

Team 13

Design Showcase 1 Report

Table of Contents

0.0 Executive Summary.....	3
1.0 Empathize phase.....	4
1.1 Summary.....	4
1.2 Stakeholder map.....	5
1.3 Tasks, Tools, Environments, and Values.....	6
1.4 Scenarios within Problem Space.....	6
1.5 Situation Impact Statement.....	7
2.0 Define Phase.....	8
3.0 Ideation Phase.....	11
3.1 Reflection of the SOC, Requirements and Constraints.....	12
3.2 SWOT Analysis.....	12
4.0 Magic Low Fidelity Prototype.....	13
Appendix.....	15

0.0 Executive Summary

This report summarizes the first half of the design process used for the BME 161 final project. The purpose of this project is to adapt the *Settlers of Catan* board game to be more accessible to those experiencing tremors resulting from conditions such as Parkinson's disease and Multiple Sclerosis. This design process included 4 steps: an empathize phase, a requirement definition phase, an ideation phase, and a low fidelity prototype.

In the empathize phase, research was conducted to further medical understanding of tremors, their variability across diseases and stages, and their impact on gameplay. These sources guided the creation of stakeholder maps to identify direct and indirect stakeholders, ultimately focusing on players with tremors as the primary stakeholder. As well, a list of tasks, tools, environments, and values was created to capture how various game elements could affect the player. Finally, scenarios were created to illustrate how value tensions caused by tremors affect players of Catan, leading to the creation of a situation impact statement to better define the project goal.

In the requirement definition phase, a needs hierarchy was made and then refined into a requirement and constraint table. A key requirement identified as the major focus of this project is for the different game components to remain stable on the game board and remove the possibility of them being knocked around.

The ideation phase consisted of divergent and convergent ideation sessions. During the divergent session, a wide range of ideas were generated without feasibility limitations. These ideas were then refined into four main project ideas during the convergent phase. Each concept was analyzed using a SWOT framework, and overarching trends and themes were identified and discussed. Based on these findings, some changes to the requirement and constraint tables were made. Concept sketches of the most promising ideas are presented in the report after the above.

Finally, a low fidelity prototype was created using common household items such as cardboard and a hot glue gun. Pictures of this prototype are included in this report, as well as a figure explaining the key modifications of the board game to improve accessibility.

Future focus will be placed on creating a functional prototype.

1.0 Empathize phase

1.1 Summary

This project aims to adapt the board game *Settlers of Catan* to the needs of people who suffer from tremors (Parkinson's Disease, Multiple Sclerosis, etc). The idea was to make the game more accessible to a broader population of diseases and symptoms while maintaining the essence of the game. Catan gameplay includes the addition of small pieces (roads and settlements) to a board composed of multiple hexagonal shapes. The game is very motion sensitive, as pieces may get knocked over and placed in the wrong spot, becoming an issue for people with tremor symptoms. Initially, broader accessibility issues, including visual and cognitive barriers, were considered; however, they were excluded from the design scope as they did not directly relate to the motor inaccessibility focused on in the project. Multiple focuses within the scope of tremors in gameplay were examined as part of the initial research:

Medical Definition

Tremors are involuntary, rhythmic shaking movements caused by neurological dysfunctions [1] [2]. However, this definition does not encapsulate the personal anecdotes of those who experience tremors. There are often no trends to the tremors, which makes it hard to classify in terms of design; there aren't many defined levels, as tremors differ between individuals. Therefore, it is important to consider that the solution must be flexible to different levels of tremors. Throughout the research, it was highlighted how motor impairments can interfere with day-to-day activities, which suggests the severity tremors can achieve and how that must be considered in design catered towards it.

Physical accessibility

When approaching a board game design to make it more accessible, it is important to acknowledge that not all inaccessibilities are physical [3]. However, when focusing on physical disabilities, some common discrepancies to gameplay include accidental movement of pieces, picking up, placing pieces and more. Across the research done, it was stressed that larger, more tactile components and stabilized game boards would reduce accidental movement and increase usability [3][4][5]. When approaching similar board games, many developers chose this tactic; however, it assumes a lot about the physical disabilities' limits and therefore is not a solution to all tremor-based problem scopes. In addition, it is important to consider all processes of gameplay, including setup and takedown [3].

