphery, it risks going unnoticed (Stewart et al., 2020).
- The pale color and lack of contrast between the edge of the marking and the background illustrations make them bleed together, further heightening the risk of it going unnoticed (Johnson, 2021c, 2021b; (Katsuki & Constantinidis, 2014).
- If players do not notice the marking, they will have to rely on memory of the initial state of the sun, which takes up mental resources in the form of working memory (Baddeley, 2010; Sweller, 2011).



CURRENT DESIGN



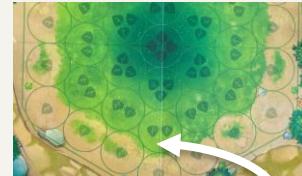
the marking for keeping track of sun revolutions is pale, small, placed peripherally, and blends with the background

ISSUE 1 – the marking for sun revolutions may be missed

Predicted issue: Players may not notice the small marking meant for keeping track of the revolutions of the sun component.

Recommendations for **redesign**:

- Increase the size of the marking and add color to make it catch the eye (Johnson, 2021c; Stewart et al., 2020).
- Increase the contrast between the edge of the marking and the background in order to make it pop out in its distinct shape (Johnson, 2021c).
- Stakeholders could also consider removing the water illustrations placed in the remaining corners, in order to avoid them drawing attention more so than the sun marking (Katsuki & Constantinidis, 2014; Lavie et al., 2014).



RE-DESIGN



no attention-grabbing blue areas

increased size and contrast

ISSUE 2 – mapping of point gradient

Predicted issue: Players risk missing that the center-most placement spot is worth more points than the surrounding area.

Problem description and **root causes**:

- Placement of trees are worth more points toward the center of the board compared to the edge, as shown with a color gradient representing soil fertility. However, the mapping of the color gradient does not follow the point gradient towards the centre. This may be cause of errors due to incorrect mental models (Gentner, 2001).
- The contrast between the background and the leaf symbols that mark fertility levels of 1, 2, 3, or 4, is quite low, making the symbols more difficult to discern (Johnson, 2021c; Mahjoob & Anderson, 2019).

the center-most placement spot is worth more points than the surrounding area



at a glance, represented by blurring the image, only three distinctly colored areas are visible

CURRENT DESIGN



ISSUE 2 – mapping of point gradient

Predicted issue: Players risk missing that the center-most placement spot is worth more points than the surrounding area.

Recommendations for **redesign**:

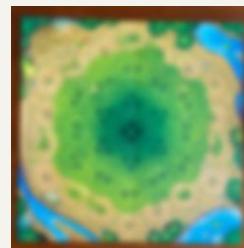
- Increase the contrast between background and foreground symbols towards the centre of the board to make the illustration pop (Johnson, 2021c; Katsuki & Constantinidis, 2014).
- Alternatively, the symbols in different areas of soil fertility can be colored according to their group, further suggesting to players that they differ meaningfully to one another (Palmer, 1999; Wertheimer, 1938).

see blurred images in the
bottom row for comparison

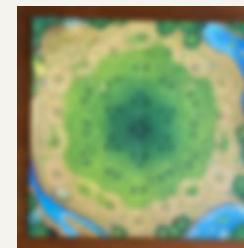
RE-DESIGN



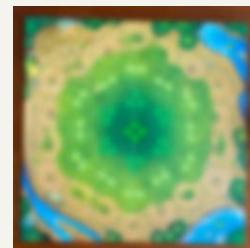
ALTERNATIVE
RE-DESIGN



redesign



current
design



alternative
redesign

Game Board Design Elements To **KEEP** ✓

- The board incorporates multiple representations of its point gradient by using both background color and symbols, making it more accessible for colorblind players (Shaffer, 2016).
- An aesthetically pleasing visual design improves the interaction experience and makes players more forgiving in terms of usability issues (Kurosu & Kashimura, 1995).

