Grandparents in Space—Asymmetry of Information and Flow of Communication in Collaborative Games for Intergenerational Play

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Declaration

I hereby declare and confirm that this thesis is entirely the result of my own original work. Where other sources of information have been used, they have been indicated as such and properly acknowledged. I further declare that this or similar work has not been submitted for credit elsewhere.

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Contents

Abstract

This thesis outlines the development of *Co-smonauts* (2016), a computer game designed for collaborative intergenerational play (in this case specifically the play between children and their grandparents). Co-smonauts is being created as a proof of concept for the theories and their applications discussed in this thesis. For intergenerational play to be possible the needs and wants of the older generations when it comes to digital technologies have to be considered. Through the summary of existing research and the analysis of two commercial games *asymmetries* are identified as a key building block for intergenerational games. Asymmetries are the main drive for a balanced game experience for players of different skill level (older and younger people) as well as a important factor for collaboration. In the development of *Co-smonauts* these asymmetries where applied to nearly all aspects of game design. Different aspects of the game were then evaluated and tested in a workshop as well as two studies. This thesis provides an overview of existing research and theories in the areas of collaborative play as well as intergenerational play and combines the result in *Co-smonauts*.

Kurzfassung

Diese Arbeit dokumentiert den Entstehungsprozess von *Co-smonauts* (2016), einem Computerspiel das für kollaboratives, generationsübergreifendes Spielen designt wurde. Co-smonauts wurde parallel zu dieser Arbeit entwickelt und dient als proof of concept für die vorgestellten Theorien und deren Anwendungen. Um generationsübergreifendes Spielen zu ermöglichen müssen die Vorlieben und Bedürfnisse der älteren Generation im Hinblick auf digitale Spiele in Betracht gezogen werden. Durch die Zusammenfassung von existierenden Forschungsprojekten und der Analyse von zwei kommerziell erfolgreichen Computerspielen werden *Asymmetrien* als wichtiges Element zur Förderung von generationsübergreifenden Spielen identifiziert. Asymmetrische Elemente ermöglichen eine ausbalancierte Spielerfahrung für Spieler mit unterschiedlichem Geschick (in diesem Fall ältere und jüngere Spieler) und dienen darüber hinaus als wesentlicher Bestandteil kollaborativer Spiele. In der Entwicklung von *Co-Smonauts* werden diese asymmetrischen Elemente in fast allen Aspekten des Game Designs angewandt. Im Rahmen eines Design Workshops und zwei Studien wurden unterschiedliche Versionen des Spiels evaluiert und getestet. Diese Arbeit liefert einen Überblick über existierende Arbeiten und Theorien im Feld des generationsübergreifenden Spielens. Diese Ergebnisse werden auf das kollaborative Spiel *Co-smonauts* angewandt und getestet.

Chapter 1

Introduction

Intergenerational play—in our case specifically the play between elderly people and their grandchildren—is a useful tool to bridge the gap between generations as well as introduce the older generation to technology they did not have any experience with previously.

This thesis focuses on two aspects of intergenerational play: creating a game environment that fosters intergenerational play and how to entice collaboration and communication between players.

1.1 Creating environments for intergenerational play

People aged 60 and above are a very diverse group, yet many of them have little to no experience with modern digital technologies like smart phones or personal computers. And while the percentage of technologically literate older people is rising, they still face hurdles of using interfaces designed without decreasing physical and mental capabilities in mind [43]. The physical and mental benefits of using digital technologies and especially computer games in an older age have been examined thoroughly. Playing games leads to mental benefits related to executive control functions [6, p. 776], can reduce social isolation [21] and depression [36] and can motivate older people to exercise regularly [22]. Intergenerational play can be one way to entice older people to overcome the initial hurdles of digital interfaces. There have been some projects attempting to create collaborative games for intergenerational audiences [1, 26, 31, 33, 42]. Yet their game design often is very simplistic or does not leverage asymmetries well. This thesis explores how asymmetrical play can benefit older people when coming in contact with computers by using game mechanics specifically adapted to their needs and wants.

1.2 Fostering communication in intergenerational collaborative play

For collaborative game environments to work players must be able to communicate effectively. Yet to create a meaningful and challenging game experience the game must actively trying to hinder communication and collaboration in some ways [4, p. 7]. This thesis examines how communication works in a collaborative game environment and how introducing asymmetrical elements of distribution of skills and information can increase communication during play.

1.3 Method

To help foster intergenerational play between older adults (aged 60+) and their grandchildren (aged 6–12) *Co-smonauts*, a digital game that is going to be exhibited and played in a semi-public museum environment, is explained and analysed. Two prototypes that pre-date the development of *Co-smonauts* are introduced. During the development phase of the game two smaller studies where held where participants tested the interface as well as the general game mechanics of the game.

1.4 Structure

Chapter 2 presents a definition for collaborative play. Different frameworks to analyse collaborative games are shown and the role of asymmetries is explored. In chapter 3 the peculiarities of creating games and digital interfaces for an older audience are explored. Existing projects are examined and discussed. Chapter 4 analyses two collaborative games (*Mysterium* [39] and *Lovers in a Dangerous Spacetime* [48]), explains their mechanics and applies different frameworks in order to identify elements that support collaboration. Finally, chapter 5 outlines the design of a new game (*Co-smonauts*) that builds on the findings of previous chapters and aims to foster meaningful collaborative intergenerational play.

Chapter 2

Collaboration in games

Collaboration does not naturally emerge in every game that is not strictly competitive. Placing players in a sandbox environment may lead to them working together in a collaborative way or it may create a competitive environment. What governs how players interact with each other in a multi-player game are the underlying game mechanics. Thus, if the goal is to design a computer game where both players work together all the time, it is important to first analyse these mechanics and how they affect collaboration in games. In this chapter explores how game design can create the need in players to work together. The author presents various ways to analyse collaborative elements of play and illustrates the importance of asymmetry to foster collaboration.

2.1 Core mechanics of collaborative game design

As this project focuses on *collaborative play* between children and older adults, the author deems it important to explore the mechanics and complex circumstances that make collaborative play possible. For this it is necessary to define the term. Zagal et al. [47] define *collaborative games* as games where "[...] all the participants work together as a team, sharing the payoffs and outcomes; if the team wins or loses, everyone wins or loses". This is in contrast to *cooperative games*, where players can work together but strive to win alone in the end [47, p. 25]. In practice, those terms are often used interchangeably. Zagal et al. [47] focus their analysis on board games where cooperative games are more common than in computer games, where collaborative games are usually labelled as cooperative games. The usage of the term cooperative games for games where players help each other but in the end a single player wins is somewhat problematic. I argue that these games are still competitive in nature and should therefore be classified as competitive games with varying elements of cooperation. Temporary alliances or short-lasted co-operations can be found in many competitive games with more than two sides, which should not automatically classify them as cooperative games. In addition, most collaborative computer games are described and marketed as cooperative games— For the purposes of this paper and to avoid confusion I will use the terms *collaborative games* as per Zagals definition for games where all players try to achieve a common goal [47, p. 25] and *competitive games* for all other titles. Hybrid forms (such as team games like *League of Legends* [53]) where groups of players share win conditions but compete against other groups are generally perceived as competitive games. For the purpose of this thesis it is however irrelevant if players play against other people or against the computer, as we focus on the mechanics that support collaboration within the team.

2.1.1 Frameworks for classifying collaborative games

Collaborative games can be further analysed and categorised. We can observe how the game fosters or hinders collaboration, how and when the players exchange resources and information as well as how the game divides those resources between the players.

Negative collaboration

Azadegan et al. [4] coin the term *negative collaboration* where (in games) collaboration is made harder on purpose to challenge the players, which in turn heightens the need to work together, increasing collaboration efforts. Of course, a balance between challenges and rewards has to be struck. This also coincides with the flow theory (later outlined in chapter 5). They highlight, that collaboration has to be made necessary by having players with different skill sets and different information, but has to be made accessible by providing the tools to communicate easily and without unnecessary costs. "This is what we consider the collaboration paradox: the game actively tries to hinder collaboration and by doing so fosters collaboration." [4, p. 7]. The game *Mysterium* [39] actively hinders communication by forbidding the one player who knows the answers to the games riddles from telling the players. Doing so actively hinders collaboration—the game would be much easier when everybody could communicate openly—but without this rule the challenge of the game would be gone, it would no longer be interesting. *Mysterium* will be analysed in closer detail in section 4.1.

Private and public spaces

Goh et al. [25] created the *MOY*-Framework ("Mine, Ours, Yours") which strives to model resources and interactions in a collaborative environment on platform that feature both private and shared elements. They divide game space into private spaces ("Mine"), public spaces ("Ours") and private spaces of other players ("Yours"). With this, they describe three basic interaction design configurations [25, p. 3]:

- **MO–YO** (Mine is ours, yours is ours) where private resources of all players are used to solve a challenge in a shared space.
- **MY–YM** (Mine is yours, yours is mine) where resources in a players private space are used to solve challenges in other players' private spaces and vice versa.
- **OM–OY** (Ours is mine, ours is yours) where the resources in a shared space are used to overcome challenges in the players' private spaces.

A great example for the **MO–YO** configuration is a card game creatively titled *The Game* [50]. Players take turns drawing cards numbered from 2 to 99 from a single card pile and then have to put down cards on one of four stacks. However, they are only allowed to place cards in ascending or descending numerical order, depending on the stack. They are also not allowed to tell other players the exact numbers they have in their hands. *The Game* has a very strict separation into private (the players' cards held in their hands) and public (the four stacks in the middle) spaces, even limiting the amount of information that can be shared between players. Players have to creatively communicate and use the resources in their private spaces to solve the problem in their shared space. Creating a challenge in a shared space is the simplest way to entice collaboration, as such the **MO–YO** configuration seems to be the most common. The other forms more often than not appear as smaller game-play elements in games that follow the **MO–YO** configuration. An example of this is *Playerunkown's Battlegrounds* [52]. The premise of the game is simple: Up to 100 Players are dropped onto an island, the one alive at the end wins. This can be player in teams of up to four players. Each player plays in a shared space (the island) but also has their own inventory as a private space. Generally players try to win the game in the shared space by using resources of their private spaces (weapons, ammunition, healing items and more). But especially at the beginning phases of the game, other configurations appear. Players use the shared space to solve problems in their private spaces (they may, for example try to find healing items in houses). In other instances players may trade items with each other if their team members are lacking those items (this follows the **MY–YM** configuration). In many more complex games more than one of these configurations will be found upon closer inspection. The framework then becomes a framework for types of collaborative interactions rather than a framework for classifying whole games.

Closely and loosely coupled collaborative games

Beznosyk et al. [7] divide collaborative games into *closely* an *loosely coupled* games, depending on the interconnectedness of the players actions. "If a game requires a lot of waiting or if the actions of one player directly affect the other player, it was categorized as the first type. The games that do not require tight collaboration between players and allow more independent performance were assigned to the second type" [7, p. 246]. A good example of closely- and loosely-coupled elements are two game modes of the real-time strategy game *Starcraft II: Wings of Liberty* [49]. Players can battle an opponent controlled by an Artificial Intelligence (AI) together. Each player has their own base and controls their own units. This mode is loosely-coupled because both players can act independently without waiting for their partner, contrary to the closely-coupled *Archon Mode* included in the games second expansion *Legacy of the Void*. Here both players are in control of one single base and share the same units and resources. If one player controls the units to attack the enemy, they have to wait for the other player to build them first.

2.1.2 Collaboration versus competition

When designing a game that is supposed to promote communication between players and learning, the decision to base it on collaboration seems intuitive. Numerous studies support this notion. Peppler et al. [40] observed, how game orientation (collaborative or competitive) affected children's concentration and willingness to learn during gameplay. They found that

> "Students in the individualistic, competitive context were 3 times more likely to be asked to redirect their attention to the activity, than in the collabora-

tive environment." [40, p. 696]

And were in turn more likely to pay attention to their fellow players' turns. Contrary to this, Abeele et al. state that competition fosters social interaction between the players [1, p. 427]. The author argues, that the preferred type of play strongly depends on the player themselves as well as their preferences and that both, collaborative and competitive play can stimulate communication if designed correctly. In terms of performance Kohn [34] suggests that "Superior performance not only does not *require* competition; it usually seems to require its absence" [34, p. 47]. In other words: Collaboration usually yields better results than competitive environments [34]. Other studies state that competition can be a useful motivator as well as a cause for social communication [28]. Jansz et al. [29] also note a correlation between competition and communication. Yet these two studies focus on people that identify themselves as "gamers". Surveys of non-gamers and older people may yield different results.

