Introduction

Our team is prioritizing interviewing and playtesting as a process for the creation and iteration of minigames. The minigames focus on creating individual player profiles, accordingly, creating personalized game controls and experiences, in an attempt to push the boundaries of how people with disabilities can play different types of game, in more accessible and challenging ways. In this way, situational, temporarily disabled players and non-disabled players can also benefit from our discovery.

The first demo on the design concept is a western-style first-person shooter game. As a skilled gunslinger, the player will shoot different kinds of targets on your horse. The game features a dynamic difficulty adjustment system, allowing players of all abilities to enjoy the game's challenge to the fullest.

The second game is an isometric platformer game with a futuristic robot theme. The game blends the process of button-mapping and remapping into the game tutorial. The design of the setting menu features a testing function to simplify players' user path. The demo allows players to control their character and execute powerful moves with a lot more ease.

Related Work

There is a growing body of research on the topic of accessible games, as the gaming industry has recognized the importance of creating inclusive and accessible experiences for all players. One key aspect of accessible game design is ensuring that players with disabilities are able to fully engage with the game and access all of its content. This can involve adapting the game's controls, interface, and audio/visual elements to make them more accessible to the player.

Mainstream accessibility features may include visual, auditory, and motor accessibility options, as well as options for players with cognitive or learning disabilities. In recent years, there have been numerous efforts to improve the accessibility of video games, both by game developers and by disability advocacy groups.

[Previous research from ablegamer]

Research of Ablegamer mentioned that even though the disabled gamers have a large population, the design and implementation of accessibility in video games is still hard even with federal regulations. Some important quotes are listed here:

> " Games are meant to be difficult but not difficult to access.
> "... players with disabilities are immensely diverse as a user group
> "... game accessibility research often sits separate from the commercial game industry

We incorporate the APX model for further ideation and design process.

3 levels of APX is: Access - Challenge - APX

Access refers more to the hardware or the physical interaction between players; challenge level refers to the in-game experience, to make the game challenge can be approachable and perceivable by people with disability.

> 'If APX is the goal, like all player experiences, it cannot be explicitly designed for (Hunicke et al., 2004) but designers can orient the game so that the desired experience is more likely to be experienced.
>
> The first step to having any experience is being able to have access to the game through its interface...

Another important takeaway from their practice is that:

> We hold that the key step to making games accessible is to hear the voice of the players with disabilities who are playing or who want to play digital games.

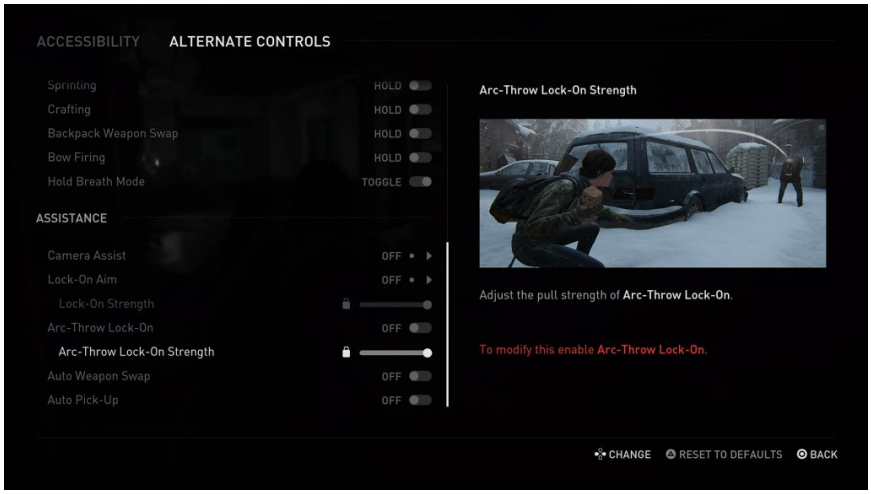
[Conversation with experts from EA]

During the talk with EA consultants, Kate and Morgan introduced us about the common 'mismatch' between players' control scheme and the designed challenges of video games. We were trying to incorporate the concept and address them in developing our demo mini-games. The common mismatches are:

- Movements
- Timed-Gameplay
- Complex Control
- Physical Fatigue
- Sensitivity

[Games with Well-received Accessibility Features]

The Last of Us Part II: This game was praised for its wide range of accessibility options, including the ability to customize the user interface, adjust the difficulty level, and use a variety of control schemes. It also features audio description and closed captioning for players with visual impairments.