User Perspective

Throughout the conducted research, most articles describe the alienation of most accessible designs; highlighting playtime increase, component overload and complex use as sources of exclusion [2]. The source then says that simplifying layouts, digital aids, and tactile markers are a few of many ways to maintain user experience while making the game accessible. All of which were considered as approaches and implemented in the project's design space by assuming the tasks and needs that would require these solutions. With the trend of user perspective importance amongst articles, it is clear that advocacy for accessibility should be integrated from the start of the design process [6][7].

In summary, the research revealed the importance of user-focused design and understanding tremors and their effects on day-to-day activities. Several stakeholders were removed as a result, including people with cognitive or visual disabilities, as they did not fit the design space focus. The challenges differ greatly from motor control and would result in a more complex board game setup, decreasing user experience as mentioned above.

1.2 Stakeholder map

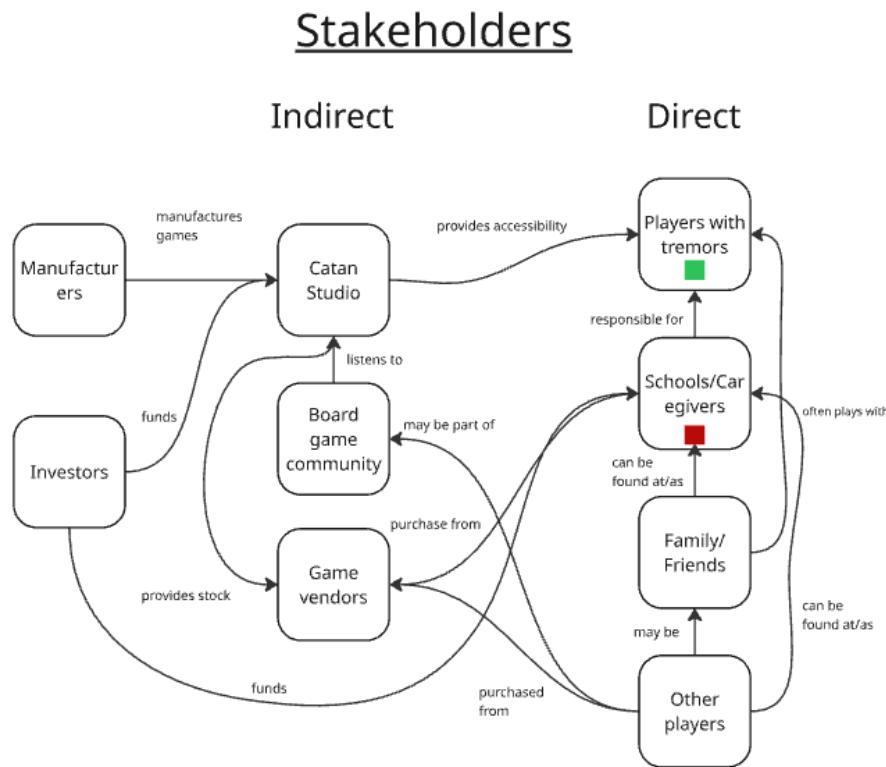


Figure 1. Stakeholder map

The direct stakeholders include players with tremors, relatives or friends, and schools or caregivers. These are the primary groups of individuals this project will focus on directly. Players with tremors provide feedback for accessibility and their needs are most greatly impacted, while family and friends would be most familiar with playing against players with tremors. With players with tremors, especially Parkinson's, caregivers are often found to play a large role in caring and aiding in daily activities. Similarly, schools may play a role for those who are younger with tremors. Thus, they are also a group of focus since they are often engaged with the gameplay when the players themselves play. Other players may also occasionally play on these boards, although not as often as caregivers or family.

Indirect stakeholders include the game studio/publisher, game vendors, and the board game community as a whole. The game studio communicates with direct stakeholders by providing accessibility for players with tremors, while also being influenced by the board game community as a whole. Game vendors are stakeholders who must purchase games from the game studio and sell the product for profit.

Other indirect stakeholders include manufacturers and investors. Manufacturers communicate with the game studio to ensure resource constraints are dealt with and regulations are met. Investors communicate with the game studio, as well as schools, to provide funding for producing and purchasing accessible board games.

