Leveraging Asymmetries in Multiplayer Games: Investigating Design Elements of Interdependent Play

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ABSTRACT

Many people develop lasting social bonds by playing games together, and there are a variety of games available so that individuals are likely to find games that appeal to their specific play preferences, abilities, and available time. However, there are many instances where people might want to play together, but would normally choose vastly different games for themselves, due to these various asymmetries in play experiences, such as grandparents and grandchildren, highly skilled players and novices, or even simply two players that enjoy different games. In this work, we aim to improve the design of *asymmetric games*—games that are designed to embrace and leverage differences between players to improve multiplayer engagement. This paper builds upon prior work to describe the elements of asymmetry that can be used to design such games, and uses these elements in the design of an asymmetric game, Beam Me ‘Round Scotty! We present the results of a thematic analysis of a player experience study, discuss these findings, and propose an initial conceptual framework for discussion of design elements relevant to asymmetric games.

AUTHOR KEYWORDS

Asymmetric games; game design; player experience testing

INTRODUCTION

Games and play is an important means by which we learn to socialize, communicate, and negotiate with each other. Within the realm of play, modern digital games are a uniquely flexible and multifaceted medium combining complex audio/visual presentation, narrative, interactivity, persistence, connectivity, and computation into a powerful gestalt experience unlike any other. Despite the millions of potential online play partners however, studies have shown that individualistic and ego-centric play is more common in modern online games that might otherwise be expected [8].

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Further, the psychosocial benefits of anonymous online interactions are often less than that of face-to-face social interactions within player’s existing social networks. [24]

For existing groups of friends and family, the diversity of individual players’ game preferences and capabilities makes it even more difficult to find a mutually engaging game with which everyone can (and wants to) participate. For example, grandparents playing with grandchildren, action gamers with strategy gamer siblings, therapists with their patients, or the able-bodied with their disabled peers.

As an attempt to tackle this problem, we focus our investigation on the design of *asymmetric games*—games that adopt a design strategy that embraces differences between players, caters to them, and leverages them to create games with multi-faceted appeal while maintaining tightly-coupled social interaction.

Many commercial games include a mild form of asymmetry [20], where players can choose from a variety of characters (e.g., Magician, Thief, Warrior, etc.) or roles (e.g., attack, defense, support, etc.). However, the base mechanics of the game typically do not vary significantly between players, and it remains difficult and unsatisfying for players with more drastic preference or ability differences to play together. There are numerous ongoing discussions in both industry and academia about how best to classify players according to different typologies [1, 2, 22] as well as the importance of balancing games for different player skill levels [11, 26] but there has been little direct discussion about asymmetric games as a deliberate design paradigm.

Potentially, asymmetric games can act as the bridge between players’ individual game preferences and players’ desire to play with members of their pre-existing social circles. However, there is as yet no established framework for the discussion, analysis, or design of such games nor an understanding of what specific elements can be used to generate different degrees of asymmetry, and how these deliberate imbalances affect the dynamics of play.

In the absence of an existing theoretical framework for the design and discussion of asymmetric games, we adopted an exploratory approach. This work focused on what we call “strong” forms of asymmetry—experiences that afford diverse players entirely different interfaces (e.g., gamepad vs mouse, tablet vs PC), and challenges (e.g., reflexive action vs strategic planning) within the same game.

In order to begin to test and refine our emerging theories, we designed and developed our own prototype asymmetric games for use in formal player studies. In this paper, we describe one of our prototype game platforms and the player study that was conducted using it. As we have come to understand through our design, development, and testing activities, strong asymmetries introduce unique design challenges including the powerful influence of existing controller and genre familiarities, the difficulty of tuning tightly-coupled game mechanics, and the interplay between leadership, "primacy", and necessity.

Our contributions include:

1. Identifying several mechanical means of employing asymmetry to generate alternately mild or strong interdependence between players

2. Demonstration of their application in a prototype asymmetric game we have developed, called *Beam Me 'Round, Scotty!* (BMRS)

3. Discussion of the results of a player study we conducted to further explore this design space

4. A preliminary design framework that facilitates the design of future asymmetric games and understanding the complex play dynamics affecting asymmetric collaboration between players.

RELATED WORK

This paper builds on several areas of related work, namely social play in multiplayer games, player types and motivation, balancing and rubber banding, and cooperative, collaborative, and asymmetric games.