2.1.3 Guidelines for collaborative game design

For the design of collaborative games Zagal et al. [47] note four lessons and three pitfalls that can foster or disturb a collaborative gaming environment .

- Lesson 1: To highlight problems of competitiveness, a collaborative game should introduce a tension between perceived individual utility and team utility [47, p. 30].
- Lesson 2: To further highlight problems of competitiveness, individual players should be allowed to make decisions and take actions without the consent of the team [47, p. 30].
- Lesson 3: Players must be able to trace payoffs back to their decisions [47, p. 31].
- Lesson 4: To encourage team members to make selfless decisions, a collaborative game should bestow different abilities or responsibilities upon the players [47, p. 31].
- Pitfall 1: To avoid the game degenerating into one player making the decisions for the team, collaborative games have to provide a sufficient rationale for collaboration [47, p. 32].
- Pitfall 2: For a game to be engaging, players need to care about the outcome and that outcome should have a satisfying result [47, p. 33].
- Pitfall 3: For a collaborative game to be enjoyable multiple times, the experience needs to be different each time and the presented challenge needs to evolve [47, p. 34].

While some of these points (in particular Lesson 3 and Pitfall 2) are more of general game design guidelines, the focus on different roles and responsibilities for different players is a very important aspect of collaborative game design. I argue however, that a tension between individual utility and team utility is not necessary for engaging collaborative gameplay. It may play a vital part in more strategically focused games but other games such as, for example *Spaceteam* [54] which focus more on twitch skills and quick reactions can work very well without relying on such decisions. *Spaceteam* is a mobile game released in 2012 by Henry Smith, where players have to keep a spaceship from exploding. Each player is presented with a control surface with various buttons an other interactable elements. However, instructions for correct handling of the spaceship are displayed on the screens of the other players. Quick and concise communication is necessary to beat a level. Various distractions (such as shaking screens and consoles that are falling apart) add to the challenge.

Lesson 2 in particular is crucial when designing for collaboration. A game that depends on players taking every decision together, more often than not a single player who has either played the game before or has a better intuitive understanding of the mechanics will take the reigns. This leads to the other players losing their autonomy, lessening their enjoyment of the game. This, like Lesson 1, can only partially be applied to computer games. Games that focus on twitch skills and quick reaction don't usually focus on strategic decision-making. The responsibility of making decisions can even be weighted on purpose. In *Natural Selection 2* [56] one player makes all important strategic decisions. This asymmetry can make for highly successful game-design and will be epxlored further in section 2.3. Lesson 4 speaks to this aspect as well.

Games such as *League of Legends* [53] incorporate most of these lessons to increase collaborative effort inside the team. Players often have to make decisions to either heal themselves or their team mates (Lesson 1). Often they are faced with the necessity to give up on gold or experience. As each player controls their own character, they are able to take actions without consent of their team (Lesson 2) and every character has different abilities and fills a different role (Lesson 4). Lesson 3 however presents some problems in a game as complex as *League of Legends*. Because there are many different variables it is impossible to trace back different outcomes reliably to the decisions a player made. This, combined with human nature, often leads to players blaming others or denying responsibility, creating conflict inside a team.

2.1.4 Communication in collaboration

Communication plays a crucial part when it comes to collaboration, it is therefore important to observe mechanics at play when multiple people try to communicate to overcome obstacles; especially because communication itself can become an obstacle rather quickly. One only has to look at four players in a game of *Spaceteam*—chaos ensues as each player frantically tries to communicate with their teammates, listen to the incoming instructions and repair his own panels at the same time.

Clark et al. [12] define a "cost of communication" as the effort that is required to communicate and understand an "utterance". They refer to *grounding* as the process of establishing "[. . .] what has been said and understood" by both parties in a conversation [12, p. 20]. There is an effort associated with each action in any conversation and normally is in the interest of all participants to keep this cost at a minimum. As this cost varies depending on the medium of communication, it is crucial to analyse this process in a collaborative gaming environment.

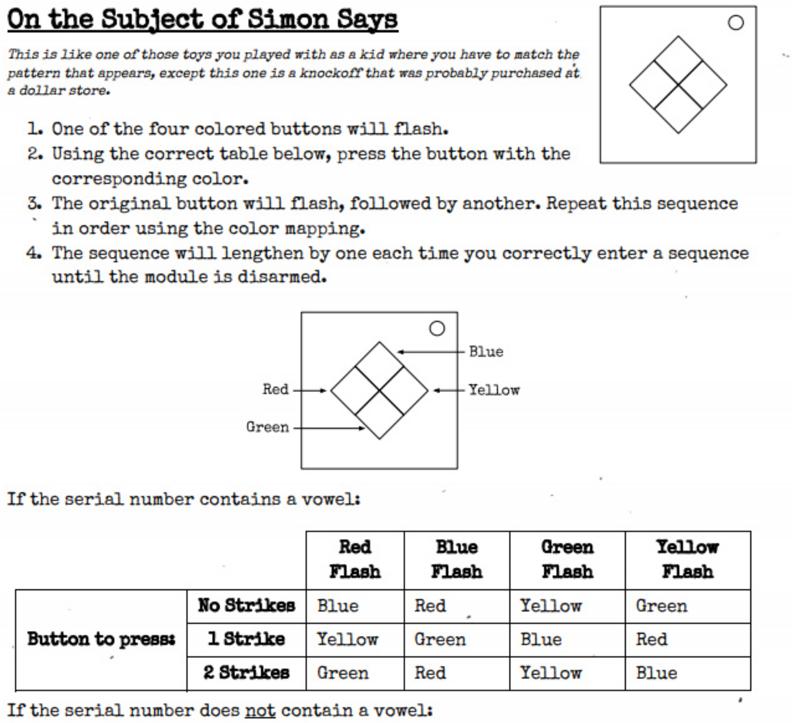
In our *Co-smonauts* (our prototype, further introduced in chapter 5) a function that allowed players to show their partner any point on the map by tapping on the screen was included in one of the earlier versions. This was generally easier than verbally communicating positions and as such we expected the majority of users to make use of this feature. However, in our primary user studies the majority of participants preferred

Figure 2.1: Screenshot from *Keep Talking and Nobody Explodes* [55]. The player on the computer sees the bomb. They have 5 minutes to defuse it with the help of their partner.

to use verbal commands. This could be due to the higher cost associated with learning this feature.

It is also worth noting, that a defining feature of most games is their challenge—it may therefore be a good design decision to introduce an artificial cost of communication to increase this challenge. An example for this is the game *Keep talking and nobody explodes* [55] in which the two players have to defuse a bomb. As only one player can see the bomb (see figure 2.1) and only their partner has access to the defusal manual (an excerpt of the manual is shown in figure 2.2). The cost of communication would be reduced greatly if one player could just show the other the bomb, but the game would be boring, as the challenge arises only through this asymmetry of information. Focused and succinct communication thus becomes a central element of the game. The Game (as in the card game called *The Game* [50]) does not allow the players to mention numbers while playing. This makes communication harder, but creates a heightened tension because no player knows exactly which cards their partners currently hold. These examples are applied forms of Azadegan's *collaboration paradox* [4, p. 7]. Controlling how and what players are able to communicate is easier in card- and board games as players need knowledge of the rules to play them. In computer games however, most rules are often times explained and regulated only through game mechanics. There are no additional "rule books" players have to keep in mind when playing. When designing a game, one can not exactly know how the players will communicate, especially when the game is played on personal computers. When creating a game for a semi-public environment however, it is possible to design this environment in a way that effects communication. One possibility is separating the player's locations, so they can not talk at all. This would, considering the aim of creating a game that fosters communication, however be rather counterproductive.

Other factors that can influence the perceived cost of communication and the willingness that players interact with each other. The example of *Coral Rift* [44] illustrates problems that can arise when this is not kept in mind. The game required players to



On the Subject of Simon Says

This is like one of those toys you played with as a kid where you have to match the pattern that appears, except this one is a knockoff that was probably purchased at a dollar store.

1. One of the four colored buttons will flash.
2. Using the correct table below, press the button with the corresponding color.
3. The original button will flash, followed by another. Repeat this sequence in order using the color mapping.
4. The sequence will lengthen by one each time you correctly enter a sequence until the module is disarmed.

If the serial number contains a vowel:

		Red Flash	Blue Flash	Green Flash	Yellow Flash
Button to press:	No Strikes	Blue	Red	Yellow	Green
	1 Strike	Yellow	Green	Blue	Red
	2 Strikes	Green	Red	Yellow	Blue

If the serial number does not contain a vowel:

Figure 2.2: One page of the manual for *Keep Talking and Nobody Explodes* [55].

communicate verbally over a certain distance. In a public showing this caused problems due to audience cheering and other noises [44]. This increased the cost of communication to a point of players abandoning the game.

As we want to encourage communication and interaction within our target audiences it is crucial to pay attention to these factors and keep them in mind when designing our game and the environment it is situated in.

2.1.5 Outgrowing mechanics—the metagame

A joint goal and the necessity to rely on others to reach it can bring players together. In some cases however the players themselves play an even bigger role in enforcing collaboration. In games like *League of Legends* [53] players take on different responsibilities (dealing damage, healing, protecting their team-mates and others) defined by the abilities of their chosen characters. The playing field is seperated into three *lanes* where characters not controlled by any player fight against each other. Players separate into those lanes and, while fighting enemy players as well as other units, slowly gain experience points and gold to improve their character. The games mechanics dictate that a team wins or loses together, how much experience the players gain, the statistics of their characters and what those characters can and can't do. There is however another layer of rules on top of the underlying game mechanics that determines which characters players can pick for what lane and how they are to interact with their enemies and team-mates. For example a player playing a support character usually shares the bottom lane with a damage-dealer with the goal of helping their partner to gather as much gold as possible. This so called *metagame* is mainly influenced by the community of players and has evolved over the years, based on different strategies and changes in the game. It serves as a baseline for five players who have never talked to each other before to quickly find a working strategy, granting them a chance to win the game. This can lead to problems if players want to deviate from these unwritten rules. They can do that, since these rules are not enforced by the games mechanics, but it usually leads to negative reactions as players are used to a certain way of playing. It also forces players to play roles they normally would not play to improve the probabilities of a victory and, more importantly, to keep their team-mates happy. This slowly evolving set of community rules and regulations does not play a role in a museum environments where players play the game only once for a short time, but it servers as a reminder that it is not only underlying game mechanics that govern the development of collaborative play. When designing for collaboration one can use this to create parallels to real world activities and roles. When used correctly, this can help players learn the game and give them a clearer understanding of their roles and responsibilities.

2.2 Flow

The term *enjoyment* is rather vague and as such hard to define objectively. The concept of *flow* [13] describes one aspect of the game experience in more detail. Flow is the state of an activity where the skills of the participants match the provided challenge [13, p. 212]. A challenge beyond the skills of the player results in worry and stress, whereas boredom follows when the challenge level is set too low (see figure 2.3). Csíkszentmihályi [13] calls the fine line between worry and boredom "flow" or the "optimal experience" [13, p. 212]. A flow experience is intrinsically motivating and usually is experienced alongside a *merging of action and awareness*, a *distortion of time* and a *loss of self-consciousness*. Csíkszentmihályi also identified several factors that often assist in reaching a state of flow [13, pp. 215, 216]:

- The goals of the activity are clear.
- The means of reaching those goals are also clear.
- Feedback on actions is instantly provided.

Przybylski et al. [41] link the enjoyment of a game to the extent it fulfils the psychological needs for *competence*, *autonomy* and *relatedness*. Fostering relatedness in players is a crucial goal in a game designed for collaboration.

The problem with balancing any multi-player game for people with vastly different levels of experience becomes clear when a designer tries to balance the game to create an optimal balance between challenge and skills. There is no way to reach a state of flow for both inexperienced and experienced players when the challenge is the same for both groups. To create an appropriate challenge for everyone, the game has to change depending on the player.