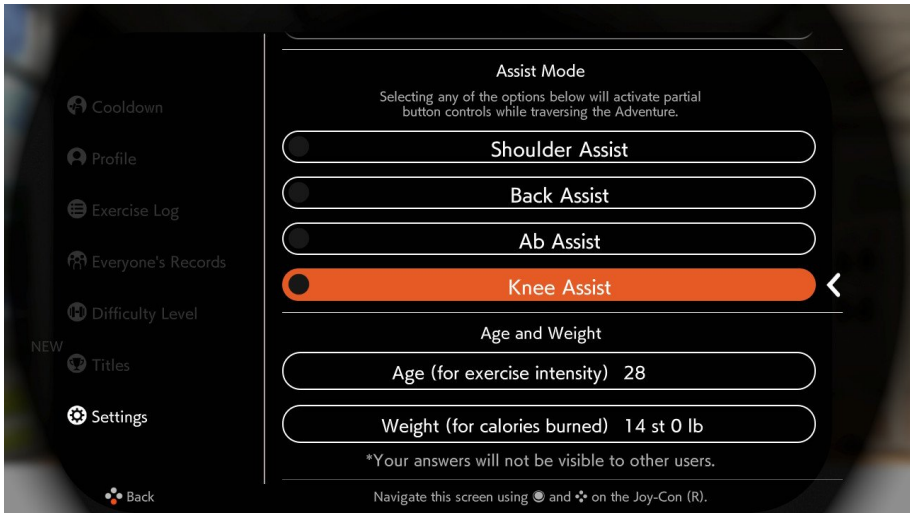
Video reference:
[The Last of Us Part II - Accessibility Features Gameplay - YouTube]
[The Last Of Us Part II - MOST ACCESSIBLE GAME EVER! - Accessibility Impressions - YouTube]

Far Cry 6: This game features a wide range of accessibility options, including the ability to customize the user interface, use alternative control schemes, and adjust the difficulty level. It also includes closed captioning and the ability to use audio cues to navigate the game world.

Video reference:
[Far Cry 6 | Motor Accessibility - YouTube]
[Far Cry 6 - Accessibility Preview - YouTube]

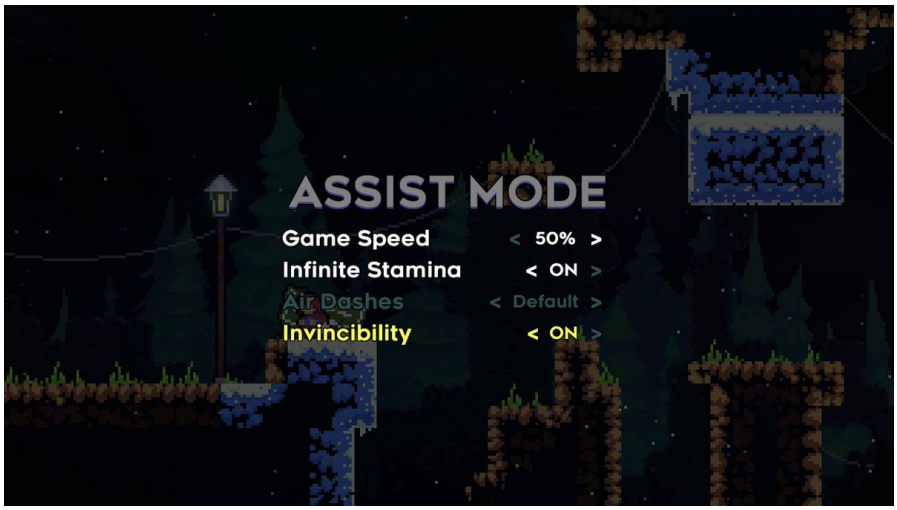
Ring Fit Adventure: This game uses a range of accessories, including a ring controller and leg strap, to track player movement and provide a variety of physical challenges. The

accessibility features includes customizing difficulty level, customizing control scheme, customizing exercises and allowing players to use audio cues to navigate the world.