1.3 Tasks, Tools, Environments, and Values

The following are the tasks, tools, environments, and values the stakeholders may encounter:

Tasks	Tools	Environments	Values
<ul style="list-style-type: none"> - Picking up pieces and placing them down in specific positions - Maintaining the board setup - Sitting down for long frame play - Reaching all parts of the board to place pieces - Picking up cards - Communicating with players - Setting up the Catan board - Trading Cards - Picking up and throwing dice - Managing turns - Distributing pieces/cards 	<ul style="list-style-type: none"> - Dice - Settlements - Border tiles - Cities - pieces - Robber piece - Road - pieces - Hexagon Tiles - Cards 	<ul style="list-style-type: none"> - Board game cafe - Living/Dining room - library - Eng-soc office - Park - Dorm lounge - Therapy rooms - Community Centre - Retirement Homes 	<ul style="list-style-type: none"> - Having fun - Efficient - gameplay - Inclusivity - Maintain - dignity - Competitive - Fair gameplay - Engaging - The essence of Catan is enjoyed by everyone - Inclusive - Social - Connection - Respect amongst players - Accessible

Table 1. Stakeholders' tasks, tools, environments and values

1.4 Scenarios within Problem Space

Scenario #1:

A father who has grown up with tremors comes back from a long day of working at the local TD bank. He opens the door and finds his family waiting for him in the living room. They tell him they have bought a board game, Catan, and are waiting to play with him. They open the box and start to set up. The father attempts to take the tile pieces and lay them out as a puzzle described in the instructions. He finds that the tiles keep shaking with his hand and are being set down where he wants them, always being shaken and moved. Eventually, with some help from his family, the game is set up. After his wife and kids, it is his turn to roll the dice to determine who picks settlements first. He fumbles the dice when picking them up, and then, through his tremors, the dice scatter pretty far when he throws them. He goes second for placing a settlement, and as he places down a settlement and a road on the desired tile, the board shakes slightly as he puts them down, and his son's settlement and road that were placed first are moved slightly. As the game continues, whenever he wants to place a piece, he shakes the board or risks moving his or another piece. He struggles with the continuous use of dice, which he must attempt to pick up and toss in an orderly fashion. Additionally, taking cards for resources and placing them or trading them without the game is difficult with constant tremors. The game takes longer than needed and is unnecessarily frustrating for all players involved.

Scenario #1 Discussion:

This scenario highlights how inaccessibilities within the board game Catan can cause difficulties with social interaction, even amongst family, for people with a motor impairment, such as tremors. This disrupts a common norm of fathers being the ones to help others instead of asking for help themselves. There is a big value tension between the Father (someone with tremors), who needs support and to maintain dignity amongst his loved ones. Needing help with small tasks like throwing dice, placing pieces, and trading cards not only diminishes the user experience, but it also results in longer playing times. When pieces get knocked over or a player needs help with one of these simple tasks, asking for help can be embarrassing. When the player has trouble with simple tasks it affects their dignity, and they may choose to keep it which can impact others in the long term.. This scenario shows how the player, environment and pieces react and highlights that the most attainable solution would be to adjust the pieces or board rather than the person or environment.

Scenario #2:

A group of friends just finished their midterms and decided to do something to celebrate. One person suggests a board game cafe. Another girl thinks to herself about how this may not be as fun for her, as she suffers from tremors often. When they reach the cafe, the girl suggests playing *Spot It*, a game that doesn't require much intricacy. After a couple of rounds, the group gets bored, and someone says they want a more complex game; another suggests Catan. When they bring out Catan and explain the rules, while those who have played before set up, the girl with tremors listens and looks at the small pieces and the insecure board. When it is her turn, she asks her friend to roll the dice for her and place the piece where she wants it. She finds herself continuously asking her friends to place pieces, pass cards, and roll the dice as she decides the plays. As the game continues and there are more pieces on the board, she fears reaching across and adding pieces or throwing the dice and accidentally knocking over something. When she does go to pick up a card, her hand shakes and pushes the chips and pieces on the tile slightly. As the other group members reset the pieces, she decides to continue playing as she was. Although this way of playing is not as engaging or fun for her, she is happy she is not wrecking the game for others.

Scenario #2 Discussion:

This scenario highlights the social stigma and self-consciousness that can come from having a disability that may impair the experience of others. Out of fear of disrupting gameplay, the player with tremors sacrifices their own experience, which would be a value tension. There is also a value contrast between the player's friends who hope to alleviate the player's stress and the player who does not want to bother their friends. These contrasting values of the player and between the player and friends cause the game to be less enjoyable and disrupted but the physical barriers of the game.

1.5 Situation Impact Statement

Design an adaptive *Settlers of Catan* system for players with hand tremors from neurological or motor-control disorders that enables rolling dice, picking up and placing pieces, managing cards, and maintaining board order with ease and precision. The product should be intuitive to use and allow players to participate in the game flow without loss of speed or enjoyment.