As described in section 3.3 the older generation is a very diverse group with varying skill-sets and comfort levels when it comes to technology. Designing challenges intended to create an optimal experience thus becomes a challenge of its own. To keep the user in the flow-zone, Chen [10] suggests to "Offer adaptive choices, allowing different users

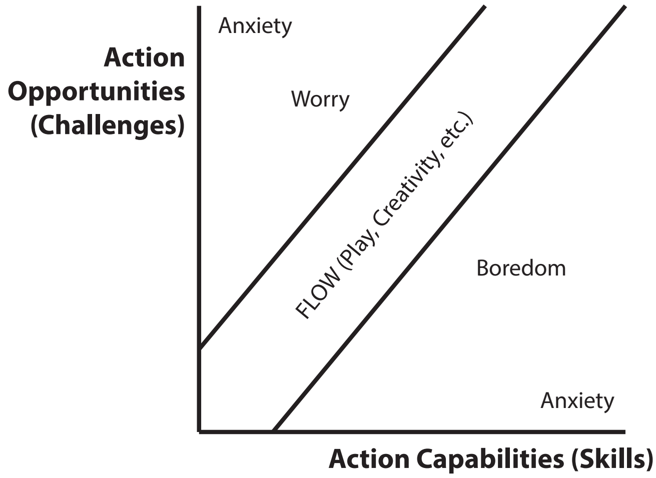


Figure 2.3: Visual graph outlining the requirement of the flow state. Original image from [13, p. 212].

to enjoy the Flow in their own way; and" to "Embed choices inside the core activities to ensure the Flow is never interrupted" [10].

2.3 Asymmetrical play

When trying to create a game designed for audiences with vastly different levels of experience, reaching a state of flow for every player becomes a challenge. It becomes necessary to introduce *asymmetries* into the game design. In games not every role is created equal. Perfectly symmetrical scenarios rarely exist, even in chess one side has to go first. The question then becomes not if there is any asymmetry at all, but how much of it there is. In the Real-time strategy game *Starcraft II* [49] players can choose one of three different races. Each race provides different buildings, units and technologies one can use to combat their enemies. Maps are intentionally kept symmetric to provide neither player with an advantage. Yet if both players choose the same race and play on a perfectly symmetrical map, asymmetries still emerge, as players build different bases and follow different strategies. Even small things such as buildings only being able to expand into one direction (as some buildings in the game do) breaks the perfect symmetry, albeit just a little. *Torchless* [14] is an asymmetrical, competitive dungeon crawler with procedurally generated levels for two players. One player places traps in a dungeon while the other has to escape. Limited light sources create the need for the second player to remember positions of traps and walls to be successful. In this example both players interact with radically different mechanics. Games if different degrees of asymmetry exist as well. In the first-person shooter *Natural Selection 2* [56] two teams consisting of up to 12 players fight against each other. Players on one side take the role of aliens while their opponents play as humans. Additional asymmetry is created through the possibility to play various different classes, each with their own abilities and weapons. Both teams also have one player taking the role of the commander. This player has an overview of the battlefield, can construct buildings and has to divide resources between the other players—as if playing a real-time strategy game.

With asymmetries in games becoming a complex net of relationship between characters, mechanics and users, it becomes necessary to define *asymmetrical play* further. Harris et al. propose a variety of possible mechanical asymmetries in games [26, p. 353]:

1. Asymmetry of Ability,
2. Asymmetry of Challenge,
3. Asymmetry of Interface,
4. Asymmetry of Information,
5. Asymmetry of Investment and
6. Asymmetry of Goal/Responsibility.

They also differentiate various kinds of asymmetry depending on the timing of actions between different players [26, p. 354]. In their game prototype *Beam Me Round Scotty* [26] they explore the dynamics at play when players with different roles collaborate. One player takes the role of Kirk, they have direct control over the character which they use to run around, jump over obstacles and fight enemies. Their partner plays as *Scotty*. Their role is to support Kirk using various abilities. Scotty's part is designed to be slower and more tactical [26, pp. 354, 355]. In their player studies Harris et al. observed "both fluid leadership dynamics, where players would trade proposed strategies back and forth, as well as heavily biased pairings where one of the players would dominate decision making and dictate the majority of actions to their partner"[26, pp. 356–357]. They note that balanced, fluid leadership dynamics were more common [26, p. 357].

Asymmetry of ability

"[. . .] where one player can do things another player cannot" [26, p. 353]. The distribution of different abilities is arguably one of the main factors that can enable collaboration. It forces players to work together if they want to achieve their goal (see also Lesson 4 [47, p. 34] in section 2.1.3). *League of Legends* [53] implements this in form of different characters with different abilities that are all necessary to win the game.

Asymmetry of challenge

"[. . .] where the kind of challenge one player faces differs from that of other players" [26, p. 353]. This asymmetry can manifest itself in multiple ways. On the one hand, the level of challenge can vary between players. This could be done by the game itself, giving an advantage to weaker players automatically to even the odds, or by the players themselves either by selecting different levels of difficulty or by choosing to limit themselves in any other way. On the other hand, the kind of challenge the players face can vary as well. In *League of Legends* one player usually plays the role of a "jungler". Their task is to run around the playing field, killing neutral non-player characters that do not belong in either team to gain gold and experience. This player has to find a way to defeat as many monsters as they can while keeping an overview of the map and helping their team-mates whenever the can. The other players mostly stay in their own region of the map, focusing more on the enemies in front of them, a different kind of challenge.

Asymmetry of interface

Interface in this context means not only the graphical user interface that is visible to the players but how the player interacts with the game [26, p. 353]. One player might play using a keyboard and mouse, while the other uses a touchscreen. In *Keep Talking and Nobody Explodes* [55] one player uses either a monitor and a mouse or a virtual reality headset to interface with the game. The other player is limited to a manual and his ability to talk with his team-mate.

Asymmetry of information

Players can have access to different amount of information [26, p. 353]. In collaborative games this creates the need to communicate crucial information to other players. An extreme form of this asymmetry is found in *Keep Talking and Nobody Explodes* [55], where only one player has access to the manual on how to defuse a ticking bomb.

Asymmetry of investment

"The amount of time players dedicate to their roles differs" [26, p. 353]. This form of asymmetry can often be observed in games that feature a consistent, online world where players can log in whenever they want. Some players will play only now and then, completing the game more slowly, while others will regularly spend big chunks of time with the game.

Asymmetry of goal/responsibility

"Players seek to achieve different outcomes. E.g. one player is the striker on a foot-ball team while another player serves on defence" [26, p. 353]. In collaborative games the final objective to win has to be the same for all players on the same team. Yet minor objectives can vary. This asymmetry is linked to the *asymmetry of ability*. But while the *asymmetry of ability* describes the player's different abilities, *asymmetry of responsibility* describes their varying responsibilities.

Keep Talking and Nobody Explodes [55] shows that it is possible to create a compelling game through focusing on just a few of these asymmetries. Most collaborative games however use many possible types of asymmetry at once. There also exists a certain amount of overlap between those symmetries, as information is often directly linked to available abilities or interfaces.

2.3.1 Applying frameworks to asymmetrical collaborative games

When it comes to some strongly asymmetric collaborative multi-player games, the MOYO-Framework (see section 2.1) is not completely able to model a game using only a single design configuration. *Left 4 Dead* [57] is a collaborative first-person shooter where players fight against hordes of zombies, using weapons and equipment they find in the world. What at first creates an *OM–OY* (Ours is Mine, Ours is Yours) configuration, as everybody tries to find a suitable equipment in the shared space (the environment) to use in their private space (their inventory). Gradually the game changes to a *MO–YO* (Mine is Ours, Yours is Ours) configuration when enemies appear in the shared space and the equipment is used to fight them off. Would we now include a hypothetical fifth player who provides his team-mates with equipment and information from a safe position, they would operate under *MY* (Mine is Yours) configuration. The more player roles we add, the more complicated the different relationships become, the harder it is to apply the MOYO-Framework.

2.3.2 Asymmetry as a driving force for collaboration

Collaboration in games is accomplished through shared goals and the need to work together to achieve these goals. This need can be created through a quantitative increase in challenges until they are simply too many to be overcome by a single player. This can however often lead to frustration when players of vastly different levels of skill try playing together. Another way to achieve a need for collaboration is through the introduction of asymmetries that require the players to work together by combining different abilities. The simplest form of asymmetry in game design is balancing the game for players of different skill levels by using, for instance, point multiplication or handicap systems. Gerling et al. [23] note that such a system is best kept hidden from the players as an obvious effort to balance the game in favour of the weaker players often results in lower feelings of self-esteem in both players [23, p. 2206]. More importantly symmetries can be used to force players to collaborate by distributing the informations and abilities necesarry to overcome an obstacle more or less equally between all players.

I argue that the inclusion of asymmetrical roles and responsibilities in collaborative games is crucial for the enjoyment and engagement with the game. Especially when it comes to intergenerational play, where, as an additional factor, games have to be designed both with a younger and an older audience in mind.

Chapter 3

Between generations

With technology advancing faster and faster the gap between generations may be the biggest it ever was in history. As social lives change drastically with the appearance of mobile technology and social media the older generation often ends up alienated and confused. Digitally supported intergenerational play may be able to bridge this gap. In this chapter, the author will summarize existing research in the field of intergenerational game design and apply the guidelines for collaborative play as discussed in chapter 2. One of the main foci will be the game design and the accessibility of technology for an older audience. Game design for children will not be explored much, as they are a core demographic for games as it stands. Games originated as entertainment form for children and, despite the average age of gamers rising significantly, children are still one of the primary target groups for computer games. Thus general game-design knowledge and practices can be applied when designing for children. A basic understanding of digital technologies as well as computer games can usually be assumed. This can not be necessarily presumed for older people [11].

3.1 Older people and technology

Of course not all elderly people shy away from contact with modern technology—they are as diverse an age group as any other. And the percentage of older people using and being comfortable around computers is rising [9, p. 363]. Yet research indicates "that there still exist significant generational gaps despite the rapid growth in Internet use among older adults" [11, p.1680]. Access and usage of digital technology are not necessary required of older adults, yet they lead to improvements in safety and ease of life. As digital technologies become more and more pervasive (for example buying train tickets or payment via smart-phone) it becomes more and more necessary to be at least somewhat acquainted with them. Games playfully provide a casual approach to digital media and the intergenerational aspect allows for help through younger generations.

3.2 Overcoming initial hurdles

Due to various factors, some elderly people often minimize their use of technology or try to avoid it altogether. This could also be seen in our study (see section 5.1.2)—most participants stated that they had few or no experience using computers and/or smart phones. Often, they would show insecurity when approached with the idea of playing a game on the computer. A number of them stated that they were not the right person for computers and that they where afraid to fail, even after we explained that the study was not a test of their abilities.

It follows, that the transition from watching a digital game to playing it has to be made as natural, unobtrusive and intuitive as possible if we want to entice play in a semi-public setting. Al Mahmud et al. [2] observed groups of people aged 65 to 73 play a board game, as well as a digitally enhanced version of the same game. They report increased immersion as well as flow in the version that was supported digitally using a projector [2, pp. 404–405]. Both versions were reportedly well received and the players adapted well to the digital elements cite [2]. Using familiar elements such as cards and tangible game pieces seems to ease the transition into digital media.

Brox et al. [8] propose persuasive strategies to make *exergames* (games that include physical exercise) more appealing to an older age group. in this case persuasion means "[. . .] the deliberate use of communication to change attitudes and behavior of people" [8, p. 547]. They state that *social influence* can play an important role in getting elderly people to play games [8, p. 548]. Additionally users are persuaded to play exergames when they use attractive and friendly user interfaces and provide information about the users past behaviour and progress in a way that is understood by players [8, p. 548]. In the case of our prototype, younger relatives could play an important role in guiding and supporting their grandparents during the gameplay. Abeele et al. [1] propose that that hurdles inherent in digital interfaces can be minimized through *enactive interaction*, where digital actions are represented by physical movements that resemble those actions and therefore are intuitive for the user, because they already know them [1]. An example for this would be the Wiimote[1]. Players swing the controller emulating movements used in sports (i.e., tennis or golf), which are then re-enacted by their player character.