Apart from the 3A games, there are also many indie games that are notable for their accessibility features.

Celeste: This platformer game was designed with accessibility in mind, and includes options such as the ability to customize the user interface, adjust the difficulty level, and use a variety of control schemes. It also includes closed captioning and the ability to use audio cues to navigate the game world.



Video reference:
[What Makes Celeste's Assist Mode Special - YouTube]
[BLIND GAMER uses Assist Mode in Celeste - YouTube]

[Conclusion]

Overall, there are a range of design strategies and technologies that can be used to make games more accessible to players with disabilities. These strategies can help to promote social inclusion and improve the quality of life for players with disabilities, while also providing a more enjoyable gaming experience for all players.

Existing accessibility features mainly includes audio descriptions, subtitles and closed captions, text-to-speech, customizable control schemes, colorblind options, difficulty options. However, there are still many problems with the current solutions. Players still need a lot of extra effort to get a hang of those features.

Primary Research

[IU1 Visit]

We visited Intermediate Unit One (IU1) on Sep 30th, 2022 for their multiple disability support classroom. The visit was part of our planning to recruit play testers and conduct our first playtesting session with our first prototype. However, most of the motor mobility challenged kids of the classroom are with neurological disorders. And all of the kids are in super diversified situations. The ways for them to approach video games are also different. Two of the young girls can only use eye-tracking technology, the rest kids with motor mobility difficulty also have vision impairment or cognitive disorder. Many of them are still on the way of learning and understanding the feedback or reaction of their actions.

Admittedly, the kids of IU1 are not our ideal target audiences and playtesters. However, by visiting the classroom, we realized that people with motor mobility difficulties are in super diversified situations and it is hard to set everyone in the same setting or provide them the same hardware for interacting with the video games.

[Interview with Jennifer]

We conducted 2 interview sessions and 2 playtesting sessions with Jennifer Phillips through the design process.

During the first interview, Jennifer introduced her daily experience with video games and we were also trying to figure out the opportunities within her experience with current video games. Access full interview notes here. The main takeaways are:

- Complex control is one of the largest barrier preventing Jennifer playing certain types of games, such as platformers
- Unlike some fully-abled body people, Jennifer would always check the setting menu for accessible features.
- The button/control mapping & remapping process is tedious for her and it is one of her pain points and a hard stop preventing her from certain games. If the game has control that cannot be mapped easily according to her situation, then she has to give up the game.