Social Play in Multiplayer Games

Research has shown that the social need to belong can be a means of kickstarting social interaction [3], that the social nature of multiplayer games can be beneficial [28], and in particular that feelings of relatedness are essential motivators for engagement and continued play [21]. However, not all multiplayer games exhibit these same benefits. Ducheneaut et al. [8] highlight the unexpectedly individualistic and ego-centric play that is often the norm in online multiplayer games. Even in so-called "massively multiplayer" games like *World of Warcraft*, they found that the multitude of other players in the shared game world are often just an audience in front of which players display their latest loot, or act as a source of idle chatter and an ambient sense of sociality via server chat.

In contrast, our research is interested in leveraging the benefits of social play by designing games that specifically encourage (and often require) players to play together, even if they may not typically enjoy the same styles of games.

Player Types and Motivation

By studying player's in-game actions and play patterns, various player typologies [1] and trait-based motivational models [21, 30] have worked to identify a wide variety of underlying player motivations such as the desire for competition, exploration, mastery, or socialization. As of yet, however, there is no widely accepted standard that fully encompasses the complexity of interactions that make up a player's experience. [2] Patterns developed from one genre of game may not necessarily carry over to other genres and player motivations have been shown to change based on time [29], environmental context [10], play partners, and even marketing awareness [25].

In our work, we build upon research into player types by identifying this as one dimension or element of asymmetry that a designer can consider when attempting to bring players together. However, we also consider other relevant elements, such as time investment, interface, and ability, as potential differences or asymmetries between players.

Balancing and Rubber Banding

The idea of encouraging players with different abilities to play together has also been studied extensively; particularly in competitive contexts. [6, 11, 26] More specifically, overt in-game balancing for skill (e.g., easy, medium, hard difficulty modes, handicaps, rubber banding) has been shown to have detrimental effects on feelings of self-esteem in player dyads [11], as the low-skilled player does not feel that they can compete on equal footing, and the high-skilled players do not feel a sense of accomplishment from winning a competition known to be unfair. Hidden balancing mechanisms (e.g., point multipliers, aiming assist) have been shown to be more effective at fostering a competitive atmosphere [26].

However, balancing for skill does not address potential mismatches in different players' underlying motivations. That is, being more competitive in a racing game through hidden speed boosts does not enhance one's experience if they dislike racing games to begin with. In our work we build on this prior research by considering differences in both ability and preference as important elements of asymmetric play.

We also distinguish these forms of in-game skill balancing from the design-time exercise of balancing or "tuning" a game's mechanics for interest/longevity. When balancing mechanics, developers tune the effectiveness of the games' available abilities and strategies to avoid the formation of a single "dominant strategy". [27] For example, when one choice of vehicle in a racing game is clearly superior in all performance metrics, every other player must also choose that same vehicle in order to compete; this makes the overall game repetitive, less interesting, and wastes the development effort that went into the many unused alternatives.

Cooperative, Collaborative, and Asymmetric Games

Researchers have also studied the effect of varying degrees of cooperation and competition in group play. Both Zagal et al. [31] and Rocha et al. [23] describe a variety of "Design Challenges for Cooperative Games" that highlight concepts such as "complementarity" between player characters, synergies between player abilities, intertwining goals, and deliberate minimization of players' competitive tendencies.

However, there is little discussion as to how designers might generate compatible game mechanics outside of the specific examples cited from existing games.

Beznosyk et al. [5] draw a distinction between "loosely-coupled" and "closely-coupled" interactions between players in casual cooperatives games. In their conceptualization, loosely-coupled cooperative games are those that "do not require tight collaboration between players and allow more independent performance" and tightly-coupled games "require a lot of waiting if the actions of one player directly affect the other player", respectively. Based on player experience surveys for six prototype games they developed around these classifications, they found that closely-coupled games tended to be rated significantly higher in terms of excitement, engagement, and replayability despite also being rated highly in terms of challenge. This highlights an exciting interplay between cooperation, challenge, and excitement, but the provided definitions of loose and tight coupling are somewhat difficult to incorporate into a design process. For example, "a lot of waiting" (a supposed virtue by the existing definition) is likely indicative of the underlying appeal of planning and coordination among teammates.

Game designer James Portnow [20] advances Beznosyk et al.'s concepts of tightly-coupled play by framing them as "signaling mechanics". Using an example of what he calls "weak asymmetry" from popular online shooter "Team Fortress 2", Portnow describes the medic character's healing beam (which can only be used on other players) as a mechanic that intuitively signals to players that medics are meant to support teammates. Portnow used *Fable: Legends* as a counter-point that exhibited much rarer "strong asymmetry", as it allowed a team of four adventurers to play against a fifth as "master of the labyrinth" who opposed the other players by spawning enemies and obstacles.