3.3 Game design for elderly people

One of the main challenges this project faces is designing a game accessible to an older audience. Elderly people face a multitude of difficulties when confronted with modern computer games. These mainly result from two factors: Lack of familiarity with digital media and physiological problems [43]. These problems include using certain controllers, pressing buttons on accident and menu navigation [24]. One of the biggest hurdles lies within time sensitive tasks [24, p. 3]. Due to low reaction times elderly people often repeatedly fail to complete those challenges and are thus discouraged and less likely to continue play. Rogers et al. [43] summarize problems elderly people face when confronted with technology. Age related reduction in the ability to recognize colors as well as a more limited useful field of view and a higher sensitivity to glare are impair use of digital technology greatly [43, pp. 133–135]. Additionally, some aspects of memory and attention weaken with age [43, pp. 135–136]. Elderly players often face problems when it comes to game speed as well. It is therefore important to provide adjustable game

[1]The Wiimote is a controller created for the Wii-console created by Nintendo Co., Ltd. (https://en.wikipedia.org/wiki/Wii_Remote – accessed 05.06.2017.)

parameters to keep the game difficulty and speed at an appropriate level [32]. The aforementioned hurdles also play a significant role when creating interfaces for elderly people. Buttons are easily missed and distracting elements can impede understanding. While these aspects are important, this paper focuses more on their impact on game design. Due to these handicaps, as well as a lack of familiarity with new digital technologies, older people often develop computer-anxieties [43, p. 141]. It is, of course, important to note that not all older people suffer from every one of these impairments. But, in general older adults

> "[. . .] have specific capabilities, limitations, and experiences that will affect their interactions with technologies. Moreover, the needs and preferences of older adults are not necessarily the same as those of younger adults." [43, p. 163]

Yet, a population of older gamers exist. De Schutter et al. [16] surveyed 124 older individuals who identify themselves as gamers. Most of these can be classified as "mainly PC users, who like to play casual games for the challenge" [16, p. 164]. The most popular genre in that age group seems to be puzzle games [16, p. 165]. It is worth noting however, that the survey included participants aged 45 to 85, a significant portion of which are younger than our audience. Jay at al [30] state that attitudes of older people towards computers can change, and that exposure to computers is a way to do so in a positive direction [30, pp. 253–254]. However Ansley et al. [3] note no such change. This could be due to the fact that the subjects' contact with computers during the study was relatively brief (filling out a questionnaire) and that the participants where positively predisposed towards computers to begin with [3, p. 110–111]. A correlation between positive predispositions towards computers and the high average grade of education (13.63 years of education in average [3, p. 111]) is possible.

For people that are negatively predisposed towards computers it should be beneficial to create contact points where older adults can experiment and play with computer games. Semi-public environments such as museums have the potential to offer such opportunities at a relatively low cost for the visitors.

3.3.1 Guidelines for game design

Carvalho et al. [15] surveyed a group of individuals aged 60 to 74 years and compiled a list of guidelines to make games appealing to the elderly [15, p. 8].

1. Follow usability heuristics for mobile devices and consider the impairments of the elderly, such as: the possibility of resizing the screen and font size, avoiding large texts with small font and small and low resolution images, using color high definition, using sounds and vibration as a way to call attention.
2. Clarify the benefits that the game will provide for the seniors.
3. Avoid the need for high levels of attention.
4. Provide entertainment: the game should be fun.
5. The game should have a story that motivates the advancement of the phases, not just a matter of increasing the level of difficulty from one phase to another.

6. Offer the option of disabling the feature of timing: users who prefer not to have time limits can go through all the stages only by overcoming the obstacles of the activities of each phase, without worrying about the time.
7. Offer motivational feedback at the time of advancing phases and making errors.
8. Offer the option of setting the difficulty level of the game.
9. Offer appropriate cognitive challenge: the game should be neither too simple nor too complex; the senior players should feel confident to play and be proud of their ability. Therefore, the importance of the encouraging feedback, even in the most simple stages.
10. Avoid monotonous and repetitive tasks that discourage users to play the game for long: if the player does not play, he does not achieve the benefits that the game can provide.

It becomes clear that a majority of those items focus on lessening the difficulty of the gameplay. But an important aspect of game design for older people is the initial hurdle. Ijsselsteijn et al. [27] report that the cost of learning to use new technologies and new types of interaction often keep older people from doing so [27, p. 18]. Yet it is the acute lack of perceived benefits that plays an even bigger role in a lack of willingness to learn. It is therefore of utmost importance to create a clear set of benefits (such as spending time with grandchildren) and keep the cost of learning at a minimum by using smart interfaces and a shallow learning curve. The inclusion of an extensive practice mode helps players to get acquainted with games at their own pace. Derboven et al. [19] state that such a mode is beneficial and reduces insecurities [19, p. 64]. It is therefore beneficial to focus on learning goals instead of performance goals to increase confidence and enjoyment of the game [27, p. 19].

It would be wrong to say that older people do not adapt to new technologies at all. They must however be convinced that

> "[...] the benefits of the new system clearly outweigh the associated costs. Such costs may be investments of money (e.g., purchasing new products), time (e.g., learning and practising a new method), or effort (cognitive resources required for learning)." [43, p. 144]

Those costs and benefits may vary wildly from the perceived costs and benefits younger users experience. Vast differences may even exist in humans of the same age group.

3.3.2 Communication

Lindley et al. observe attitudes and preferences of older adults towards communicating with their grandchildren [38]. They note, that preferred mediums of contact "allow for a level of intimacy that is personalised", should be *focused and intense* and *support reciprocity* [38, p. 1699]. And even though most participants of their focus groups wished for more communication with their relatives, they themselves did not like being connected for prolonged amounts of time, as they had busy lives of their own [38]. As such shorter, but more intense personalized communications seem to be preferred. Collaborative games can offer the potential for events like this, if they are designed to support them. Ideally play-sessions are short but require intense communication to stimulate all players. To achieve this *asymmetry of information* and *asymmetry of ability* (see section 2.3)can be used.

Older people often wish to "[. . .] dedicate time to creating thoughtful and reflective communications, and in their desire to breach distances to retain contact with loved ones" [38]. Technology can be the key to creating and upholding this contact—if those benefits are communicated clearly enough to overcome initial hurdles.

3.3.3 Benefits of play

Multiple studies found that playing computer games at an older age showed improvements in cognitive as well as physical abilities. Basak et al. observed 19 people of the average age of 70 without existing gaming habits over a period of eight weeks where the participants played a strategy-based video game regularly [6]. They found significant improvements in executive control functions compared to the control group [6, p. 775]. Tian linked the activity of giving and receiving support to a significantly higher self-esteem in people of the older generations [45]. Collaborative games provide a way to increase time spent with each other as well as showing support for your teammates. Other studies also show the effects of digital games on mental capabilities and well being of elderly people [20, 22, 36] as well as their physical health [21].

Additionally to health benefits through play, Lim et al. [37] propose a system that enables the collection of data from games to monitor the user's condition, which could give doctors additional information that would not depend on surveys or personal statements. Delello et al. [18] showed that the usage of iPads and social media websites have the potential to reduce social isolation during retirement—once initial hurdles of usability and technological literacy are overcome [18, p. 21].

Elderly people are as diverse a target group as any other. Comfort with technology ranges from none all the way to very proficient. It is as such difficult to specify an exact target age for our prototype. In the interest of our goal to reach as many people in that age group as possible and increase their understanding and trust in technology it is important to build our prototype in a way that allows even people with no prior understanding of digital computer interfaces to interact with the game as smoothly as possible.

3.4 Intergenerational play

A game designed for intergenerational play not only has to be designed to accommodate young and old users separately, but shape their interactions and communication in a way that benefits all. De Schutter et al. [17] propose game design guidelines for meaningful play in elderly life . Amongst others, they strongly argue for games to support "vicarious play", where elderly people don't play actively but support the player (usually their grandchildren) without needing to interact with a controller [17, p. 87]. Yet, other projects and studies support a more active involvement of older people in the gameplay process. This section outlines existing games and prototypes that seek to involve the older generation in digital play. Their mechanics and implementation will be analysed according to the guidelines presented in chapters 2 and 3.

3.4.1 *Xtreme Gardener*

Rice et al. [42] created *Xtreme Gardener*, a collaborative game where the players' objective is to nurture and grow a group of garden plants by manipulating and controlling a number of different weather elements using the silhouette of their upper bodies as shown in figure 3.1. They have to guide the direction of rain, shield the plants from too much sunlight and other weather conditions and hazards (such as attacking birds) [42, p. 1083]. *Xtreme Gardener* was not created explicitly for intergenerational play but to observe differences in communication between different age groups. And while the older participants (aged 55–74) fall into the demographic that is relevant for this paper, the younger group (aged 15–20) is older than our target audience. In their analysis Rice et al. observed different pairs of people play the game together. Players where paired in combinations of Old-Old, Old-Young and Young-Young. They noted, that "the older participants had a tendency to prefer more explicit instructions, while the younger participants preferred instructions that allowed autonomy in their decision-making." and that "[. . .] verbal communication was highest when participants had to problem-solve together" [42, p. 1089]. Many older participants noted the steep learning curve and Old-Old pairs generally had a harder time learning the rules of the game [42, p. 1087]. Yet "While poor instructions were also perceived to hinder their initial understanding, paradoxically, this was seen to encourage cooperative behavior in understanding the purpose of the game" [42, p. 1087]. This points toward the *collaboration paradox* as described in section 2.1.1. In general Rice et al. observed that

> "[. . .] the older participants demonstrated less cognitive flexibility in terms of their understanding of the game mechanics. More interesting however, while the younger participants readily accepted differences in the gameplay elements to real life knowledge (i.e., in the nurturing of plants), a number of the older participants found it difficult to do so. At times, this resulted in conflicting conceptual models in understanding the gameplay logic, and subsequently weaker performance in the game." [42, p. 1088]

This heavily points towards the importance of using pre-existing knowledge and conventions when designing mechanics for intergenerational games—with the included benefit of creating a learning environment for younger users. *Xtreme Gardener* does not rely on built in asymmetries to create collaboration. Players work together because they are given a shared goal that cannot be completed by a single player on their own, simply because there is too much to do for a person to handle alone. Using a silhouette based control scheme the designers use the bodily limitations of participants (e.g., not being able to exist on more than one location at the same time, as is the case for most humans) to ensure game balance. Asymmetries develop naturally as players take on different responsibilities like protecting the plants from the sun or securing a steady supply of water. Thus an *asymmetry of goals/responsibilities* [26, p. 353] is created. Since *Xtreme Gardener* does not feature any dedicated private spaces, it is difficult to apply the MOY-Framework [25, p. 3]. If we look at resources spent instead of interfaces a clearer picture emerges. Players spent their private resources (in this case the space their silhouettes take up and the energy required for movement) to overcome challenges in a shared space which correlates at least somewhat to the **MO–YO** configuration.

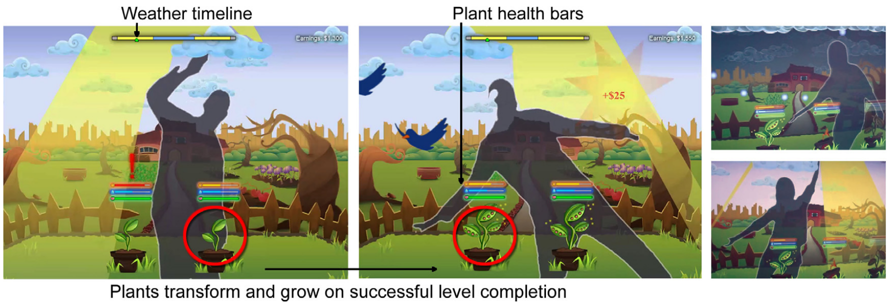


Figure 3.1: *Xtreme Gardener*. Silhouette controlled gameplay in practice. Image source: Rice et al. [42].

The game can be considered *loosely coupled* since no actions taken directly require other players involvement [7]. *Xtreme gardener* shows, that problems in understanding digital interaction methods can be overcome by communication between players but to be effective at least one player needs to have some understanding of the subject. In the best case scenario intergenerational play enables a flow of information in both directions that allows all players to benefit.