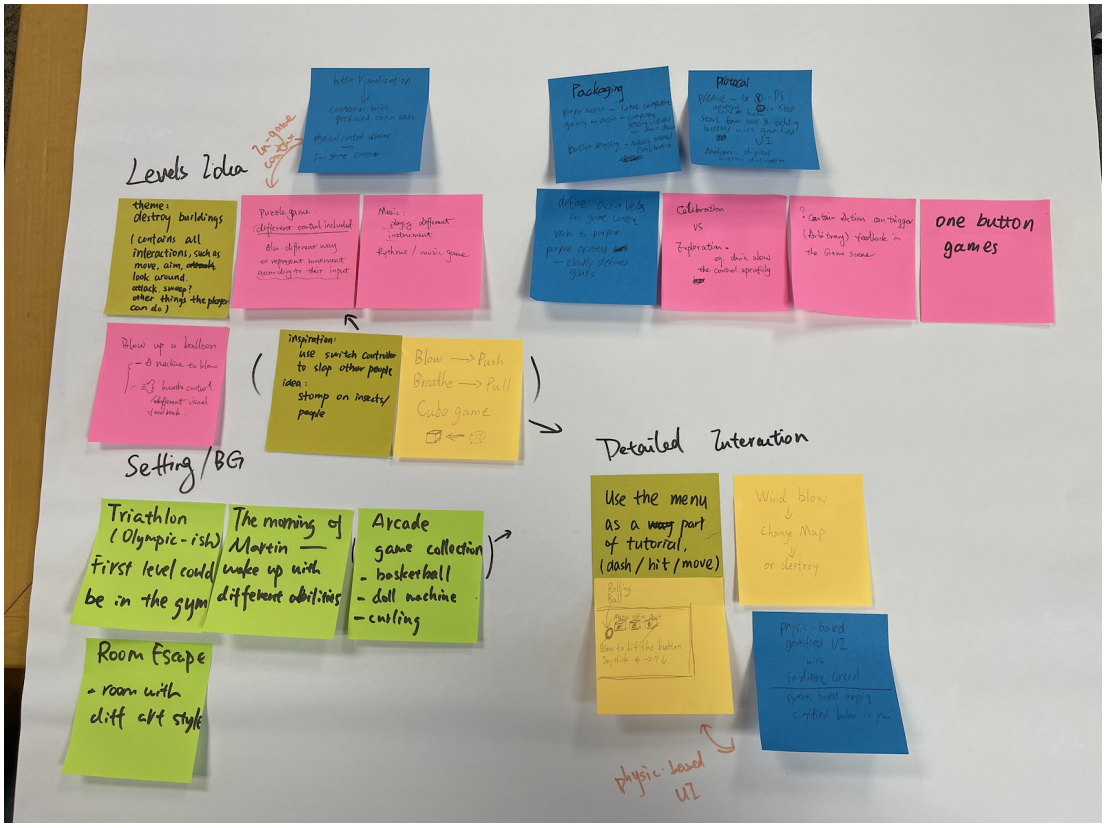
Design Mind Map

The dynamic accessible setting system was developed based on the idea of projecting the full game challenge to individuals' skillset. In other words, we want to design a system that can automatically change to fit different players' skill level, or based on their level of skill, adjust the assistant or accessible settings for their different situations. Some references helped us brainstorm or finalize our design proposals: link

The design of automatic button mapping is based on the pain points we extracted from Jennifer's experience with the current platform and the idea of optimizing player experience with a more intuitive game control scheme.

The design and development of the prototypes has three phases: exploration ideation, data-collect and analyze, prototype and iteration.

[Exploration and Ideation]
We started the brainstorm by donating 3~5 thoughts of game design or game control design proposals that can address inclusiveness and accessibility. We put the different solutions and



design ideas in different categories - level design, game background, detailed interaction. The key concept we summarized from the brainstorm is that we hope the system can be different and adjusted automatically for different user cases. Referring back to the model of APX,

'challenge' is a crucial step for players to access and experience the game and have fun within the virtual world - how might we design a system that could automatically offer help and offer a suitable challenge level for the players so as to improve their gaming experience.

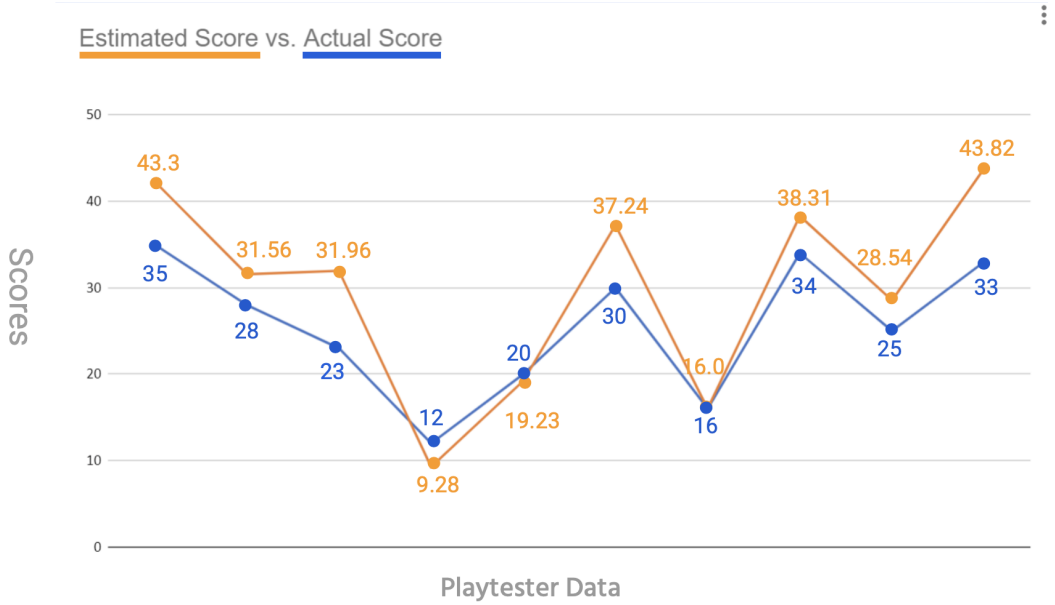
We pivoted the first demo as a first person shooting game, since the game genre has a large amount of audiences and sometimes the genre is not friendly for people with disabilities.