In our work, we integrate the vocabulary of *strong asymmetry*, but opt for the term *mild asymmetry* rather than "weak asymmetry" to avoid any characterization of such games as "lesser" in any way (which "weak" implies). Our game designs incorporate their ideas of collaborative and strongly asymmetric games, and we present findings from a study that investigates these asymmetries with observations from an exploratory player study.

Asymmetric Games in Research

Recent research has either explored asymmetric games directly or incorporated asymmetric design elements to achieve other goals. [4, 14, 19] Most relevant to our current work, in their game "Tabula Rasa" [13], Graham et al. presented one player with a gamepad-controlled platforming game and a second player with an interactive tabletop level editor that could alter the platforming game terrain in real time. When the players were allowed to play freely, the experimenters observed a wide variety of emergent play styles as the tabletop players alternately collaborated with, shepherded, constructed challenges for, or deliberately antagonized the platforming player. Our work draws inspiration from this project while also seeking to bring a more active and deliberately cooperative role to the non-gamepad player through the use of asymmetry and pro-interdependence mechanics.

In Gerling's and Buttrick's "Last Tank Rolling" [12], a player in a wheelchair controls a powerful virtual tank that a freestanding player can hide behind for protection. Although an exciting example of allowing players with different physical abilities to leverage their unique strengths without relying on artificial skill balancing, they did not evaluate their design in a player experience study.

Asymmetric Games in Industry

Although there are numerous examples of asymmetric commercial games (e.g. *Team Fortress 2*, *Starcraft)*, mild asymmetry (e.g. class-based character choices or weapon variants) is significantly more common than strong asymmetry, and both types are vastly outnumbered by symmetric competitive, cooperative, and single-player games.

ELEMENTS OF ASYMMETRIC PLAY

Combining this history of asymmetric game design, discourse, and research, with our own analyses, prototypes, and player studies, we have begun to build up a vocabulary of asymmetric design elements which we present now. We build upon the Mechanics, Dynamics, and Aesthetics (MDA) framework [17] framework and hope that these "elements of asymmetric play" can serve as a starting point for the further refinement and expansion of asymmetric game design practice and discussion.

Mechanics, Dynamics, and Aesthetics (MDA)

The MDA framework follows a trend in industry, where game designers have formed their own amalgam of theories from psychology, marketing, and games user research. Design frameworks such as Vandenberg's "5 Engines of Play" [25] are used as design guidelines tailored for an individual studio's culture/capabilities and refined over time based on real-world performance and sales data. In these frameworks, the efficiency of approximate but practicable guidelines often outweighs the difficulty and high cost of developing scientifically precise player motivational models. Our work builds upon the MDA framework by providing design insights specifically centered on ideas of asymmetry. As we adopt the vocabulary of the MDA framework and use it to frame our discussion of asymmetric game design elements, we briefly detail its three conceptual layers here.

Mechanics - At the Mechanics layer, the game's designers plan and implement the game's individual rules, interfaces, and algorithms. For example, how high does a player character jump? How many times can they restart if they fail a level? How many obstacles are there in a level and how difficult are they to overcome? At this layer, before the game has even begun, the game can be viewed as a series of small design decisions under the direct control of the game's designers.

Dynamics - At the Dynamics layer, the game is running and the myriad of individual Mechanics combine with the player's inputs, to form a lively and interactive whole.

Aesthetics - Finally, a game's Aesthetics are the emotional responses the game evokes in the player as a result of their individual preferences and previous experiences engaging with the game. This resultant player experience can be subtly steered and influenced by the designers' efforts but, at this layer, is furthest from their direct control.

For a player unused to third-person action games and gamepad controls, a grueling melee combat game like *Dark Souls*, with tight mechanical timing and punishing enemies, might be viewed as a frustrating and unfair slog. Alternatively, a player seeking a challenge and already familiar with complex gamepad controls might instead view such games as an invigorating odyssey through an exciting but dark fantasy landscape. Viewed within the MDA framework, it can be said that the Mechanics of the game have not changed, but each player's unique personal experiences alter the Dynamics at play and give rise to vastly different Aesthetics.