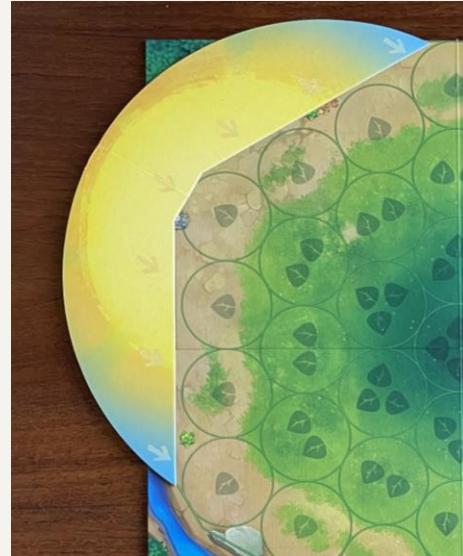


b) Sun Segment

The following pages contain suggestions for redesigns of the *sun segment*, including:

- Predicted issues
- Problem descriptions and root causes
- Recommendations for redesign

The core game is kept unaltered, while game pieces and layout may be subject to suggested alterations.



ISSUE 1 – placement

Predicted issue: Placing the sun segment in its correct placement spot risks being performed slowly and with difficulty.

Problem description and **root causes**:

- The margin for error when placing the sun segment is quite small, likely causing the action of placing the sun segment to be slow and deliberate (Fitts, 1954).
- The stopping mechanism is placed at the backside of the segment, forcing players to “feel around” for secure placement rather than lying the component down directly.

backside of sun segment with
“stopping mechanism”/edge



CURRENT DESIGN



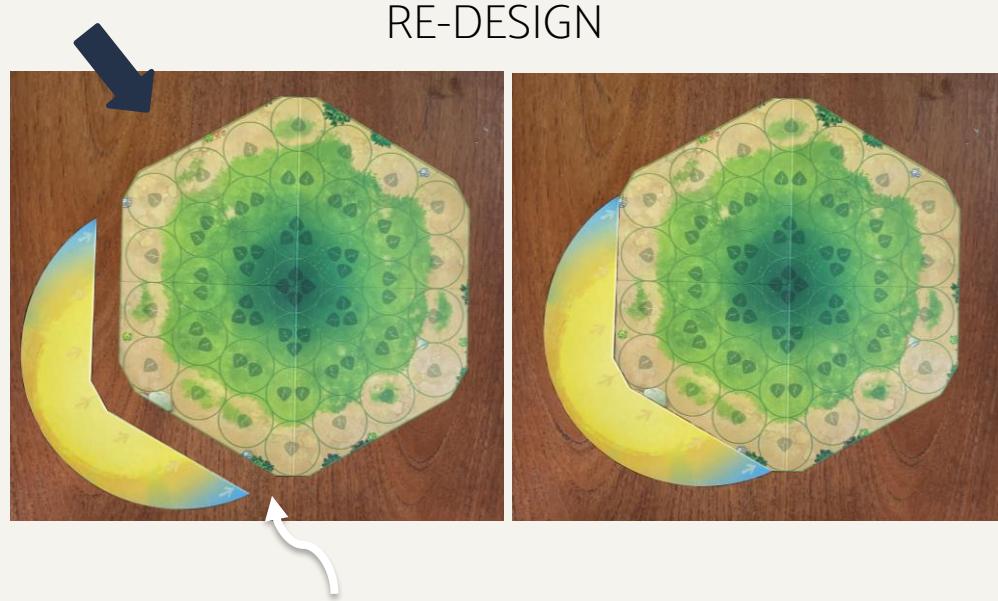
sun segment placed “out of line”
with the target edges

ISSUE 1 – placement

Predicted issue: Placing the sun segment in its correct placement spot risks being performed slowly and with difficulty.