3.4.2 *Age Invaders*

Another project that focuses mainly on the physical qualities of intergenerational play is *Age Invaders* [33]. Based on the classic game *Space Invaders*[2] Age Invaders uses a floor display that players interact with by moving around in the physical space, making it easy and intuitive to interact with the game (as seen in figure 3.2). The game is designed to be played by older people and their grandchildren while the parents can join in remotely and affect the game. Besides the encouragement of physical movement the most interesting aspect of Age Invaders is that the game is balanced to compensate for older peoples disadvantages. This makes a fair competition possible [33]. This approach relies mainly on *asymmetry of challenge* [26] (see section 2.3). While this can work to create an even playing field for both younger and older players, it does little to take into account the differences in preference and interest between younger and older people. *Age invaders* includes some other asymmetrical elements in form of puzzles. “When a player steps on a puzzle, the game enters a “hyperspace” mode where it is specially designed to enhance collaboration between the players” [33, p. 246]. In this mode the younger participants have to solve a puzzle while the older players help by giving hints. While this mode is strongly asymmetrical I argue that the older players are being reduced to mere spectators, unable to directly participate in the game themselves. This mode fails to adhere to the guidelines for collaborative games created by Zagal et al. [47]—neither does it provide the individual players with different responsibilities or abilities nor does it create a tension between individual utility and team utility [47, pp. 30–34].

Age invaders succeeds in creating a low barrier of entry by providing simple controls and easy to understand game mechanics. Ease of access is hindered somewhat through

[2]Space invaders is a video game released in 1978 by Tomohiro Nishikado. The player has to stop waves of aliens from invading earth by shooting them.

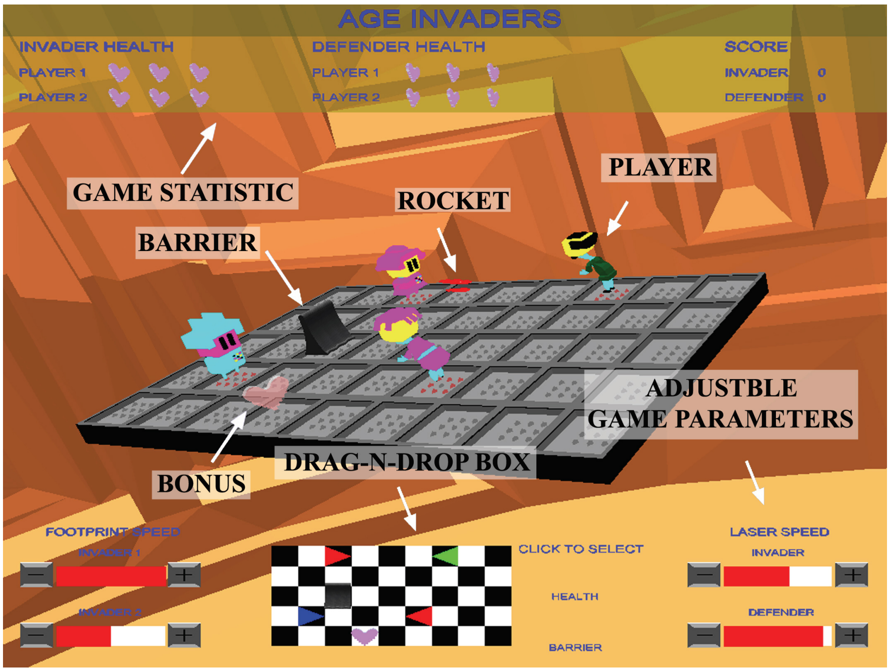


Figure 3.2: A graphic overview of the game *Age Invaders*. Image source: Khoo et al. [33].

the necessity to put on special shoes with Radio-frequency identification (RFID) tags to be able to play. This, and the size of the floor plates and complex physical set-up limits opportunities for play to supervised events and makes private usage not feasible.

3.4.3 *Atomium*

Abeele et al. [1] take an alternative route when balancing their game for different generations. In their mini-game *Atomium* players have to repeat simple movements using a Wiimote to "[. . .] screw (by rotating the Wiimote as a screwdriver), rub of some dirty spots (by rubbing in the air with the Wiimote) and put one of these balls in the right place by swinging a crank [. . .]. Whoever finishes first, is the winner." [1, p. 431] To do this players use simple, straightforward motions which are easy to learn for both older and younger users, according to the principle of enactive interaction [1] (see figure 3.3). And while this certainly makes it easy for older people to quickly learn the game, the application is limited to very simple games that rely on motion controls. Keeping the difficulty level very low for all players may also lead to boredom in more experienced participants (this phenomenon will be more closely observed in chapter 5).

Abeele et al. opt for a competitive game-design in order to increase communication. They state that "In order to foster social interaction between generations, the game should stimulate competition" and "In order to stimulate competition, the game should offer a goal that can only be achieved by one player, to the exclusion of other competitors. Furthermore, the game should offer non-parallel play where players should be able to directly influence each other's actions in the game" [1, p. 427]. The focus on competition seems to have some merit—Abeele et al. report animated discussions and friendly banter between participants [1, p. 432]. The influence of competitive and collaborative gaming modes on communication is not completely clear and warrants further research (see section 6.1.6).

Both *Age Invaders* and *Atomium* try to balance intergenerational play by either giving older players a mechanical advantage or keeping the game simple enough to be understood immediately by older and younger attendants. Both approaches have value, but severely limit possibilities for game design. It should only logical to create distinct roles for players of each generation which allows us to cater to preferences of both older and younger players without sacrificing complexity. At the same time this fits very well into our design goals for collaboration, as it emphasizes the need to work together since one player cannot succeed without the unique possibilities the other role provides.

3.4.4 *Curball* and *Distributed Hide-and-Seek*

A game that focuses more on distributed roles and responsibilities is *Curball* [31], a variant of bowling that includes digital elements. Kern et al. designed the game to be played by children and their grandparents. The goal of the game is to throw a ball—if it reaches the goal without hitting any obstacles both players win. The younger player is in control of the playing field - they can rearrange multiple objects in certain ways to make it easier for the elderly player to throw the ball. The elderly player (while possibly being in a completely different location) "throws" the ball by manipulating a tangible object via simulating a throwing motion. The set-up is shown in figure 3.4. The two players can talk to each other and coordinate their approach [31]. While the game design seems very simplistic (there is limited re-playability and the solution, once arrived at, doesn't require any active involvement on the child's part anymore) it still uses the different roles of children and grandparents to a great extent. Older players act as guides while their younger partners work on the obstacles. There are strong elements of *asymmetry of ability* and *asymmetry of goals/responinsibilities* [26]. In contrast to previously presented projects *Curball* uses *asymmetry of interface* to create a game that is very different depending on the side a player is on. This allows the designers to better take into account the unique circumstances and preferences of players of different age groups.

Similarly, *distributed Hide-and-Seek* [46] enables grandparents to play hide-and-seek with their grandchildren over long distances (as shown in figure 3.5). Both players can play from their houses but are in constant voice communication with each other during the game. The hider has a complete map of the seekers house. On their platform they can hide a virtual present (like an image or a text) anywhere on the map. The seeker now has to go around his house, using a Bluetooth enabled PDA to find the hidden present. Locations are tracked using Bluetooth beacons that are spread around the house. Once the treasure is found players can play again or switch roles. One of the problems the project is facing is the limited accuracy of bluetooth beacons. Additionally a large amount of work is required to set up a test environment at a home. Bluetooth beacons have to be placed in multiple spots of the house and an accurate model of the home has to be created [46]. Both these games try to enable players to play over long distances while still including tangible elements and the need for movement. They also both embrace the possibility for asymmetrical gameplay.

3.4.5 A different form of collaboration

Both *Curball* as well as *Distributed Hide and Seek* are not purely collaborative games nor purely competitive games. Each player follows their own objectives, but not necessarily to the exclusion of the other player. To analyse the unique relationship between the players in *Distributed Hide and Seek* we can look at the goals of the players. The goal of the younger player is simple: Find the virtual object the other player has hidden in the house as quickly as possible. For the older participant the objective is less straightforward. Their goal is not to have their grandchild to find the object as fast as possible—they have to hide it after all. It is, however also not their goal to make the object impossible to find—this would limit the enjoyment of both parties drastically. The objective of the older player is simply to hide the object in a location that is a challenge for the younger player to find, but ultimately they want them to find it. They take on a guiding role, focused on creating a pleasurable game experience for the other participants. This concept is similar to many tabletop role-playing games (see section 4.1.3). Having the older player be the guide and creating or modifying the experience for the younger participant on the fly could be an interesting concept for future reasearch and projects.

Figure 3.3: Participants playing *Atomium*. Image source: Abeele et al. [1].

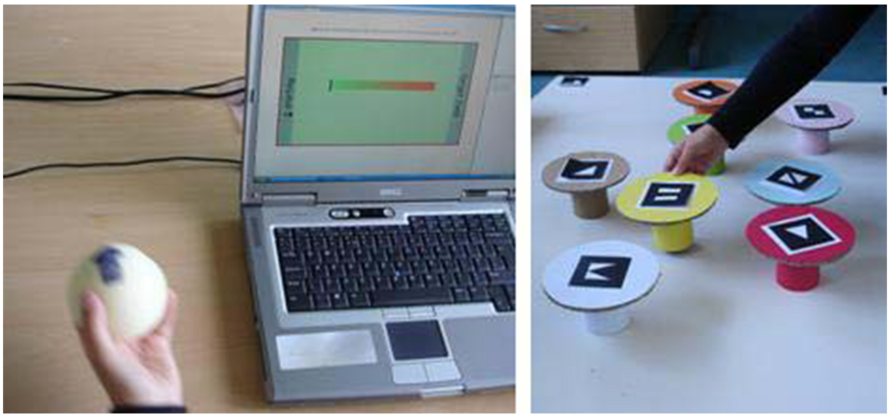


Figure 3.4: The *Curball* set-up. The older player (left) has a tangible ball they can control using a throwing motion, the younger player (right) places obstacles for the ball on a playing field. Image source: Kern et al. [31].

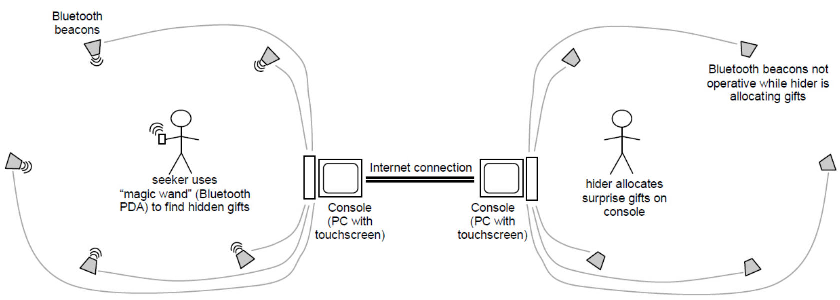


Figure 3.5: The set-up of *Distributed Hide and Seek* allows for remote play. Image source: Vetere et al. [46].

Chapter 4

Game analysis

In this chapter two commercially available collaborative games are examined more closely in order to find elements that support collaborative play and communication. The board game *Mysterium* [39] and the digital computer game *Lovers in a Dangerous Spacetime* [48] are briefly explained and then analysed. It is shown how elements of asymmetry can be used to foster collaboration.

4.1 *Mysterium*

Board games provide a convenient opportunity to analyse game mechanics without having to focus on elements of digital interfaces, physical dexterity and knowledge of interactive media. As such we can look at *Mysterium* [39] as an excellent example of how to use asymmetrical game design to foster collaborative play.

Mysterium [39] is a collaborative board game for two to seven players. It fits the definition by Zagal et al. [47] for a collaborative game since all players either win together or lose together [47, p. 25]. It also relies heavily on asymmetry to make play interesting. One player takes the role of the ghost of a murder victim. The other people are mediums trying to identify the murderer by means of seance. Mysterium is closely coupled when observing play between the ghost and other players, since each has to wait for the actions of the other to proceed, but loosely coupled when observing play between the mediums themselves because players can help each other freely without waiting for other steps to be complete [7].

4.1.1 Elements of asymmetry

In this section I analyze asymmetric game mechanics that exist in Mysterium according to the list of possible asymmetric game mechanics (see section 2.3).

Asymmetry of information

The main mechanic of the game relies on an asymmetry of information. The ghost is equipped with all the information the other players need to find out at the beginning of the game.

Figure 4.1: A screenshot of the digital version of the board game *Mysterium* [51]. On the right side the cards given by the ghost to help the players figure out the murderer are visible. On the bottom side the different suspects are displayed.