In the following sections, we employ the MDA framework to frame the insights we have gained both in analyzing existing asymmetric games and through our ongoing work designing, developing, and testing our own asymmetric games.

Mechanics of Asymmetry

In this section, we describe some of the possible mechanical manipulations that designers can employ in order to give rise to asymmetric player experiences.

Asymmetry of Ability - Where one player can do things another player cannot. E.g. one player can lift extra heavy objects while another player can leap over tall buildings.

Asymmetry of Challenge - Where the kind of challenge one player faces differs from that of other players. This is distinct from differences in the *scale* of challenges, where one player simply faces *more* obstacles than other players. E.g. one player must time a frog's jumps across a busy highway, while another player must solve a logic puzzle in order to open a treasure chest

Asymmetry of Interface - The means by which players engage with the game differs; both in terms of input and output. E.g. one player uses a dual-joystick gamepad and a VR headset while another player uses a touchscreen tablet.

Asymmetry of Information - Where one player knows something other players do not. E.g. one player has a map of a maze but is otherwise blind, while the other player can see the configuration of the local walls.

Asymmetry of Investment - The amount of time players dedicate to their roles differs. E.g. one player executes daily hour-long tactical maneuvers with their military platoon while another player take five minutes to update the overall strategic plan for the war once a week.

Asymmetry of Goal/Responsibility - Players seek to achieve different outcomes. E.g. one player is the striker on a football team while another player serves on defense.

While this list is not exhaustive, it can be used as a design tool to generate ideas for new gameplay mechanics depending on project requirements and constraints. It has been our experience that changing what type of mechanical asymmetry a game employs results in a major transformation of the overall player experience. As will be discussed next, altering more specific aspects of how individual mechanics are implemented can be used to create more subtle changes in a game's dynamics.

Interdependence and the Dynamics of Asymmetry

Particularly within cooperative play contexts, one of the most salient dynamics of asymmetric play is an emergent interdependence between players. At runtime, the asymmetries between players' mechanical abilities, interface, information, etc. force players to rely on each other for different reasons and at different times. Each must coordinate with the other and contribute where they are best able in order for the group to meet their shared goals.

In this section, we extend Beznosyk's [5] concepts of "tight" and "loose" coupling based on the player interactions we observed during our player study (presented below). Our framework introduces additional specificity regarding the directionality and timing of interdependent player relationships.

Directional Dependence

Depending on the designer's goals and specific mechanics involved, the directions of players' interdependence can be varied. Particularly when dependencies are not reciprocal, these dynamics can lead to interesting imbalances of power dynamics between players.

Mirrored Dependence - This is the simplest form of interdependence and is most commonly seen in traditional cooperative games. Often referred to simply as "teamwork", the nature of each player's reliance on each other is identical. E.g. two soldiers covering each other's back in a firefight.

Unidirectional Dependence - In this form of interdependence, Player A's progress is reliant on Player B's intervention but this dependence is not reciprocal. E.g. one player relays map information to another player.

Bidirectional Dependence (AKA Symbiosis) - In this form of interdependence, Player A and Player B rely on each other's intervention but in different ways. E.g. one player carrying a flashlight down a pitch-black, zombie infested tunnel, while a second player defends the pair with a pistol.

Synchronicity and Timing

Instances of interdependence between players in asymmetric games also have inherent time constraints. When discussing synchronicity, we are concerned with the *duration* of and *relative timing* between each player's interdependent actions at a mechanical level. Each player's actions can be viewed as either discrete events (e.g. pulling a trigger) or continuous (e.g. remaining inside a designated zone). This is considered in combination with when each player takes their action relative to their partner (e.g. before, during, or simultaneously). Together, a number of unique combinations (Figure 1) emerge that can be applied for specific purposes in an asymmetric game's design:

Asynchronous Timing - Player A performs an action (either discrete or continuous) and Player B is unconcerned with the specifics of when. E.g. one player picks up a coin and places it in the other player's inventory.

Sequential (Disjoint) Timing - Player A completes their action some time (Δt) *before* Player B begins their action. E.g. one player removes the protective casing from an armoured enemy with a grenade, allowing the second player to finish the enemy off at their leisure.

Expectant Timing - Player A can trigger an action *if* Player B is prepared (and waiting). E.g. one player must stand atop a spring-loaded gate, weighing it down into place, while the second player locks it into place.

Concurrent Timing - Both Player A and Player B continuously perform their respective actions. E.g. one player controls the left tread of a tank while the second player controls the right tread.