Recommendations for **redesign**:

- Let the sun segment and border of the board share the same shape, making for an increased and more forgivable target size: This lets players efficiently place the sun segment in its correct spot (Fitts, 1954).
- In letting separate board components fit snugly together, the design adheres to standards (Yablonski, 2020) of games with attachments to the main board.



example of attachments to the main game board in the case of Everdell (Wilson et al., 2018) and one of its expansions

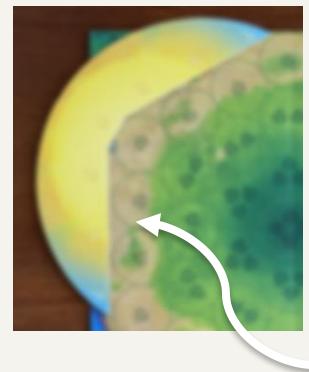
the long edges allow for faster and less deliberate placement – while placing it incorrectly becomes more difficult than placing it correctly

ISSUE 2 – discernability

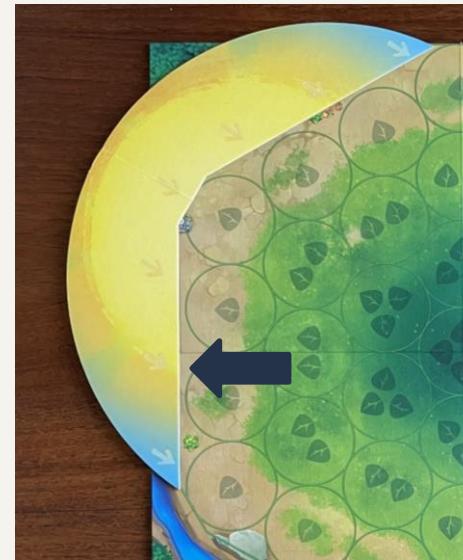
Predicted issue: The arrows indicating the direction of the sun beams could be missed by players.

Problem description and **root causes**:

- The low contrast and similar color palettes used for the coloring of the arrows and the sun itself make the arrows blend in with the background (Johnson, 2021c; Stewart et al., 2020), making them at risk of going unnoticed.
- For players with vision impairment, the lack of discernability is even more profound.



CURRENT DESIGN



when blurred, the 7 arrows
disappear almost completely

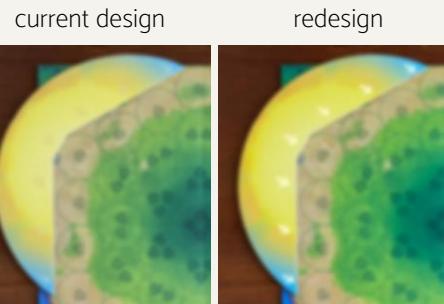
ISSUE 2 – discernability

Predicted issue: The arrows indicating the direction of the sun beams could be missed by players.

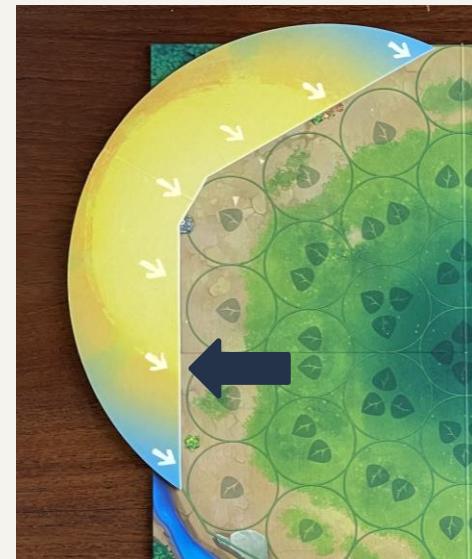
Recommendations for **redesign**:

- Increase the brightness of the arrows to make the contrast greater, consequently them more easily perceived (Johnson, 2021c, 2021b; Katsuki & Constantinidis, 2014).
- The tone should still be relatively muted in order to not draw too much attention outside of its purpose (Katsuki & Constantinidis, 2014) and to keep the aesthetically pleasing design (Kurosu & Kashimura, 1995).