We derived the concept of automatic button mapping from another level, ‘Access’. We targeted the button mapping in between access level and challenge level. With an easier button mapping process, players can easily access the whole game control schemes, and potentially mitigate their barrier to complex control within the different game genres. The automatic button mapping can also be targeted for fully-abled body people to finish their first time setting up for a game and thus shorten their learning time for the game actions.

We used the genre of third person isometric platformer to illustrate the idea of automatic button mapping and remapping. Platformer, as Jennifer mentioned, is the genre she faced a lot of barriers. The game genre can have simple interactions or complex control; we can also test whether our button mapping method can help them deal with the difficulty with complex control.

[Data collect and analyze]
The data collecting and analyzing is important for the first demo. We developed two lo-fi playable levels for collecting users’ data and profile related to their performance. The data phase is a playtesting phase where we collect data from the players and analyze it to establish a prediction model. To achieve that, we further divide the data phase into 2 parts. In part A, we monitor a set of players’ behaviors and quantify them into meaningful data, X. Whereas in part B, we ask players to complete a standardized task and get the player’s score Y, as the measurement of their ability. At last, we use mathematical data fitting to formulate a prediction model F, so that F(X) approaches Y.

Access the full dataset here. The model will then be used in the game phase. The game starts with a calibration level that has a similar setting to the Part A of the data phase. We also monitor the player’s performance and feed the data to the prediction model to predict his/her ability for the game, and adjust the challenge level of the game according to their predicted scores and detailed data. We have already conducted our first round of playtesting for the data phase. We’ve collected a lot of data, among which, some we found related to players’ game ability. We incorporated these factors into the prediction model. That includes the maximum time interval between two hits, the average lifetime for all the hit targets, the hit target number as a percentage of the total target number, and the hit accuracy of the player.



This table contains the raw data we collected from playtesters. About 75% of the data was taken as the train set, we analyzed them to construct the prediction model and applied the model to the rest 25% of the data, the validation set, to validate the model's effectiveness.We have already conducted our first round of playtesting for the data phase. We've collected a lot of data, among which, some we found related to players' game ability. We incorporated these factors into the prediction model. That includes the maximum time interval between two hits, the average lifetime for all the hit targets, the hit target number as a percentage of the total target number, and the hit accuracy of the player.