Asymmetry of ability

While the ghost has all the information, their ability to influence the game is very limited. Each round they randomly draw seven cards which they in turn hand to the other players. Each card is illustrated with different objects or scenes that can be rather surreal in nature. The mediums then have to guess a person, location or weapon the cards could point to. The ghost then tells them if they are wrong or right. The only mechanical influence the ghost has on the game is deciding which card to give to which player (an example for this can be seen in figure 4.1). To restrict them even further, the game doesn't allow the ghost to speak or mimic in a way that could point the other players towards their correct answers.

Asymmetry of challenge

While the challenge for the ghost is of a slightly different nature than the challenge for the mediums, at its core Mysterium is still a game of interpreting images. So even though the ghost has all the information, and the other players have none both sides are faced with the essential question "which target could this illustration point towards?"

Asymmetry of interface

Mediums interact with the game by placing small tokens on their suspected answers. The playing field includes a hourglass to limit available guessing time, a cardboard clock used to count rounds and various other elements used for counting points and decorative purposes. The ghost can see all these object, but cannot interact with them directly. They have their own private space behind a cardboard screen where all their information and cards are stored.

Asymmetry of investment

In general all players play the game for the same amount of time, although there are a few periods where the ghost has to prepare their cards for the next rounds and the mediums are idle. These moments are usually used to chat about the previous round or speculate about the next cards. Conversely, while the mediums are taking their guesses, the ghost has nothing to do. These time periods are not without activity however, as the ghost needs to play close attention to the other players' thought processes and actions.

Asymmetry of goal/responsibility

All players follow the same goal, which is essential for collaborative games, but the ghost takes on the responsibility of guiding the other players into the right direction. While this section focuses mostly on the asymmetries between the ghost player and the mediums, there are some small asymmetries between the individual mediums as well. Those develop, because each player is dealt a different combination of person, location and weapon they have to find out. Additionally, since those clues have to be uncovered one after the other, one player could still be stuck at trying to find the culprit while another has already moved on to the location or even the weapon. However, since the game is collaborative in nature, players are helping out each other constantly, working with the same clues, trying to solve the same mysteries, therefore reducing the amount of asymmetry.

4.1.2 Possible disadvantages of asymmetrical analog games

Analog games depend on the players themselves to uphold the rules. Especially in collaborative games, where the opponent is the game itself playing requires a certain amount of discipline. In the case of Mysterium, the ghost can easily hint at solutions through physical reactions to the other players' guesses or even tell them through carelessly spoken words. Especially when playing with children this can happen rather quickly, but on the other hand it also provides a good opportunity to practice self control.

4.1.3 Similarities to tabletop role-playing games

This concept, where one player is in possession of most of the information in the game world and the other players act upon this world is very similiar to existing tabletop role-playing games such as *Dungeons and Dragons*[1]. This configuration allows for more variety in storytelling as well as added replay value. Tabletop RPGs create a unique variation of collaboration as the Game Master (the player who is in control of the imagined world) creates and controls opponents and challenges for the players, but ultimately wants them to succeed. This puts the Game Master into the position of a game designer rather than a player themselves.

[1]First Edition designed by Gary Gygax and Dave Arneson in 1974, now published by *Wizards of the Coast* (http://dnd.wizards.com/).

4.1.4 Lessons

In many collaborative games one player often takes the lead and makes most decisions, often to the detriment of the other players' enjoyment. Mysterium avoids this problem, since there is never an objectively superior answer as everything depends on interpretation. This allows for an interesting back and forth between mediums where different theories are put forth and rejected, often in a matter of seconds.

Mysterium makes good use of asymmetry of information and the subjectivity of interpretation to create a collaborative game experience that engages all of its players most of the time.

4.2 *Lovers in a Dangerous Spacetime*

Lovers in a Dangerous Spacetime [48] is a computer game that was released in 2015 by the developer and publisher *Asteroid Base*. It can be played alone or collaboratively by up to four players. The game allows players to take on various different roles that can be switched at a moments notice, thus creating a highly dynamic asymmetrical gameplay. The goal of *Lovers in a Dangerous Spacetime* is to steer a spaceship through various levels while avoiding obstacles like asteroids and laser beams and defeating enemies. The players need to find "captured friends"—bunnies that have been imprisoned by evil forces in each level to proceed. Players can run around their ship and man various stations to control elements of combat (an example of combat is shown in figure 4.2). The steering wheel allows them to move the ship, four different turrets can be used to fire in any direction, a shield that protects one side of the ship can be moved around, a big cannon that rotates around the ship constantly can be fired and the map station can be used to take a look at the current level and progress. Single stations can be upgraded by using gems that are found during gameplay. Communication is an important part of the game, since different roles need to be assigned and changed in short intervals.

While the single-player mode provides the user with AI-controlled companions, when playing cooperatively the players are on their own. Collaboration is necessary because there is more obstacles on screen at any given time than one player alone could handle and often two different elements of the ship are needed at the same time (e.g., shields to protect the ship and turrets to fire at enemies). *Lovers in a Dangerous Spacetime* constantly switches between loosely coupled and closely coupled gameplay, as some obstacles require coordinated actions and other can be completed independently from other team-mates.

4.2.1 Elements of asymmetry

In this section the asymmetric game elements of *Lovers in a Dangerous Spacetime* are analysed (see [26, p. 353]). It is important to note, that the basic abilities of the character each player is in control of are the same. They can move around the ship and control a station. It is those stations that lead to the asymmetries present in the game. The asymmetries are not as pronounced as in *Mysterium* but nevertheless allow for varied collaborative gameplay.

Figure 4.2: A screenshot from the game *Lovers in a Dangerous Spacetime* [48]. The players' spaceship (middle) is attacked by enemies.

Asymmetry of ability

The abilities of each player are defined by their position in the ship. The need for collaboration is created by the inability of occupying more than one station at any time.

Asymmetry of challenge

Each station comes with it's own set of challenges. As a pilot the player has to be aware of their surroundings and plan ahead. In contrast a player using the shield has to react quickly to incoming fire and adjust the direction of the shield accordingly.

Asymmetry of goal/responsibility

Like in *Mysterium* all players follow the same goal—making it through the level while taking as little damage as possible. Still, they're responsibilities shift according to their position on the ship. Additionally the player's responsibilities are effected by future events. If a players is steering the ship at any point in the game and enemies appear, their responsibility might change to reaching a relevant turret as soon as possible. This shift is motivated by the situation as well as by the communication between the players. Which player occupies which station is a focus of constant discussion.

4.2.2 Lessons

Lovers in a Dangerous Spacetime is a collaborative space game with two-dimensional gameplay that uses different roles and responsibilities to foster collaboration in players. The dynamic switching of roles allows players to easily find a play-style that suits them most and requires all team-members to communicate effectively. Allowing for players to choose their own positions at any time follows Zagals Lesson 2 [47] of allowing each player to make individual decisions or mistakes.

Chapter 5

Design and implementation of the prototype

Co-smonauts is a collaborative game for two players. Together, they take control over a spaceship and have to steer it through various levels encompassing our solar system. Every level has their own challenges to complete. Co-smonauts is designed as a proof of concept for the theories discussed in this Thesis. The design process of the game is outlined in this chapter.

5.1 Designing Co-smonauts, a game for intergenerational play

5.1.1 Design constraints

The final prototype is going to be displayed for a prolonged period of time in a museum setting. Thus there are a few prerequisites that have to be kept in mind while designing a prototype.

- *Short duration.* Players should have to spend 10 to 15 minutes with the game at most, while still experiencing most of the content.
- *Quick learning curve.* The core concepts of the game should be easy to grasp.
- *Educational content.* Due to being situated in a museum context, the subject matter of the game should include some content that facilitates learning.

According to the research the game additionally needs to be designed in a way to satisfy both younger and older players.

- *Collaborative game design.* The game should be played collaboratively to foster connectedness.
- *Asymmetric game design.* The game should provide different roles for different players to speak to their individual preferences and skills.

5.1.2 Design process

The design process for *Co-smonauts* began in January 2016 and proceeded in three phases. First the concept was explored and the two preliminary prototypes *Power Grid* and *Mr. Robojump* (see sections 5.2 and 5.3) where created. *Mr. Robojump* and other games where then tested in a preliminary design workshop in July 2016 (the results of which can be seen in [35]). The goal was to identify game mechanics that support collaborative play. Three desired core elements where identified. The final prototype would include

- elements of customization,
- an iterative game loop that would allow players to quickly test different configurations and
- tangible items that would allow players to interact on a physical level.

After the workshop the design phase for the final prototype began. Elements of *Mr. Robojump* where used and built into a space exploration game (the prototype will be described in more detail in section 5.4). In May 2017 a study was held with the primary goal to identify which type of interface worked best with older users. 26 Participants aged 60+ where invited to play an early version of *Co-smonauts*. A member of the research team would take the role of their team-mate. They played three different levels, using one of the following modes of input each:

- Buttons on a touch-screen,
- sliders on a touch-screen and
- a physical flight-throttle controller[1].

According to the questionnaires the participants filled out, the touch-screen sliders was the most liked mode of input (preferred by 53.8% of participants). This variant was then used in all further versions of the prototype. In July 2017 another study was held in order to determine the most liked set-up for a building phase where players could build their own spaceship. Again, three variants where tested:

- Using a 27 inch touch-screen to build the spaceship.
- Placing tangible items on a grid to build the spaceship.
- No building phase—the players would play the game using a pre-built spaceship.

This study was held in the Welios Science Center Wels during normal business hours (the setup is shown in figure 5.1). Visitors where invited to try out the prototype and fill out a questionnaire afterwards. Although it was tried to focus on the intergenerational set-up (one older player playing together with a child), this could not always be guaranteed. Sometimes persons old enough where simply not present, other times multiple children wanted to play or switched roles midway through the game. Although this hindered the study somewhat, it was a good opportunity to observe how play would work in a museum environment where it is impossible to predetermine the different roles. The results of the study remained relatively inconclusive. Using enjoyment as a metric, the variant without a building phase was clearly inferior to the others, but using a touch-screen or tangible objects did not produce results that differed much. In the end it was decided to focus on a touch-screen based interface for the final prototype at first. If the possibility arose, a variant using tangible objects would be created. A final long term study is planned for late 2017 where the prototype will be exhibited in the Welios Science Center for a prolonged period of time.

[1] http://www.saitek.com/uk/prod/quad.html

Figure 5.1: Visitors playing *Co-smonauts* during out second study.

5.2 *Power Grid*

The first possible game design was called *Power Grid*. It was conceptualized as a collaborative puzzle game where players had to attempt to create a network of power plants and cables to provide energy for a growing city. Players had to place tangible objects on a surface to build a city and create a power grid that would support all of the buildings. The challenge consisted of placing tetris-like blocks on the grid to achieve the best possible flow of electricity. An early paper prototype is visible in figure 5.2. Figure 5.3 shows a concept for the touch interface players would use to build their energy networks. Some ideas and variations of the concept included

- the construction of different buildings, that would in turn give the players access to more advanced energy tiles,
- interactive lighting, that would illuminate the tangible objects as more energy was provided,
- connections between tangible objects, that would be displayed via top down projection.

A paper prototype was produced and tested. Advantages of this concept did mainly lie in the educational possibilities. The energy grid could be modelled to closely resemble a realistic network, using different voltages for different purposes, as well as different ways of creating electricity. Additionally, awareness could be created for environmentally sustainable forms of energy and problems that arise when using other forms such as coal or nuclear energy.