a greater contrast makes the arrows more easily discernably – this becomes evident when comparing the blurred sun segment before and after redesign



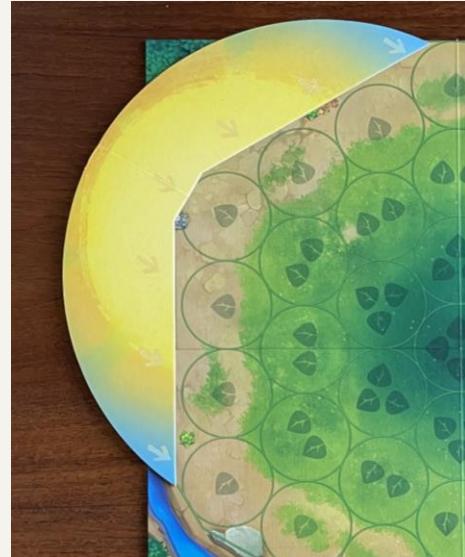
RE-DESIGN



Sun Segment Design

Elements To **KEEP**

- The physical interaction involved in the movement of the sun around the board lets players engage with the board game to a high degree, and ensures that they are never in doubt of where the sun is (Baddeley, 2010; Sprevak, 2019).
- The directional arrows help players identify sun beam directionality, as arrows are conventionally used for symbolizing direction (Yablonski, 2020; Westendorp & van der Waarde, 2001).

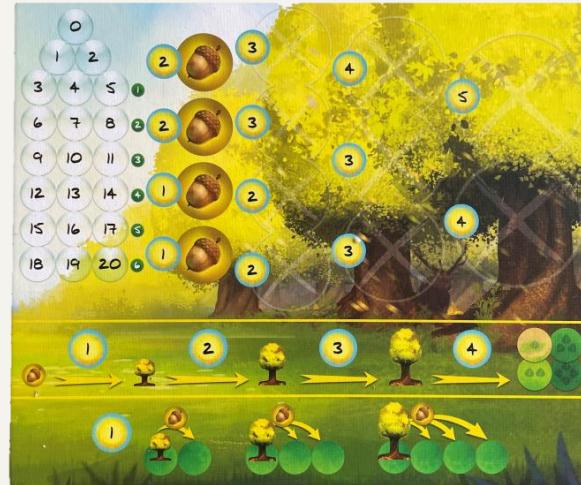


c) Player Board

The following pages contain suggestions for redesigns of the *player board*, including:

- Predicted issues
- Problem descriptions and root causes
- Recommendations for redesign

The core game is kept unaltered, while game pieces and layout may be subject to suggested alterations.



ISSUE 1 – inconsistent use of symbols

Predicted issue: The distinct meaning behind each of the arrows risks being mixed up.

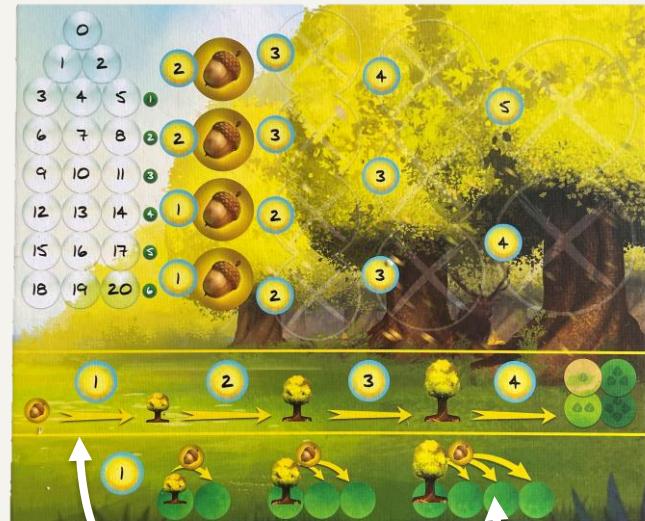
Problem description and **root causes**:

- The arrows depicted in the bottom two panels of the player board are very similar in appearance, but are used to convey two different concepts:
 - a) tree growth (*in which arrows represent time passing*)
 - b) seed spreading distance for variance tree sizes (*in which arrows represent physical movement*).