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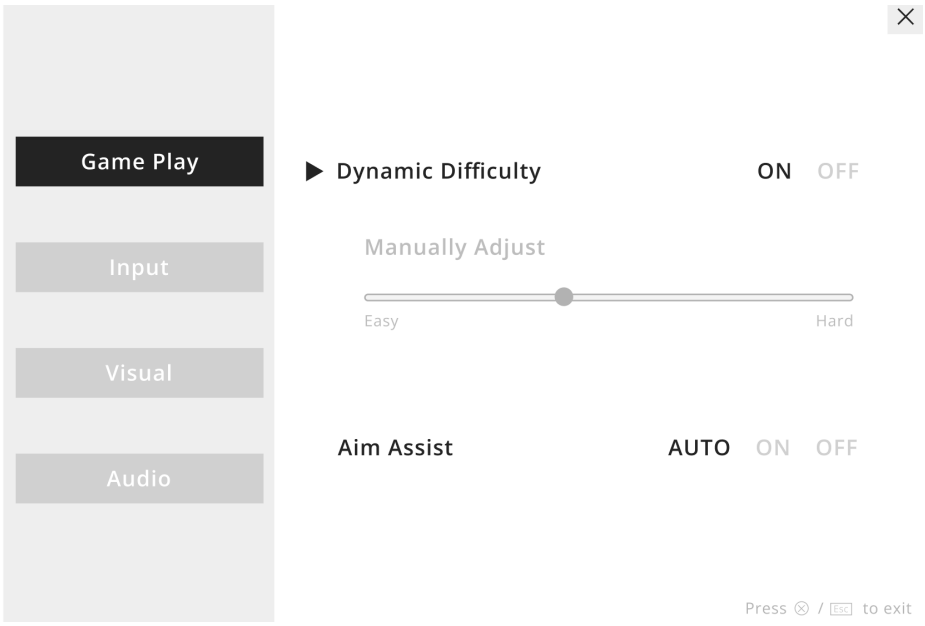
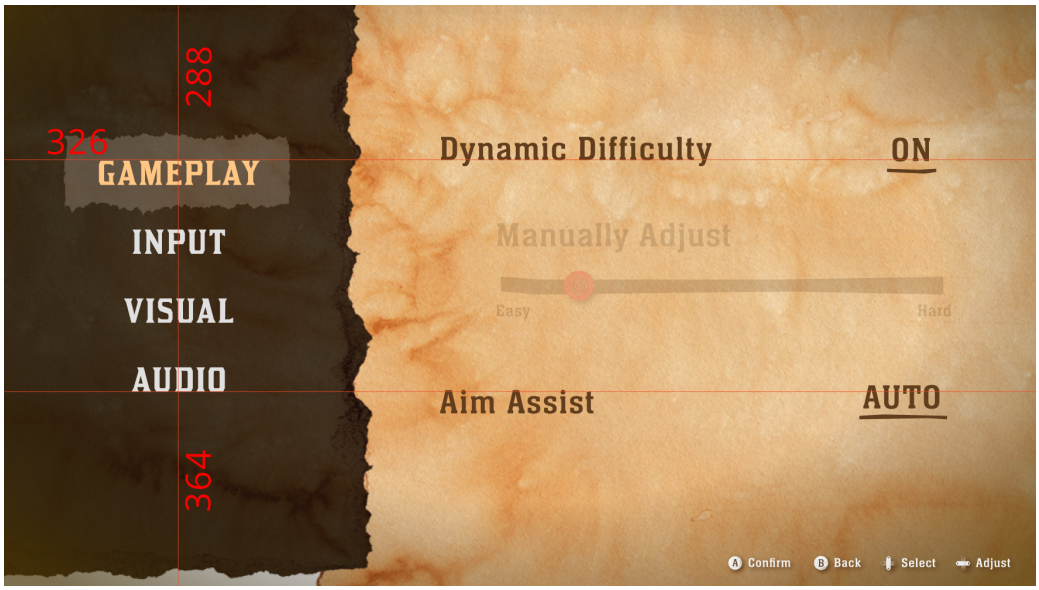
For demo 2, the game system of automatic button mapping would incorporate users' profile of mapped buttons from the back end; which means, the profile and information adjustment would happen in the tutorial step.

[Prototype and iteration]
For the level and game design of prototype1, refer to **Appendix Document A**. The major iterations of prototype 1:

1. Unified the game demo to be a controller game
2. Adding the setting menu (make the dynamic difficulty as an option for players, which is feedback from participants, they want to have more control on the game)
3. Adding aim assist system to improve the experience for controllers with joystick