Coincident Timing - Player A and Player B must perform discrete actions at the same moment (or within some small ε). E.g. Both players must throw a matching pair of switches within 1 second of each other.

Considering both the direction and timing of interdependence can be a useful design exercise for generating new play mechanics or modifying existing ones. It has been our experience that there is a general increase in "interestingness" (or at least the difficulty of execution) as one progresses down these lists. For example, actions with coincident timing are distinctly harder to execute than those with disjoint sequential timing. Considering these heuristics when designing for the generation of flow states [7] (i.e. tuning for appropriate challenge level), this would suggest for example, that pairs of more skilled players would likely prefer coincident and bidirectional interdependence over lesser demanding forms.

Aesthetics of Asymmetry

In the MDA framework, a game's aesthetics emerge during play in combination with each player's unique perspectives and expectations. As such, we incorporated several of the above mechanics and dynamics of asymmetry into our own prototype game design called *Beam Me 'Round, Scotty!* (BMRS) [15, 16]; providing us with a configurable platform with which to conduct formal player studies and explore the emergent aesthetics of asymmetric play. Primarily an exploration of asymmetries of ability, challenge, and interface, the design of BMRS focused on crafting two distinct but interdependent player experiences.

In the following sections we describe the relevant elements of *Beam Me 'Round, Scotty!*, we detail the study protocol we employed, and we discuss our observations and the feedback we gained which informed our design framework.

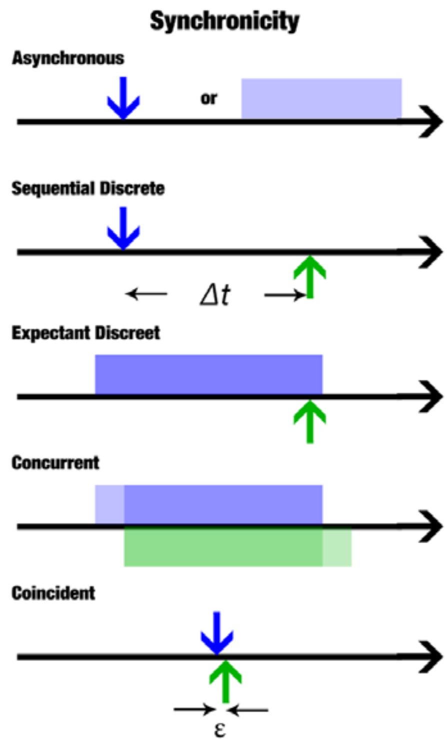

Figure 1 - Graphical timelines demonstrating different degrees of synchronized action. Player A's actions are blue. Player B's actions are green. Arrowheads and boxes represent discreet and continuous actions in time respectively.

Beam Me 'Round, Scotty!

In order to provide players with a quickly understandable narrative context, we modelled the in-game characters and scenarios of BMRS around the popular television series *Star Trek*. Previous knowledge of *Star Trek* was not required to play or understand the game however and the character names "Kirk" and "Scotty" are used in this paper as short-hand labels to encompass the respective asymmetries of interface (gamepad vs. mouse), abilities (shooting vs. teleporting), and challenges (reflex vs. planning) participants experienced in each role.

In this version of BMRS, one player controlled the courageous captain Joanna T. Kirk using a dual-joystick gamepad in an action-oriented experience that challenged the players' manual dexterity, coordination, and reaction speed. Kirk's mechanics focused on walking, aiming, and shooting a simple blaster while avoiding taking damage from hostile aliens and environmental hazards.

The second player used a mouse to assume the role of plucky engineer Scotty who deployed the orbiting starship's various abilities to assist Kirk in her adventures. The Scotty experience was designed to be low-anxiety, low-speed, and favour forethought over reflex. Scotty's mechanics employed a radial menu to select from 5 available abilities: a Shock Beam that stuns enemies in place, a Heal Beam that can restore Kirk's vitality, a Shield Wall that can erect force fields around Kirk, a Torpedo that can blast apart enemies and obstacles after a short delay, and a Teleporter which can move Kirk short distances. Each of Scotty's abilities was also tied to a slowly regenerating pool of energy which had to be carefully managed lest Kirk be left in a dangerous situation without support.