However, similar looking symbols are generally assumed to have similar functions (Johnson, 2021b).

- A slight difference between the arrows is present in the form of split ends for the arrows representing tree growth. The difference is however minuscule and may thus go unnoticed (Johnson, 2021c; Stewart et al., 2020).

CURRENT DESIGN



arrow representing
trees growing as time in
the sun passes

arrow representing
movement of a seed
away from its source
tree

ISSUE 1 – inconsistent use of symbols

Predicted issue: The distinct meaning behind each of the arrows risks being mixed up.

Recommendations for **redesign**:

- Replace one of the two sets of arrows, using a distinctly different design for the new ones.
- By letting the arrows vary with shape and color, they are more likely to be understood as representing different functionalities (Johnson, 2021b; Palmer, 1999; Wertheimer, 1938).
- Consider using a dashed line, which often represents something transitional (*The Visual Language of Dashed Lines*, n.d.), thus further helping the player interpret its meaning by adhering to conventions (Yablonski, 2020).

RE-DESIGN



the two types of arrows are now shaped and colored differently depending on symbolic function

ISSUE 2 – point tracking

Predicted issue: Players risk moving the light point tracker incorrectly.

Problem description and **root causes**:

- On the board, points go up as the light point tracker moves down on the board. However, points conventionally go up as trackers go up.
- There is currently no congruence between the directionality of movement and points gained. Having to override standard ways of interacting with point tracking may increase cognitive load (Sweller, 2011).

light point tracking occurs by moving the sun token down the board as more light points are gained

CURRENT DESIGN



ISSUE 2 – point tracking

Predicted issue: Players risk moving the light point tracker incorrectly.

Recommendations for **redesign**:

- Flip the point tracking area around, mapping it such that points go up as the tracker goes up. By adhering to standards, players are better able to interact with the components (Yablonski, 2020).
- The same progression of rows should be kept such that the point scale is the same as in the original layout.

current point tracking design
next to the suggested redesign



RE-DESIGN



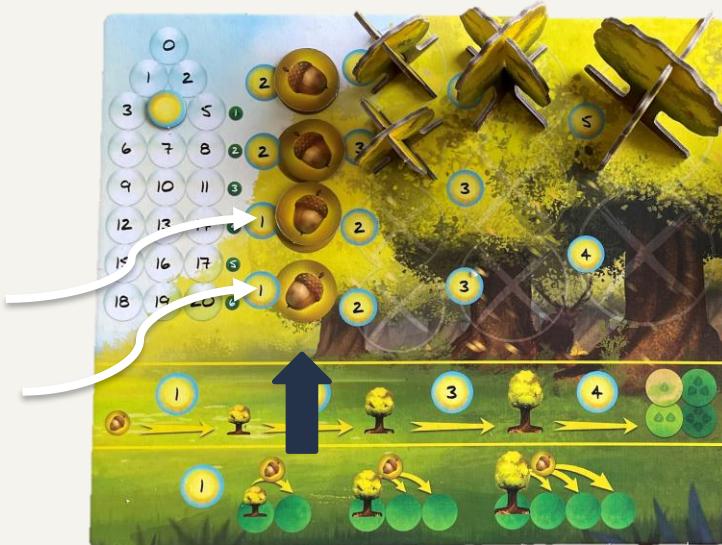
ISSUE 3 – token availability

Predicted issue: Players may find it difficult to see whether the designated spots for seeds are occupied or not.

Problem description and **root causes**:

- The designated spots for storing seed tokens are identical to the tokens themselves, making it difficult to see how many of the tokens are available for buying (Johnson, 2021c; Ware, 2004).
- Due to humans having quite poor peripheral vision (Stewart et al., 2020), players will have to look directly at the spots to see whether a token lies on top of it or not.
- No commonly used clues for suggesting availability or lack thereof is utilized.