Ultimately the idea was scrapped due to the high complexity as well as the difficulty of creating distinct roles for two players. For puzzle games the possibility of one player taking control of the solution and their partner being degraded to a mere spectator was

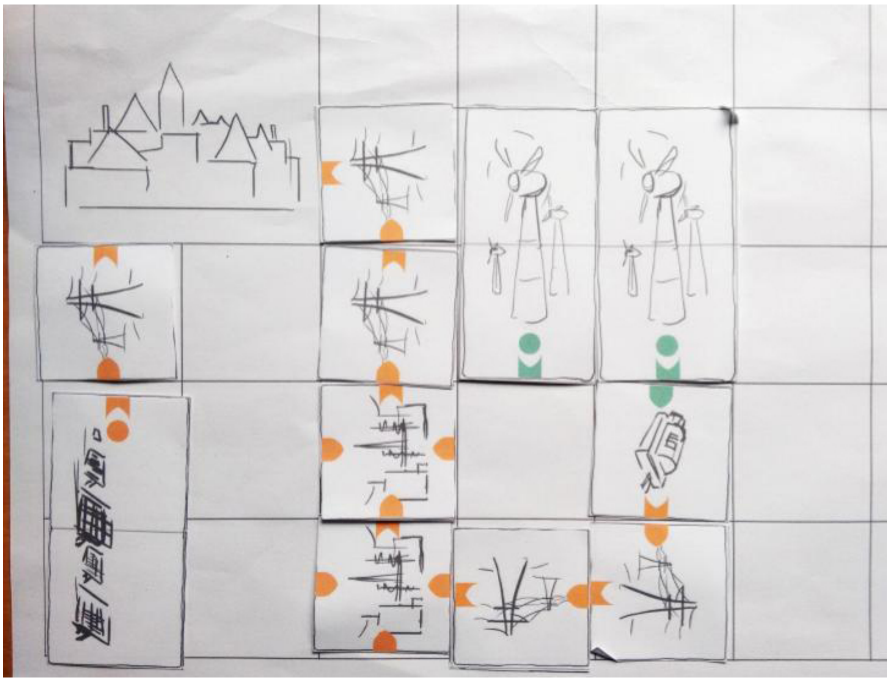


Figure 5.2: An early paper prototype to test out various game mechanics.

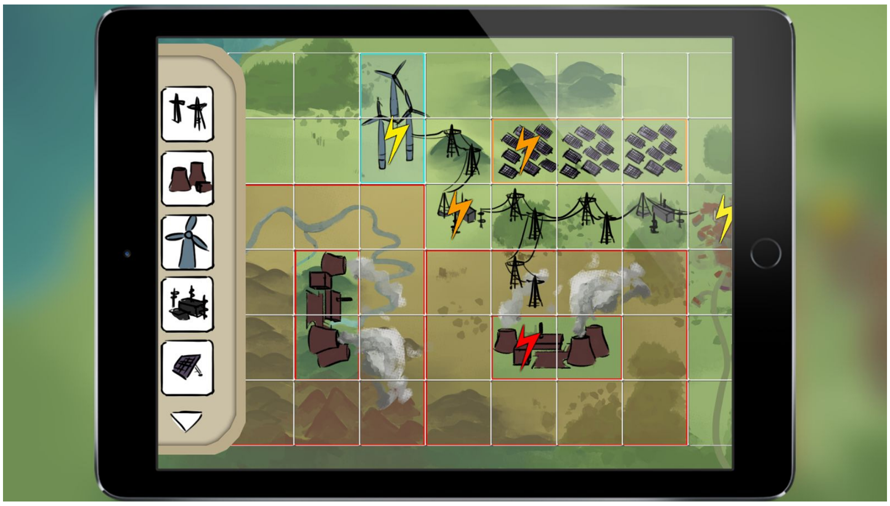


Figure 5.3: Mockup for the digital interface.

simply too great.

5.3 *Mr. Robojump*

Mr. Robojump was developed in parallel to *Power Grid*. In this prototype the goal of the players is to build a robot that jumps as high as possible. To achieve this, they have

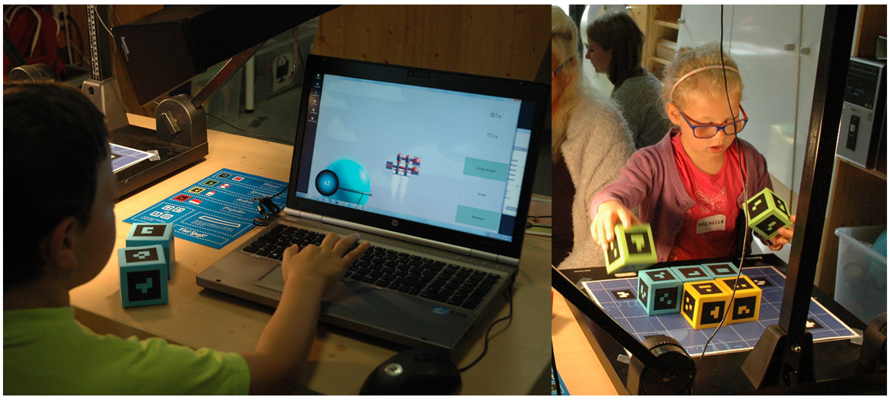


Figure 5.4: The first *Mr. Robojump* prototype being playtested at our first workshop.

to place tangible objects on a grid. These cubes are scanned in real time by a camera and tracked in unity using the *ARToolkit*[2] library. Players have access to different parts (springs, propellers, jets and weights) that are represented by cubes of different colors. Once the robot is complete, players can enter the play scene to test it out. Players have limited control over the robot while jumping to dodge obstacles that are scattered in the level. They can also get a short boost while in the air. Once the jump is complete players may try again or build a different robot.

This prototype was built in unity and used in the first workshop (as seen in figure 5.4) to observe interactions with tangible objects as well as an iterative game loop. It had a quick learning curve and players didn't have to stay a long time to experience all of the content. Still, it lacked educational content and didn't really specify different roles and responsibilities for the players. It might as well have been a single player game. The basic concept was then refined and built into a third prototype.

5.4 *Co-smonauts*

Co-smonauts lets players explore our solar system with their own spaceship. It uses multiple screens and tangible objects to create an immersive game experience. The game is controlled by two people who build their spaceship together and take on different roles trying to steer it.

5.4.1 Early concepts

The game design process for *Co-smonauts* started after the first workshop in July 2016. Early concepts for the prototype evolved out of *Mr. Robojump*. Instead of building a robot and jumping as high as possible, the mission of the players was to create a rocket using tangible interfaces. They would then try to fly up as high as possible. To reach a high score players had to balance the weight of the rocket with their fuel and other parts

[2] ARToolkit is a library that enables the user to track different symbols and images through cameras and is used to create Augmented Reality apps. It is also available as a Unity plugin (https://artoolkit.org/ – accessed on 05.06.2017).

such as shields or containers for objects. The younger player would steer the spaceship while their older partner would play the part of the navigator and look out for the best path as well as warn the other player in case of obstacles. The concept was then changed slightly due to various reasons:

- Our research showed that older people preferred calmer, more strategic play-styles without stressful time constraints.
- The museum environment lent itself to a more educative game design.
- The role of the navigator was more suited for a calmer setting as well.

5.4.2 Designing against fear

As shown in section 3.2, the initial hurdles when facing digital interfaces are often enough for older people to give up before even trying. But as IJsselsteijn et al. note, it is more often than not the perceived lack of benefits rather than the cost of learning that keeps them from doing it [27]. So for Co-smonauts design decicions were made to eliminate barriers of entry as much as possbible.

- *Tangible items.* The use of tangible items was motivated from the results of our first prototype as well as their ease of access. When entering the room, players do not have to interact with the digital interfaces at first, they build their spaceship only using their cubes.
- *Simple controls.* The navigator only has to interact with a limited amount of features, all of them controlled by three sliders.
- The navigator has enough time to get used to all the controls available to them.

5.4.3 First iteration

In the first iteration of the prototype we strongly focused on the role of the navigator.

Building phase

For our study in March 2017, the building phase was not yet important, since our focus was mainly on testing the interface and gameplay mechanics of the navigator during observation. Nevertheless, the phase was already implemented and fully functional. In the building phase players place blocks of different colour on a glass surface between them. These colors are tracked by the prototype using a webcam. Players have a limited space and a limited amount of cubes they can place to build their spaceship, there is however no time limit. The inclusion of the building phase was deemed important after the preliminary design workshop in July 2016. Bailey et al. [5] monitored presence and arousal of children playing adver-games. They found that both arousal and subjective feeling of presence increase when players can customize their own avatar [5, p.281]. After they complete the ship, they enter the exploration phase.

Exploration phase

The players enter a level that represents our solar system. Although all objects are three-dimensional, the navigation and gameplay takes place on a 2D-plane. Here the players

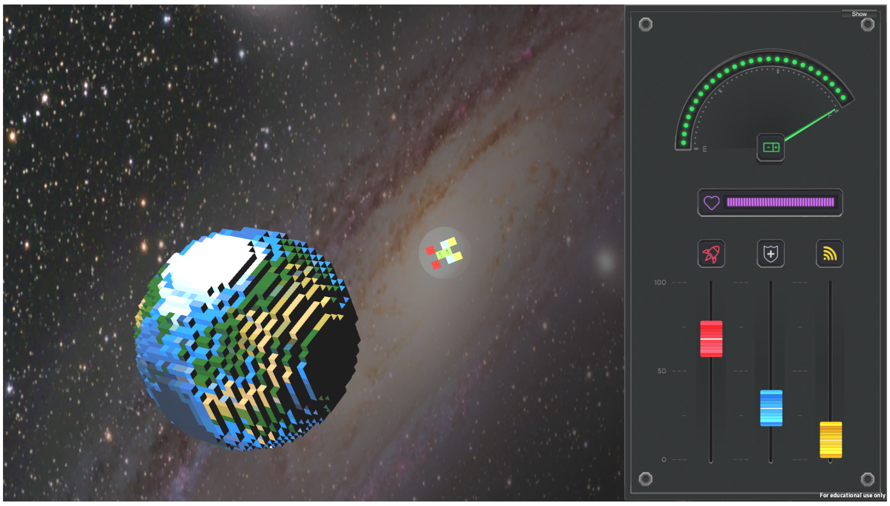


Figure 5.5: The view for the navigator in the first iteration of the Co-smonauts prototype.

have to take control over their spaceship and explore as many planets and moons as possible. In this phase the different roles come into play. The captain, who is usually played by the younger person, has direct control over the spaceship movement. Their job is to fly to planets, pick up energy packs and dodge obstacles on the way. However, they have a very limited view of their environment and must rely on the navigator to lead them. The navigator sees a bigger part of the environment and can thus help the captain with their endeavour. The navigator also has control over various functions of the spaceship. They can limit the thrusters to slow down the spaceship in dangerous territory, activate shields to protect the ship and put energy into the scanners to increase his range of view. All of these functions take energy – and how much energy the ship has depends on how the players built it. The goal of this phase is to find as many stellar as possible before the energy runs out or the spaceship gets destroyed by asteroids. A screen-shot from the exploration phase of the first iteration can be seen in figure 5.5. A schematic view of all physical components of the game can be seen in figure 5.6.

5.4.4 Applying guidelines

When designing the prototype the guidelines by Zagal et al. [47] (see section 2.1.3) where kept in mind. In *Co-smonauts* the tension between individual utility and team utility mainly manifests on the side of the captain. As they always have to balance the ships energy levels they can choose between individual utility (increased rangs of sight through scanners) and team utility (more protection through shields or more speed through thrusters). Since the captain relies more on mechanical skills an reactions this aspect was considered not as important. Lesson 2 was of little concern due to the nature of *Co-smonauts* as a digital game. In comparison to board games it is easier for a computer game to force players to make individual decisions and take individual actions. Separate input methods as well as separate displays allow for the game to fully control which player makes what decision. Lesson 4, ("[. . .] a collaborative game should

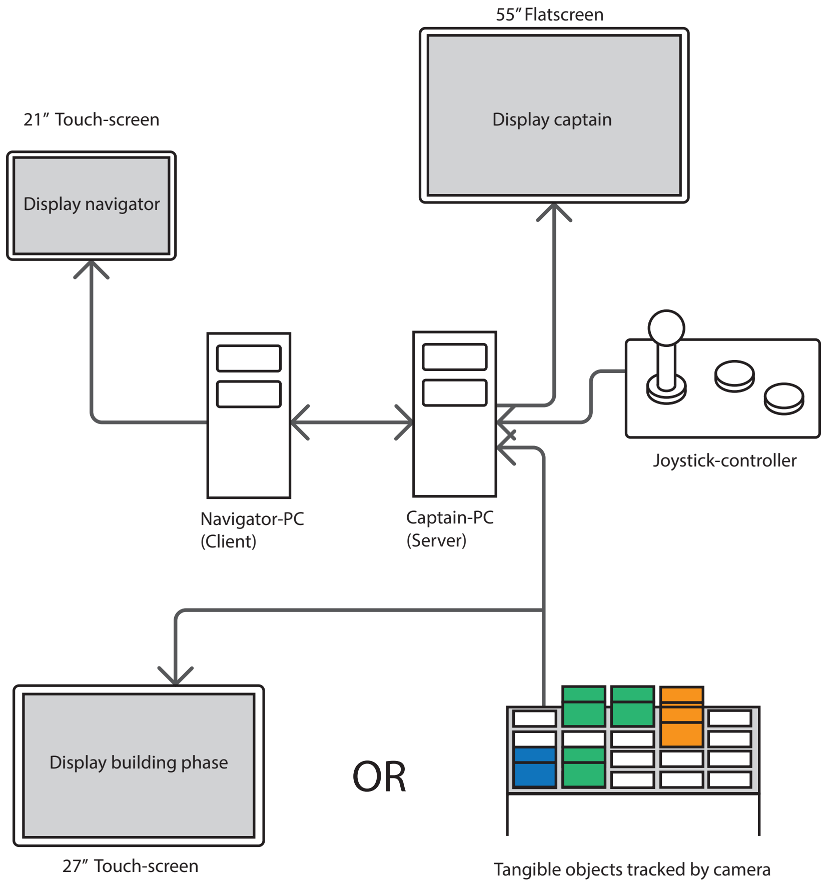


Figure 5.6: A schematic view of all components used to play *Co-smonauts*.

bestow different abilities or responsibilities upon the players" [47, p.31]) is at the heart of the design of *Co-smonauts*. It was the basis for separating the control of the ship into two distinct roles.