Level Configurations

BMRS consisted of five distinct levels. The Kirk Challenge and Scotty Challenge levels were tutorial levels that taught players the basics of playing as Kirk and Scotty, respectively. Both Level A and Level B were composed of a series of distinct sections that were each meant to invoke different styles of interaction between the Kirk and Scotty players. Below, we detail the aesthetic goals of each section and describe how our elements of asymmetric games were used to guide their design:

Mild Combat (Unidirectional, Asynchronous): Consisting of only a few enemies at a time, these sections were designed to be easily handled by Kirk with minimal intervention from Scotty.

Physical Obstacles (Unidirectional, Expectant): Large geographic obstacles such as chasms, steam jets, and windy walkways were designed to prompt Scotty to jump into action once Kirk reached a roadblock.

Maze (Bidirectional, Asynchronous + Concurrent): With teleportation disabled, precarious walkways, threatening laser sentries, and destructible boulders blocking the path, this section required constant attention from Scotty and required Kirk to pick up extra energy pods to fuel his partner's abilities. Scotty had to clear away the boulders with torpedoes and stun sentries while Kirk quickly and carefully walked their way through the maze.

Heavy Combat (Bidirectional, Asynchronous + Concurrent + Coincident): With many different kinds of enemies (some jumped, some shot, some were invulnerable or required special tactics) simultaneously assaulting Kirk, both Kirk and Scotty players had to work together quickly and efficiently to deploy shield walls, dodged enemy attacks, and gradually progress forward.

Teleportation Challenge (Unidirectional, Asynchronous): In Level A, pairs of enormous flaming boulders rolled down narrow side-by-side walkways with alternating timings. In Level B, an archipelago of lava fountains bridging two sections of terrain exploded intermittently. In both cases, these sections pushed the typical directional dependence of Kirk on Scotty to the limit as Scotty was forced to rapidly teleport Kirk around the shifting obstacles. Scotty had to be quick and deliberate with teleportation while Kirk essentially stood still.

Having developed a game that exhibited strong asymmetries of ability, interface, and challenge and multiple levels that manipulated the dynamics (direction and timing) of interdependence between Kirk and Scotty players, we then mounted a player study to explore whether and how our deliberately designed play mechanics/dynamics interacted with the diverse preferences of real players and their resultant aesthetic experiences.

STUDY METHODOLOGY

In this section, we detail the experiment methodology we employed in order to investigate the player experience of our prototype asymmetric game.

Participants

Thirty-four participants (8 female) were recruited in pairs (2 female-female, 6 female-male, 9 male-male) from the local university area (21 aged 18-20, 9 aged 21-23, 4 aged 24-29). Pairs were recruited with some pre-existing relationship (e.g. friends, housemates).

Design

Our study was centered on the asymmetries introduced in the levels described in the previous section, which varied in both dependence (unidirectional or bidirectional) and timing (various combinations of: asynchronous, expectant, concurrent, coincident). However, the primary controlled factor in our study was the character that was played (either Kirk or Scotty) which varied primarily in its asymmetry of interface (Kirk was played with a game controller, and Scotty with a mouse and keyboard).

Study Procedure

Each study session lasted approximately one hour broken up into several phases (Table 1). The study was conducted in an isolated room with two large-screen displays on opposite walls, each with its own computer, speakers, mouse, keyboard, and gamepad input devices. When playing on their own computers, players could talk to each other and hear each other's in-game actions but could not see each other unless they turned around. This arrangement was chosen in an attempt to preserve the atmosphere of co-located play regardless of whether pairs were playing on the same screen or separately.

PLAYER ONE	PLAYER TWO
Intro. Survey	Intro. Survey
Kirk (gamepad) training	Kirk (gamepad) training
PENS	PENS
Scotty (mouse+kb) training	Scotty (mouse+kb) training
PENS	PENS
Level A (counterbalanced w/ Level B):	
w/ gamepad (Kirk)	w/ mouse+kb (Scotty)
PENS	PENS
Level B (counterbalanced w/ Level A):	
w/ mouse+kb (Scotty)	w/ gamepad (Kirk)
PENS	PENS
Semi-Structured Interview	

Table 1. Stages of the play study

An initial survey collected demographic information, details about each participant's game playing habits (e.g. favourite games, frequency and duration of typical play sessions), as well as a series of self-rated skill scores in various game genres (e.g. "How skilled would you consider yourself when playing first-person shooter games?")

The next four phases had participants play a particular level from the game with each play session followed by a post-gameplay experience survey. Based on the PENS questionnaire [21], the survey asked participants to rate their experience based on their feelings of autonomy, competence, relatedness, immersion, and intuitive controls during play using a 7-point Likert scale.