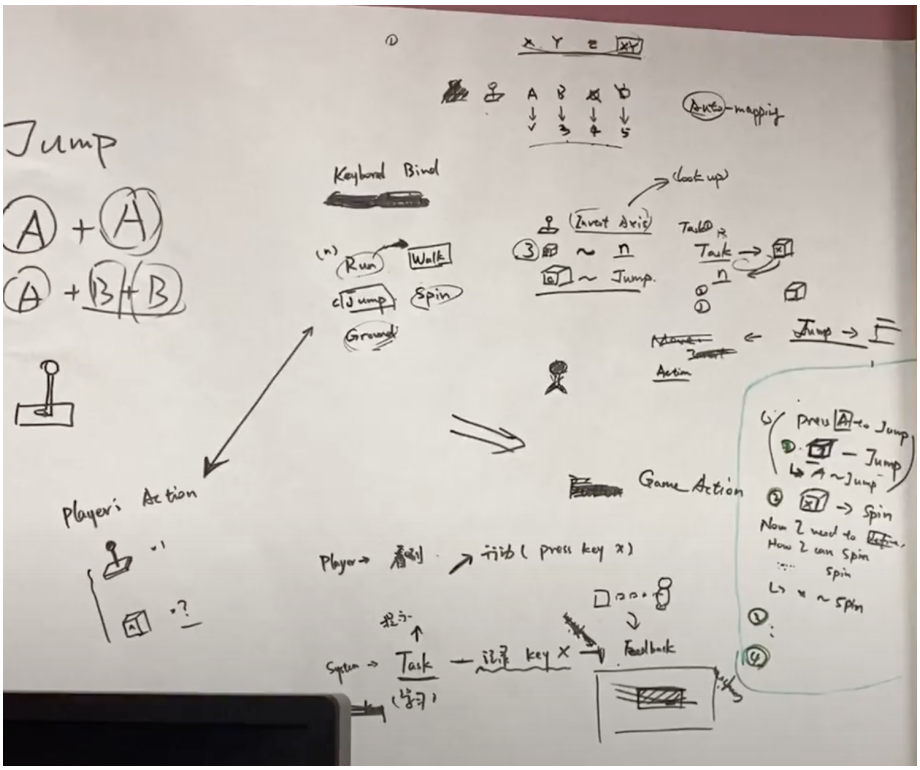


Design and iteration of prototype 2:
For the design of the automatic button mapping, we were aiming to embed the system into the tutorial, so we followed the in-game task-like design for completing the mapping process.

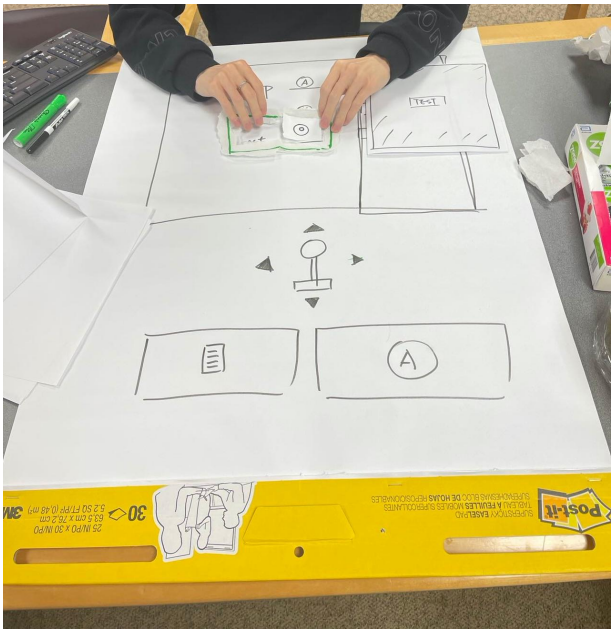
We have ideated three different flow for the button mapping:
Proposal 1: Inform the button mapping first - acquire mapped button - pop up dialog for confirming
Proposal 2: Use certain area in the level, inform players to map and change button in the specific area - the leaving action serves as the confirmation

Proposal 3: Provide the action task - read different buttons - repeat with the same button for several times as confirmation.

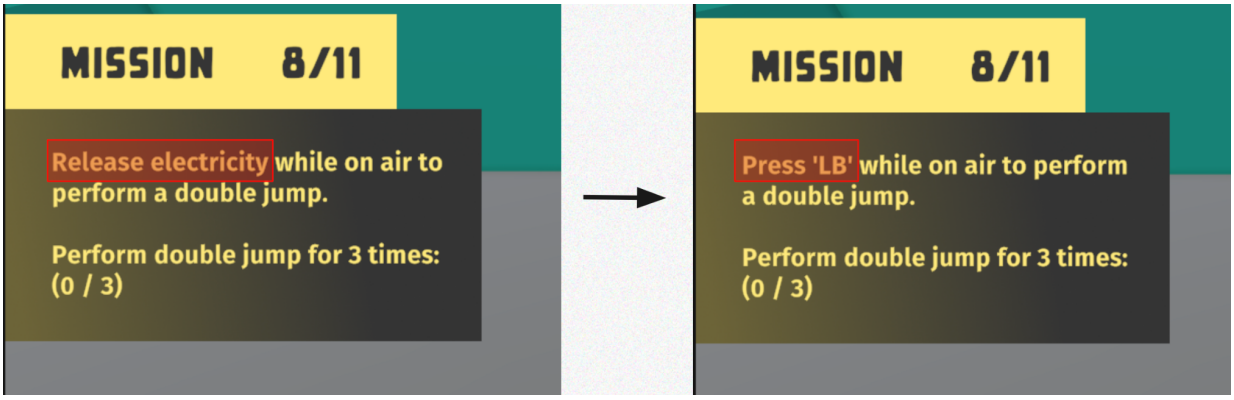
We decided to go with the proposal 3 since the flow can be smoothly embedded in the tutorial level without popping up information that can break gaming flow for players.