When applying guidelines it is always important to keep in mind the context of the game they are applied to as well as the circumstances that led to the design of said guidelines. In particular Pitfall 4 ("For a collaborative game to be enjoyable multiple times, the experience needs to be different each time and the presented challenge needs to evolve." [47, p.34]) was not of concern for the development of *Co-smonauts*. The semi-public setting makes it only necessary for visitors to enjoy plying through the game once. It is therefore not of importance to vary the gameplay to a great extent or provide enough content for multiple hours of play.

When looked at through the lens of the MOY-Framework [25], *Co-smonauts* mostly resembles the **MO–YO** configuration, where all players use resources in their private spaces to solve a common problem in the shared space. The common space is represented through the big screen all players can see. Both navigator and captain possess a private space (the touchscreen and the joystick that controls the spaceship) they use to solve the level. Yet, due to asymmetry in game design, Co-smonauts also implements other configurations at times. If, for instance the navigator spots an asteroid field in the path of the spaceship, he then may ask the captain to change their route. The captain then solves a problem in the private space of the navigator using his own private space (MY—"Mine is Yours").

5.4.5 Utilizing asymmetries

Asymmetrical game design elements where introduced to *Co-smonauts* to necessitate collaborative play. This section illustrates these asymmetries according to the possible elements of asymmetry as described by Harris et al. [26, p. 353] (see section 2.3).

Asymmetry of information

Co-smonauts distributes the information available to the players highly asymmetrically. Most information is imparted to the navigator. As the other player steers the ship, this creates a need for communication and thus collaboration.

Asymmetry of ability

Through the nature of the different roles allocated to each player their abilities to affect the game are vastly different. The captain can control the spaceship's movement along the two-dimensional playing field while the navigator allocates energy to different systems. This asymmetry in addition to the *asymmetry of information* creates the core game-play experience of *Co-smonauts*.

Asymmetry of challenge

Resulting from the previously explained asymmetries the challenges the players face differ from each other. While the caption focuses on dodging immediate obstacles which requires mainly fast reaction times and good eye-to-hand coordination, the challenge for the navigator consists of keeping close watch over the playing field and finding and identifying goals. Communication becomes a challenge as well. The navigator has to be very deliberate and constantly react to changes in the course by giving new information to the captain.

Asymmetry of interface

Modes of input vary as well. While the navigator uses a touch-screen to gather information and control energy distribution, the captain plays the game using a joystick and buttons while looking at a bigger screen mounted on a wall.

Asymmetry of goal/responsibility

Different modes of input and the asymmetry of available information lead to different responsibilities. The players share the same end-goal. They want to explore the level and complete the challenge presented by the game. To achieve this they have to work together and use their asymmetric abilities to steer the spaceship together.

5.4.6 Second iteration

The first iteration of the built prototype is already very close to the final game, but after playtesting and observing other people play some changes were made to the gameplay. Mainly two big elements of gameplay changed. Firstly, instead of one vast region the players would explore, the game was split into several smaller levels with different planets and challenges. This would make getting feedback from players much easier. They could also rebuild their ship specifically for one level, and if they failed, they would not have to start completely from the beginning. Secondly the control scheme for the captain was changed. The captain can now point in any direction with his joystick and the ship will automatically accelerate in that direction. The break button still exists, and there is a second button that boosts the ship speed for a short while. Additionally the ship now breaks faster when the player stops accelerating and is generally less inert. These changes lead to a less realistic but more fun and reactive control scheme which was lacking in the previous iteration. The prototype will be developed further until fall 2017.

5.4.7 Designing the physical setup

To situate the game in a museum environment a physical table was designed. Both players have their own place at the table, slightly angled towards each other, so that they can more easily communicate. Situated between them is a glass surface with a grid, where they build their spaceship with tangible cubes. The table is designed in a way, that they can easily turn around to collaborate on the spaceship and then turn back to the control interfaces. While the navigator has all the information and input possibilities he needs right on the touch screen in front of him, the captain controls the movement via a joystick. He can see the game screen on a flat-screen on a wall, but he cannot see the navigator's perspective.

The table will be constructed and exhibited in a museum space when the final prototype is finished. Figure 5.7 illustrates how this might look like.

Figure 5.7: A 3D-rendering to illustrate how the final version of the table might look like.

Chapter 6

Discussion and future work

This paper outlined possible benefits of digital play for the elderly as well as intergenerational play. For this purpose *Co-smonauts*, a computer game created for semi-public intergenerational play in a museum environment, was created. A need for designing game mechanics specifically targeted to older, more inexperienced users, that goes beyond overcoming accessibility obstacles has been found. During the design-process several obstacles where uncovered. This chapter outlines some problems and uncertainties and how they could lead to further research in this field.

6.1 Problems and solutions

Due to the complex nature of computer games many obstacles are not clearly visible at the beginning of the development cycle. They surface when the game is in production or in the process of being tested. This chapter outlines some of the problems the developers faced while designing and implementing *Co-smonauts*.

6.1.1 Communication does not equal communication

When one player is the Captain and the other plays the role of the navigator, information tends to be more readily available to the second player. In a close model of real world behaviours, the navigator would sift through the data, pick out relevant information and relay it to the captain, who in turn would make a decision. In the ideal version of our prototype this would then create an interesting discussion, followed by a consensus on where to go and what to do. What more often than not happened during our studies, was the following: The Navigator would look at the map, pick out a point to go and lead the captain there giving short commands like “left”, “turn right” or “keep going in that direction”. This unidirectional communication, while better than no talking at all, is definitely not our goal. This points to a lack of agency the captain has in the game. Most decisions are made by the navigator which leaves the captain purely with the challenge of steering the spaceship according to the navigators whim. Possible game design solutions to this problem could consist of one or more of the following.

The inclusion of more captain-centric game mechanics or puzzles

Giving the captain immediate things to do that do not require information provided by the navigator would certainly increase the captains agency. If, for instance, on their way to a nearby planet the captain spotted a small alien capsule, they then could decide whether to pursue the objective given by the navigator or go off chasing the alien. However this would lead to situations where the navigator not only has nothing to do, but has a possibility of actively being ignored. Ideally a level would consist of challenges that would require communication from both sides (Captain: "I think we need a red star next, can you find one?" Navigator: "There should be one to your left, but be careful there are asteroids on the way!"). One problem with our current set-up is, that all the information available to the captain through the big screen is also at the same time available to the navigator. Therefore a skilled navigator would not necessarily need the captain to communicate with them.

Provide objectives only to the captain

This approach balances the scales in regards to information discrepancy between the captain and the navigator. Providing the captain with information his co-player does not have would possibly increase the amount of discussion, since the opposite is still true as well – the navigator still has information regarding the surroundings of the ship as well as its destination. This, however, would to some problems with the current set-up of *Co-smonauts*. Since both players can see the screen of the captain, the navigator has access to all the information as well. Additionally, since the younger player is playing the role of the captain one cannot guarantee that they can (or want to) read the objectives.

Direct decisions for the captain

In a more complex version of the prototype with various possibilities to solve a challenge or maybe even branching dialogue trees with possibilities to make decisions with impact on the game, the role of the decision-maker could fall to the captain. This would increase their agency as well as stay true to the theme of the game. This is however outside the scope of the prototype at the moment.

6.1.2 The case for swapped roles

This game was designed with an intergenerational player-base in mind. In an actual museum setting it will be hard to control which person will play which role. In most cases there will most certainly be one or more children playing as each role with the adults watching from the sidelines. This does not mean that the intent of the project failed. The benefits of increased communication needn't apply only to children's relationships with their grandparents. In contrary, it could possibly be of great benefit for children, helping them to learn to communicate effectively. Future research could focus on the development of empathy and communication skills between children with the help of collaborative computer games. The analytical and tactical play-style required by the navigator could possibly be interesting to younger players as well.

6.1.3 Diverging goals

As *Co-smonauts* is planned to be displayed in a museum context it is important that the game provides a well rounded experience. For this a polished user interface and a well designed tutorial are needed. To create a fun experience for visitors, the game needs to capture their attention for a while. The goal of creating a complete game are sometimes at odds with the aim of scientific research. If single game mechanics or types of interaction are to be studied it is important to quickly create different variants of the game to be able to study their effects. The more complex the game is, the harder it is to modify it without disturbing other elements of gameplay.

6.1.4 Usability problems

The older generation is, as mentioned beforehand, a very diverse group, especially in terms of computer literacy. This can lead to various problems when trying to analyse playing behaviour in terms of collaborative and communicative behaviour. During the studies usability often posed a big challenge for the players, which makes the comparatively more subtle changes in game mechanics or means of communication relatively unimportant.

6.1.5 The problem with distinct roles

During the second play-test *Co-smonauts* was observed being played in a museum environment. More often than not groups of more than two people entered the room and wanted to play. This lead to players switching between missions, swapping roles or even multiple players using a single station. In the latter case interesting interactions where observed. In particular children would join their grandparents or parents in playing the navigator role. They would start discussing what to do next while pointing at their screen and interacting with the other players. In a way this form of communication was more active and two-sided than the usual communication between the captain and the navigator (as outlined in section 6.1.1). Playing together on a single touch screen could possibly lead to more connectedness as well as increased quality of communication.

6.1.6 The influence on competition and collaboration

Co-smonauts focuses on creating a collaborative game environment to foster communication between the players. An argument could be made that competition leads to increased communication as well. Further research will have to observe how different modes of play effect the amount and quality of communication as well as the effect of different kinds of communication on the relationship of the players.

6.2 Conclusion

This thesis outlined the development of *Co-smonauts* a game designed for collaborative intergenerational play. The needs and wants of the older generation when it comes to game design where discussed. Through the summary of existing research and the analysis of *Mysterium* [39] and *Lovers in a Dangerous Spacetime* [48] asymmetries where identified as a key building block for intergenerational games. Asymmetries are the main drive for a balanced game experience for players of different skill level (older and younger people) as well as a important factor for collaboration. In the development of *Co-smonauts* these asymmetries where applied to nearly all aspects of game design.

6.3 Future steps and research

Since the prototype is currently in the final stages of its completion, it will be ready to be exhibited in late 2017. Until then, more game mechanics and levels not described in this thesis may be implemented. Once the game is complete, visitors of the museum can play it on their own terms, after which they will be asked to fill out questionnaires. This long term study will yield answers with a sample size sufficient for statistical analysis. Effects of various elements of game design on communication and collaboration in an intergenerational context may still be observed. Future research may go into more detail when it comes to the effect of collaboration and competition on communication. It may also be necessary to observe positive or negative long term effects on communication and relationships of people playing intergenerational computer games.

Appendix A

Content of the DVD

A.1 PDF-Files

Path: /...

Ruehrlinger_Moritz_2017.pdf	Complete master thesis

A.2 Additional files

Path: /images

*.ai	Original Adobe Illustrator-Dateien
*.jpg, *.png	Original Rasterbilder
*.pdf	Bilder und Grafiken im PDF-Format

Path: /Co-smonauts unity Project

Assets	Unity Assets
ProjectSettings	Unity project settings

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