2.0 Define Phase

Stakeholder statement	Need statement
"I keep knocking over the roads and settlements and accidentally shifting the tiles when I reach across the board."	Stability and control while playing the game
"I keep dropping the pieces when I pick them up, and the cards slip out of my hands when I try to hold them."	Ease of handling and reduced use of fine motor skills throughout the game
"Small pieces are hard to place on the board."	Accessibility and independence while playing the game
"I cannot reach the other side of the board because it takes up too much table space."	Individual comfort and an enjoyable experience while playing the game

Table 2. Stakeholder need statements

Description	Details
R.1 Facilitate easy grip for individuals with dexterity issues [5]	R1.1 Tactile R1.2 Pieces are large enough to pick up with limited dexterity R1.3 Lightweight R1.4 Easy to pick up
R.2 Maintains stability for sudden movements across the board [8] [7]	R2.1 Pieces remain in place when nudged R2.2 Pieces remain in an upright position
R.3 Visually simple for people with tremor-related issues [9]	R3.1 Colours are easy to distinguish, fonts and symbols are readable R3.2 Easy to tell where each piece goes
R.4 Keeping the vital characteristic of Catan [6]	R4.1 Pieces do not change the rules of the game R4.2 Pieces do not drastically change the look of the game
R.5 Keeping the board reachable from all areas for people with mobility issues [9]	R5.1 The layout of the board allows for effortless reach wherever necessary

Table 3. Requirements Table

Description	Details

C.1 Does not infringe on copyright [10]	C1.1 No reproduction or distribution without approval
C.2 Deliver on Budget	C2.1 Must be affordable to produce C2.2 Must be affordable to purchase
C.3 Complies with board game safety standards [11]	C3.1 Must be constructed out of safety-approved materials C3.2 No sharp edges, corners, or very small parts C3.3 Must not be flammable
C.4 Time	C4.1 Must be able to be constructed in less than a month

Table 4. Constraints Table

2.1 Stakeholder Needs and Design Implications

Settlers of Catan is a game that involves many small physical components that are constantly moved across the board. People who have Parkinson's disease may experience tremors that could make any tasks involving fine motor skills, such as placing settlements, picking up cards, and rolling dice, more difficult.

One of the most important needs for the user is stability while playing the game. Users with tremors may struggle to keep all pieces on the board stable and upright, which may lead to an unpleasant playing experience. They need a playing surface where components stay stable and are resistant to any sudden movements. A requirement for the design is to improve the physical stability of each component to make it more inclusive and enjoyable for players with tremors. Pieces should maintain stability when unintentionally bumped on the board. This may affect the design of the game moving forward because the pieces and the board should have a mechanism that allows them to click into place. This design could include altering various components of the game so that the pieces use an interlocking or magnetic system to maintain contact.

For stakeholders, a need is for accessibility and independence. With Catan being a game where players are placing and moving pieces across the board, it can be less accessible for players with dexterity issues. This may hinder their independence when playing, as they might have other players move their pieces to the other side of the board due to restricted reach across the board. Addressing this need ensures inclusivity and user satisfaction, guiding the design project toward features like larger, textured components, card holders, or magnetic pieces.

Regarding the movement of the pieces, it is an important need for users to have ease of handling and reduced use of fine motor skills when using the various components of the game. Each component of the game that requires precise placement should be made thicker and larger to make it easier to pick up, especially for individuals with limited motor control. This might affect the design moving forward because the design of each piece should be adjusted to ensure that the pieces are large enough to grab onto without extreme precision. The overall board design would still have to be compact, so that is an aspect of the game components that would be compromised. These adjustments would make the Catan gameplay more comfortable and enjoyable for users with limited control over their hand motions, while still keeping the original feel of the game.

Individual comfort and an enjoyable experience are other essential needs for stakeholders during gameplay. With tremors, reaching across the board while holding pieces can be a challenge, causing frustration and reducing the enjoyment of the game. Addressing this requirement is essential to ensuring that all players can comfortably access and interact with the board without physical strain. This may involve redesigning the board to be more compact so that all areas are within easy reach. These modifications are important in order to create a version of Catan that is welcoming and inclusive, improving user satisfaction, gameplay flow, and the overall social experience of playing together.