CURRENT DESIGN



ISSUE 3 – token availability

Predicted issue: Players may find it difficult to see whether the designated spots for seeds are occupied or not.

Recommendations for **redesign**:

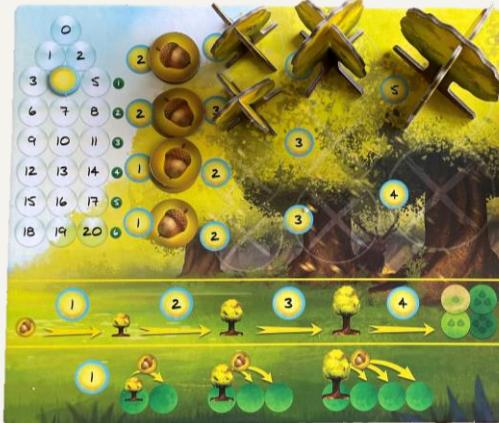
- Gray out the designated spots to suggest to players that they are unoccupied (Ware, 2004).
- At the same time, keep the illustration constant, such that the token and its spot will still be perceived as belonging to the same group (Palmer, 1999; Wertheimer, 1938), letting players know where to place the seeds.

RE-DESIGN



Player Board Design Elements To **KEEP** ✓

- The x-markings where cardboard trees are supposed to be placed do a good job of affording placement (Gibson, 1977; Nye & Silverman, 2012).
- The incorporated player aid in the player board frees up working memory resources and decreases the cognitive load (Baddeley, 2010; Sweller, 2011).



d) Playable Elements

The following pages contain suggestions for redesigns of the *playable elements*, including:

- Predicted issues
- Problem descriptions and root causes
- Recommendations for redesign

The core game is kept unaltered, while game pieces and layout may be subject to suggested alterations.



ISSUE 1 – similar-looking colors

Predicted issue: When mixed together on the game board, players may find it difficult to discern the differently colored trees from one another.

Problem description and **root causes**:

- Due to poor color perception in the peripheral vision (Stewart et al., 2020), players will likely find it difficult to get an overview of the different tree types. This is especially true for the yellow and green colored trees, which are close to each other in hue.
- The problem is further amplified for individuals with various types of color blindness, in which the ability to distinguish certain colors from one another is diminished (Mather, 2016).

CURRENT DESIGN



green-weak/
deutanomaly
color blindness filter



ISSUE 1 – similar-looking colors

Predicted issue: When mixed together on the game board, players may find it difficult to discern the differently colored trees from one another.

Recommendations for **redesign**:

- Change the colors of the trees to make them more easily distinguishable from one another (Johnson, 2021c; Mahjoob & Anderson, 2019).
- Make sure to check the visibility for both regular color vision and common types of color blindness.
- The division into themes of the four seasons can be kept, for instance by letting pink replace yellow for the spring theme.

RE-DESIGN



green-weak/
deuteranomaly
color blindness filter



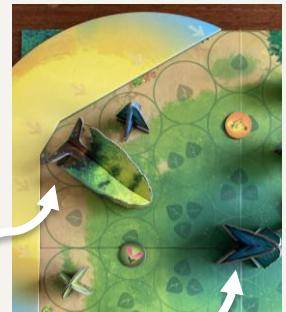
ISSUE 2 – mapping between tree heights and shadows

Predicted issue: Players may experience difficulty in mapping the heights of the trees with how much “shadow” they cast over other trees.