Each of the introductory surveys, the post-gameplay surveys, and the first two levels were completed by both participants separately on their own computer. "Level A", "Level B", and the concluding semi-structured interview were completed by both players together as a pair on the same computer.

The training levels were always completed by both players first and individually so that both players could learn to control the two different in-game characters. These levels presented a series of simple challenges that would instruct the players how to employ each character's primary abilities. For Kirk (gamepad), this included walking, aiming, and shooting with no Scotty present. For Scotty (mouse), this included the use of the five ship abilities (Teleport, Heal Beam, Shock Beam, Torpedo, and Shield Wall) as players escorted an A.I. controlled "RoboKirk" towards the level exit. RoboKirk would navigate towards the exit while shooting at any enemies within range and pause at impassable obstacles or chasms.

Levels A and B were played by both participants together with one as Kirk (gamepad, ground fighter, shooting) and the other as Scotty (mouse, teleporter, planning). When the pair played the second level in the sequence, they would switch roles (i.e. the participant who played Kirk in the first level would play Scotty in the second level and vice versa). The order of Level A and B was counterbalanced between pairs.

RESULTS

We incorporated quantitative statistical analysis into the structure of our exploratory study in order to highlight unexpected trends or future avenues of investigation. In this section, we present the statistical analysis of our player experience surveys, followed by a thematic analysis of participants' gameplay and interview recordings.

Survey Results

We designed our study with the intention that the first two single-player sessions (first as Kirk, then as Scotty) were for the purposes of training, and so the primary design involved only one factor: which character (and thereby, which distinction combination of interface, abilities and challenge) was experienced during the second two play sessions (two-player). However, because each player also played single-player versions of the game to start, we also had data available for single-player vs. two-player experiences, and so conducted a 2 (character) × 2 (number of players) RM-ANOVA on the same subscales.

There was a significant main effect of character on autonomy ($F_{1,33}$ = 52.8, p < .001, $\eta_p^2 = .62$) where playing as Kirk was rated as affording less autonomy than playing as Scotty. Similarly, there were significant main effects of character on ratings of intuitive controls ($F_{1,33}$ = 4.83, p < .05, $\eta_p^2 = .13$), with the gamepad (Kirk) rated as more intuitive than the mouse (Scotty).

There were also significant main effects for number of players on autonomy ($F_{1,33}$ = 28.76, p < .001, $\eta_p^2 = .47$), relatedness ($F_{1,33}$ = 135.26, p < .001, $\eta_p^2 = .80$), intuitive controls ($F_{1,33}$ = 5.60, p < .05, $\eta_p^2 = .15$), and immersion ($F_{1,33}$ = 36.09, p < .001, $\eta_p^2 = .52$). In all cases, playing together was rated higher than playing separately.

However, it is important to note that the single-player experiences were not counterbalanced, and so this could be an order effect, and not conclusively an effect of character (i.e. interface, abilities, or challenges). Thus, survey results were inconclusive, though the thematic analysis described next provided much richer data and was the primary intent of our study design.

Thematic Analysis

A thematic analysis was performed on the gameplay footage (19.96 hours of audio + video) from all of the participant pairs. In this section, we describe the salient themes most relevant to the design of asymmetric games. When relevant, participants are labelled according to their group number and distinguished as either partner A or B (e.g. P.13A and P.13B).

Leadership and Primacy

From a narrative perspective, the character of Kirk was introduced as a marooned spaceship *captain* trying to escape from a hostile planet with remote assistance from their ship's engineer. When designing BMRS, Kirk had been envisioned as the main focus of play, but our observations of players' experiences highlighted how the dynamics of play can yield different results.

In our player study, we 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.

In imbalanced pairings, we observed the dominant player dictating what tactics and timings to employ (e.g. "go here, do this"), regardless of which in-game character they were playing. During interview, many such pairs highlighted that the subordinate player often didn't *want* the responsibility of leadership. These players often claimed to feel less competent with the game and were happy to allow their partner to take on the additional cognitive load of coordinating their cooperation.

More common however, was a balanced and fluid leadership dynamic wherein whichever player had the most promising strategic proposal at any given moment would temporarily lead the pair. Noticing a new obstacle or recognizing a new opportunity, each player would call out suggestions as they arose and command/subordination would flow back and forth rhythmically. This cycle of observation, negotiation, decision, and action repeated on rapid time scales (e.g. "I'll deal with this enemy while you stun that one!"), large time scales ("Let's take our time and explore. We might find hidden treasure!"), and with different flavours of synchronicity. (E.g. coincident teleportation maneuvers, expectant shield wall shootouts, and sequential activation of switches.)