3.0 Ideation Phase

During the convergent ideation sessions, several design concepts were evaluated to improve accessibility in board games for players with limited motor control. A SWOT analysis was conducted for each concept to determine overall feasibility and inclusivity. The main ideas included click-in game pieces that connect securely into place, roads embedded in the game board that light up with a player's colour when tapped by them, a claw machine mechanism to assist with piece movement, and a card trading app as an alternative to physically holding cards. Refer to *Figure A2* for the detailed SWOT analysis on each concept. Each concept was assessed based on feasibility, user experience, inclusivity, and the ability to maintain the social and tactile qualities of how Catan is played traditionally.

There are a few key themes across all of the solution concepts, the biggest was the desire to include technology and software. For example, the claw machine and card trading app introduce different methods of interaction (mechanical and digital) to make gameplay easier for all users. Similarly, the click-in pieces and light-up roads both prioritize physical accessibility by reducing the need for fine motor precision. One reason the click-in pieces were chosen as the most promising idea was that it is the sole option without technology embedded. Although technology has incredible benefits, click-in pieces can be more feasibly made within the time and budget constraints listed in the constraint list. This would also make the final product more affordable to the general population.

A strong trend toward balancing tradition with innovation was also evident. Many ideas attempted to preserve the charm of the original board game while including modern solutions such as automation, electronics, or digital integration. For instance, the light-up roads and card trading app pushed toward both physical and digital play. However, the SWOT analysis showed that it is hard to balance both goals. Making the game more modern can make it more exciting and inclusive, but it might also push away players who prefer the classic version of the game, leading to the click-in pieces being the best option.

As well, each concept aimed to make the game easier for everyone to play, without making those without disabilities feel excluded or as if the gameplay is impeded by the accessibility aid. The claw machine idea, for instance, turns an accessibility aid into a fun, interactive feature that all players can enjoy. This shows an effort to move away from designing purely assistive tools and toward inclusive design that benefits everyone. Additionally, sustainability was considered when choosing the final idea. Many of the weaknesses and threats addressed issues such as the use of plastic, power, and electronic requirements.

3.1 Reflection of the Situation of Concern, Requirements, and Constraints

The SOC, requirements, and constraints enabled us to understand the needs of the stakeholders and determine which solutions and designs would be most beneficial for them. The SOC gave us more insight into the struggles that the stakeholders face when playing board games such as Catan, which allowed us to develop the most important need statements for the SOC. Based on the need statements, design requirements were created, which gave the group a clear idea of the specific elements that would give players the most enjoyable experience. Refining and detailing the requirements allowed us to think of design solutions that fit into the guidelines and could be considered for the final design. The constraints also gave us an idea of whether the design would be realistic or not, which was essential for developing the current prototype.

It also had to meet the requirements and constraints identified earlier, such as accessibility, usability, cost, and the overall experience for players. The SWOT analysis (refer to *Figure A2*) was especially helpful because it made us evaluate each concept from several angles, including its strengths, weaknesses, opportunities, and threats. This allowed the group to narrow down which design should be pursued, as the SWOT analysis provided a deeper understanding of how feasible each design was and which designs would be the most valuable to the stakeholders.

For example, the claw machine idea seemed fun and engaging, and it supported accessibility by reducing the need for fine motor movement. However, it had a lot of mechanical complexity, would need a power source, and would likely be too expensive to produce and sell. The card-trading app had potential for digital interaction, but it went against one of the main goals within the problem space: maintaining the original feel of the game. It also created barriers for people who do not have access to smartphones.

After comparing all of these ideas, the consensus amongst the group was that the click-in pieces concept was the best choice. As shown in *Figure 2*, the design chosen ultimately met the goals of the SOC the most effectively. It keeps the gameplay tactile and interactive while remaining simple, affordable, and accessible. The SWOT analysis showed that it had few weaknesses and strong potential for usability and manufacturing. Unlike the other concepts, it did not rely on technology or complicated parts, which made it a realistic and inclusive solution. The Empathize and Define phase helped us better understand the importance of creativity, practicality and how design choices must always connect back to the real needs of the stakeholders.