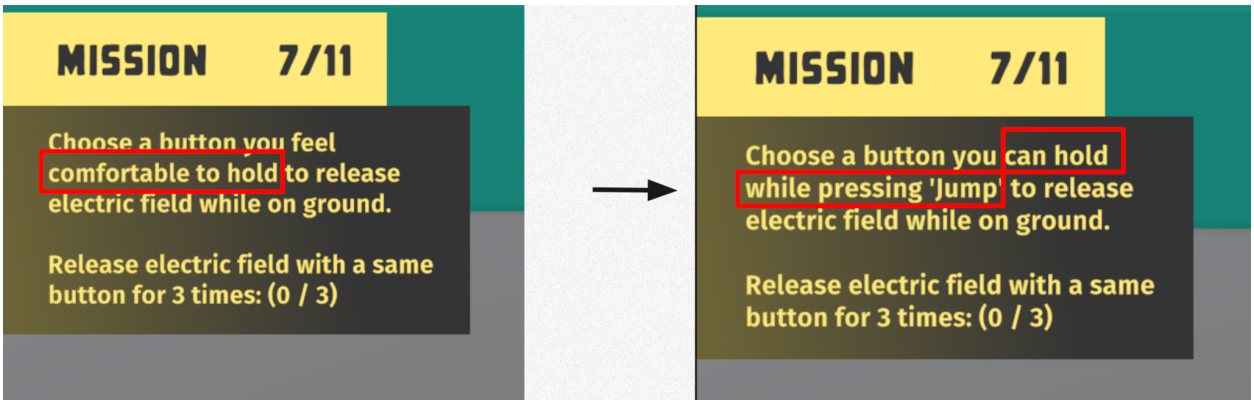
Besides, we used a paper prototype to design the button remapping process for players' in-menu setting up experience. The setting menu features a function of testing, which can simplify their button mapping user flow.



For the level and game design of prototype2, refer to **Appendix Document B.** The major iterations after playtesting the prototype:



1. Replace actions with the mapped button for a lower perception need



2. Provide ‘expectation’ for future actions when they are mapping multiple buttons.

Design Solution Evaluation

Due to the limited time and resources, it can be difficult for us to conduct the usability testing and play testing with people with motor mobility disabilities. So we included the general public players into our test for a quantitative evaluation; take Jennifer’s playtesting result as the main qualitative measurement of the prototype.

Method 1 (for prototype1): NASA TLX score to test the subjective task load for participants. Some of the indicators, such as performance and effort, are worth investigating since our first demo focused on the dynamic challenge. TLX could help us better understand how the participants perceived their performance. Ideally, if the scores are not extremely divergent, and when they all have a low score for frustration, we can say they share the similar, ideal experience that we want to deliver. In other words, given the situation that we did not control

the skill level for our participants, if they perceive the game difficulty and challenge similarly, then we could say the dynamic difficulty system helped them balance the experience. The data: please refer to Task Load Index for FPS (Responses)

Method 2 (for prototype 2): The System Usability Scale (SUS) to test general usability for the whole system. The data: please refer to Usability test: Button Mapping System (Responses)

Appendix Document A: Dynamic Difficulty Level Game Design Document

Games for All Prototype 1

Appendix Document B: Automatic Button Mapping Level Game Design Document

Games for All Prototype 2