Problem description and **root causes**:

- The height of the trees and the “shade” they cast does not follow a 1:1 relationship, making understanding the mapping and forming a correct mental model less easy (Gentner, 2001).
- Humans are very attuned to perceiving light and shadows (Morgernstern et al., 2014) and have to manually “override” any naturally occurring shadows for the sake of the game.

tall trees are 2 “placement spots” in length but cast a shadow of 3 spots, excluding its own base spot



tree in “shade”

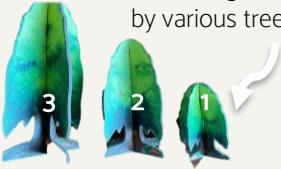
CURRENT DESIGN



depicts shadows,



depicts trees in shade



shadow lengths cast by various trees

ISSUE 2 – mapping between tree heights and shadows

Predicted issue: Players may experience difficulty in mapping the heights of the trees with how much “shadow” they cast over other trees.

Recommendations for **redesign**:

- Elongate the tall and medium sized trees to make them appear similar in size to the length of their “shadow”, facilitating the formation of correct mental models (Gentner, 2001).
- Greater size differences between the trees also makes them more easily discernable from one another (Duncan & Humphreys, 1989).
- Alternatively, stakeholders may add a sort of ruler or measuring device to free up mental resources (Baddeley, 2010; Sprevak, 2019).



the tall tree is now
equally as long as its
shadow

RE-DESIGN



depicts shadows,



depicts trees in shade



Playable Elements Design Elements To **KEEP** ✓

- The shape of the trees vary, which helps players, including those with color deficiencies, in telling them apart on the board. The blue trees are especially easy to discern due to their unique shape (Mahjoob & Anderson, 2019; Shaffer, 2016).
- Consistency in the tree color and the color of its seeds make them appear as belonging to the same group (Palmer, 1999; Wertheimer, 1938).



e) Tokens

The following pages contain suggestions for redesigns of the various game *tokens*, including:

- Predicted issues
- Problem descriptions and root causes
- Recommendations for redesign

The core game is kept unaltered, while game pieces and layout may be subject to suggested alterations.



ISSUE 1 – currency

Predicted issue: Players may experience a disconnect between the functionality of the sun token and the way the game makes them interact with it.

Problem description and **root causes**:

- The currency for buying and growing trees is sunlight, which is tracked with the sun token by moving it around on the player board. However, such markers are conventionally used for tracking points, which may cause players to have the wrong expectations (Gentner, 2001; Yablonski, 2020).
- The act of paying for something is analogous to actions that can be performed in real life. However, no payment method in real life resembles the act of moving a tracker, so no transfer of learning occurs (Leberman et al., 2016).
- Players may find it difficult to place and move the sun marker correctly due to the small size of the target (Fitts, 1954).
- Having 0 sun currency leaves the token still visible to players, wrongly suggesting (Ware, 2004) to them that they still have some currency left.

CURRENT DESIGN



ISSUE 1 – currency

Predicted issue: Players may experience a disconnect between the functionality of the sun token and the way the game makes them interact with it.

Recommendations for **redesign**:

- Adhere to standard by letting the sun tokens function as individual coins rather than as a tracker (Yablonski, 2020). In doing so, free up the part of the player board previously used for tracking.
- The lack of sun tokens represents a meaningful zero point, making it clear to players that no currency is left for spending.
- The lack of designated areas for the tokens lets players avoid having to hit precise targets, making them able to interact with the tokens less precisely and with less effort (Fitts, 1954).



RE-DESIGN



Token Design Elements To **KEEP**



- A first player token helps players keep track of the current round while decreasing the cognitive load associated with keeping track of it in working memory (Baddeley, 2010; Sprevak, 2019; Sweller, 2011).
- The point tokens are identical to different areas of the board, making them appear grouped and letting players know from which stack to draw from (Palmer, 1999; Wertheimer, 1938).



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Rule books

Rule books can be found online for each of the reviewed games, following the links provided below:

O1 – Haven

https://static1.squarespace.com/static/57d708c929687f67b6429112/t/5bbe767f41920241a7e45d5b/1539208854687/haven+rulebook_03.pdf

O2 – Tang Garden

<https://www.ultraboardgames.com/tang-garden/game-rules.php>

O3 – Photosynthesis

https://ilo307.com/public/pdf/BO-PHOTO-002_RULES.PDF