3.2 SWOT Analysis

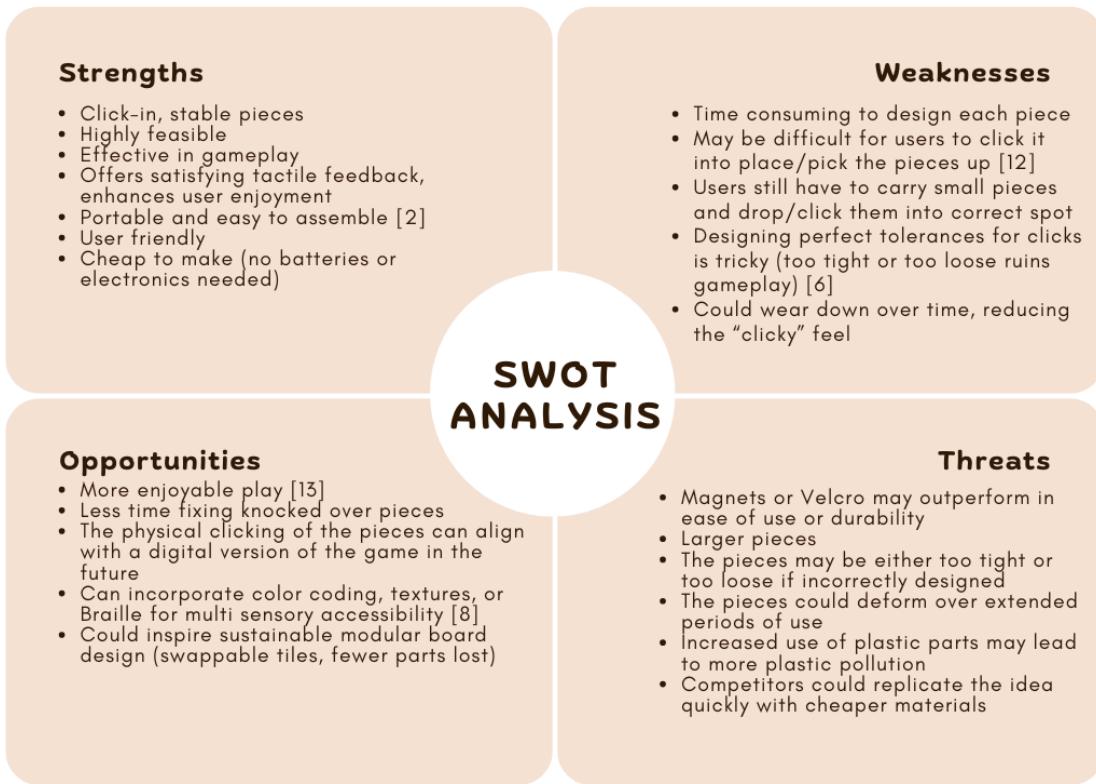


Figure 2. SWOT Analysis of the most promising idea

The concept of game pieces that fit into place on the board seemed the most promising, as it shows strong potential as a functional and engaging design. Its main strengths include being highly feasible, user-friendly, and cost-effective since it does not rely on batteries or electronics.

The tactile feedback enhances user enjoyment and creates a stable, portable, and engaging gameplay experience that is easy and fun to assemble. This change in design would not only affect the main stakeholders but also all players by reducing the frustrations caused by moving pieces.

However, there are also several weaknesses and risks. Designing each piece will be time-consuming, and designing a system for pieces to click into place could be challenging: pieces that are too tight or too loose could disrupt gameplay. Over time, wear and tear might reduce the efficacy of the click mechanism. In addition, users still need to handle small pieces, which could pose some issues. Although the idea of pieces fitting into place helps those with mild hand tremors, actually placing the pieces might pose a problem to those with grip issues or severe tremors.

Opportunities exist in making the design more inclusive through colour coding, textures, or possibly Braille. Nonetheless, potential threats include competition from magnetic or Velcro-based alternatives, which may be easier to use or more durable, as well as environmental concerns from increased plastic use.

4.0 Magic Low Fidelity Prototype

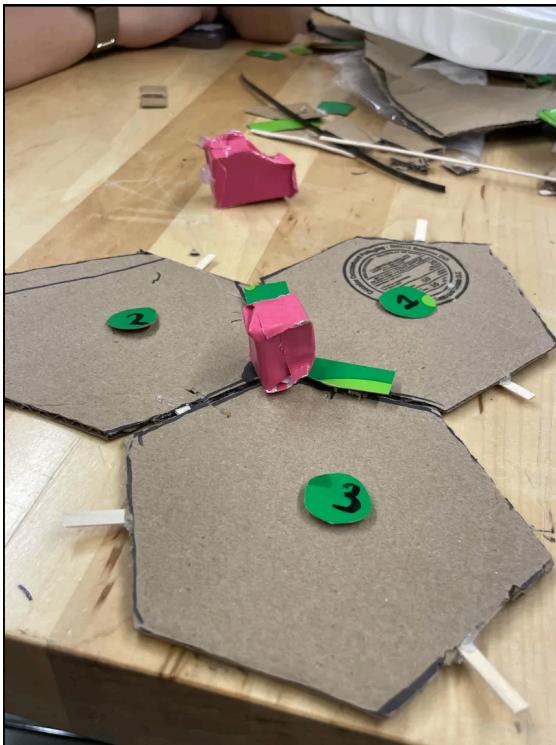


Figure 3. Low-fidelity prototype side view



Figure 4. Low-fidelity prototype without attachments

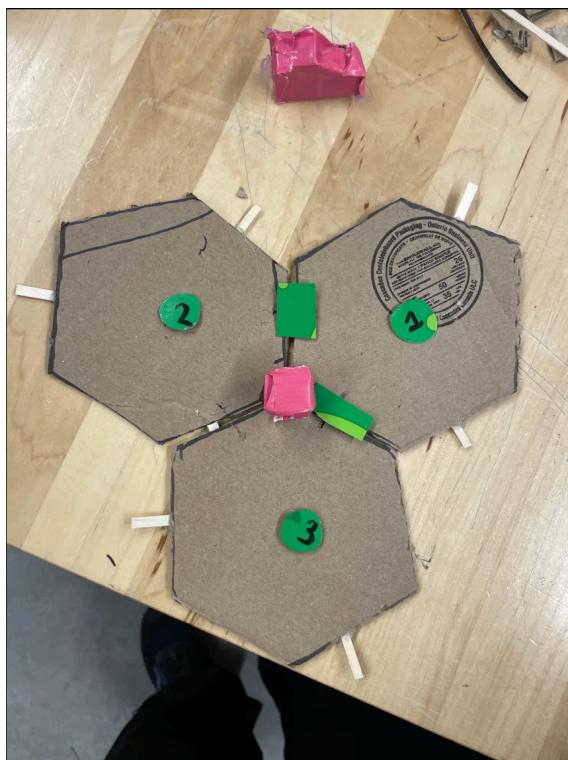


Figure 5. Low-fidelity prototype top view

This design is targeted at individuals with tremors or those with limited fine motor skills. As shown in *Figure 3*, the low-fidelity prototype increases the size of the various components of Catan. This included making the tiles thicker and making the roads, settlements, and numbers larger to allow for less precision to be required when placing down the pieces and for players. *Figure 4* shows the adjustments made to each component of the game. On the side of each tile, there is a mechanism that allows neighbouring tiles to click into place gently. This keeps the pieces from moving whenever the board is shaken or nudged. The settlements, shown in *Figure 4* in pink, have a magnet attachment on the bottom, and there is a magnet attached to the board between the intersection of each tile, allowing the settlements to easily connect into place, requiring less precision and increasing stability. There is an indentation perpendicular to the length of the roads, shown in *Figure 5*, which lets the roads also click in place, ensuring that they do not shift around the board. Refer to *Figure A1* for more details.

Appendix

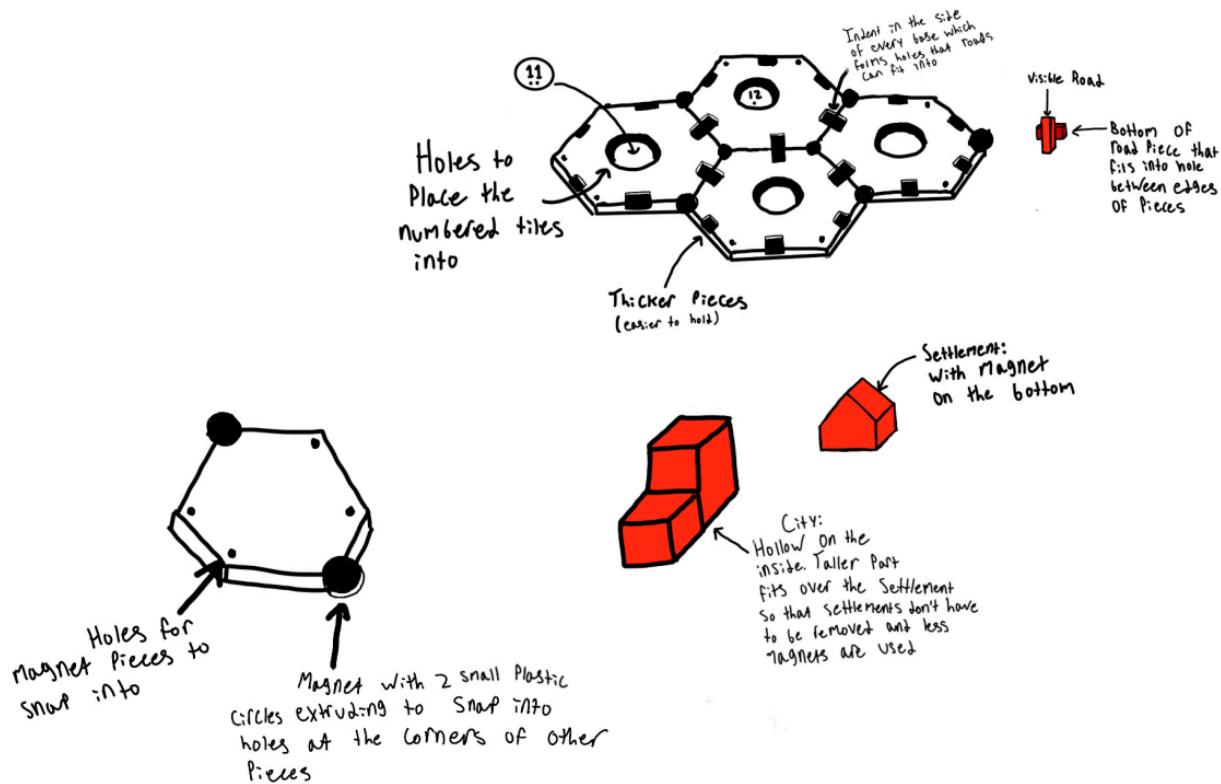


Figure A1. Concept sketches

SWOT analysis

Ideas	Strength	Weaknesses	Opportunities	Threats (other alternatives)				
Claw machine picking up Catan pieces	<ul style="list-style-type: none"> Minimal movement required Effective once working Provides a sense of independence for users Could have adjustable sensitivity features Turns accessibility aid into a cool game upgrade rather than a limitation 	<ul style="list-style-type: none"> Difficult to execute Expensive Requires a power source Large and bulky, difficult to transport High risk of mechanical failure Requires intricate design Could integrate it with an app for voice-controlled automation Can customize the claw machine look 	<ul style="list-style-type: none"> Fun idea Could make gameplay more engaging/unique Can use with other games Could integrate it with an app for voice-controlled automation Can be used for unintended purposes Magnetic pieces are an easy alternative 	<ul style="list-style-type: none"> Players may find it frustrating or uninteresting High maintenance and durability issues Can be used for unintended purposes Magnetic pieces are an easy alternative 				
Pieces that click into place on the board	<ul style="list-style-type: none"> Clicky, stable pieces Highly feasible Effective in representing terrain Offers satisfying tactile feedback, enhances user enjoyment Portable and easy to assemble User friendly Cheap to make (no batteries or electronics needed) 	<ul style="list-style-type: none"> Time consuming to design each piece May be difficult for users to snap into place/pick the pieces up Users still have to carry small pieces and drop/click them into place over and over again Designing perfect tolerances for clicks is tricky (too tight or too loose ruins gameplay) Will wear down over time, reducing the clicky feel 	<ul style="list-style-type: none"> More enjoyable play Less time fixing knocked over pieces The physical clicking of the pieces can align with a digital version of the game in the future Can incorporate color coding, textures, or Braille for improved accessibility Could inspire sustainable modular board design (swappable tiles, fewer parts lost) 	<ul style="list-style-type: none"> Magnets or Velcro may outperform in ease of use or durability Larger pieces The pieces may be either too tight or too loose if incorrectly designed The pieces could deform over extended periods of use Increased use of smaller parts may lead to more plastic pollution Competitors could replicate the idea quickly with cheaper materials 	<ul style="list-style-type: none"> Simple to use once set up Software-based (no physical movement) Portable across devices No need for any fine motor control 	<ul style="list-style-type: none"> Requires all players to use it Inconvenient for some users Excludes those without phones May reduce physical interaction May make the game less fun and interactive Need to know how to use tech Notifications on devices mid-game play could cause a distraction 	<ul style="list-style-type: none"> Less time spent moving cards around, faster play time Expansion features (tracking, digital enhancements) Can use with other games Could integrate with the Catan app Notifications on devices mid-game play could cause a distraction 	<ul style="list-style-type: none"> Larger physical cards Technical malfunctions or app bugs Dependence on device compatibility and availability People may have difficulty understanding how the app works Wi-Fi or battery problems would stop gameplay

Figure A2. SWOT analysis conducted in the ideation phase.

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