We also identified a distinct element of what we call "primacy" motivating many player-player negotiations. For example, if Kirk is suddenly ambushed by a group of enemies, this sudden danger would rapidly override existing team goals and a new leadership proposal would spring forth. ("Oh wow! Look out! Let's deal with those enemies first!") Alternatively, in the midst of a rapid teleportation obstacle course, Scotty's dwindling energy reserves (and the swift death Kirk would suffer should Scotty run out of energy at that time) prompted "collecting energy pods" to become the prime motivator for new action proposals.

We observed that the play partner who proposed these reactive strategies (leader) did not necessarily correlated with the player whose needs assumed primacy at that moment.

Effect of Player's Skill on Experienced Aesthetic

After playing both roles, participants generally either viewed Scotty as a helpful assistant and Kirk as a lead actor/hero/captain OR they viewed Scotty as a powerful, commanding overseer and Kirk as a fragile liability meant to be protected and shepherded to the level's exit. These sentiments are exemplified by player comments such as:

"(As Kirk) you feel like you have more control than you give Kirk respect as Scotty. When you're playing as Scotty, you're like 'He's my pawn.' And when you're Kirk, you're like 'I need Scotty to do things. (Feebly) But I have ***some*** *control. I have* ***some*** *self-respect! Ha! … But I think Scotty, in this case, would be the main character, since he has so much control. Kirk was really just walking through." [P.11B]*

Which perspective was taken depended on the relative confidence and skill of the two players. Highly skilled Kirk players (accurate shots, minimal damage) could easily progress forward through enemies and hazards with minimal assistance from Scotty; typically only pausing at obstacles that *required* Scotty's abilities. (E.g. clearing a boulder away with torpedoes). Alternately, weaker Kirks tended to progress more slowly, always waiting for Scotty's tactical intervention (e.g. shield walls, stun beams).

When asked to describe the relative potency of Kirk versus Scotty, almost universally participants described Scotty as the more capable and more interesting character. With her simple "run and gun" mechanics, Kirk was described as a much more straight forward character to play as but with her own straight-forward appeal.

"(Kirk) is technically the leader but she doesn't have as much control as Scotty, really. Although…it is fun, the shooting parts." (P.11A)

In addition, participants near universally complained about Kirk's slow movement speed and suggested future improvements such as running faster, a dedicated sprint button (with limiting stamina), jumping, or a dodge-roll. These results highlight shortcomings in BMRS' current tuning of abilities, options, and excitement.

Overall, we saw that even though the underlying mechanics had not changed, the previous experience, skill, and perspectives that players brought to the game created striking differences in their ultimate aesthetic experience.

Mechanical Interactions

We also noted that interdependence between players was both an advantage and disadvantage from a design perspective. Implementing the previously mentioned player suggestions would be complicated due to the myriad of interconnected mechanical systems involved. For example, giving Kirk a jump or a dodge-roll would potentially invalidate a number of existing platforming challenges (e.g. the maze, lava boulder sections) and takes away from Scotty's responsibilities as the teleporter and primary provider of long-distance movement.

More subtly, synchronization between players' actions during heavy combat situations was consistently described as one of the most troublesome aspects of Scotty players' experiences. Scotty players said they often felt overwhelmed trying to rapidly switch between Scotty's various abilities and deploy them accurately and quickly. In essence, the reflex challenges designed for Kirk players were negatively affecting Scotty due to tight synchronicity demands.

This problem was exacerbated by an unanticipated design decision within BMRS's camera system mechanics. Because the shared camera view shifts based on *Kirk's* movements, Scotty had to attempt to counteract these movements on-the-fly in order to keep his target beneath his cursor. This is counter to the slower and more thoughtful Scotty experience original envisioned.

Familiarity with Interface

Despite our efforts to design unique player experiences that catered to distinct player preferences, our analysis highlighted the strong role our participant's gaming history played in selecting new game experiences.

Many players expressed a distinct preference for one in-game character over the other. This was primarily due to their existing familiarity with the two different control schemes and was largely unaffected by their positive or negative experiences playing as either Kirk or Scotty. Players who predominately played console games preferred the gamepad whereas players who predominately played games on PC preferred the mouse.

Familiarity with Player Partner Limits Interdependence

Similar to finding by game analytics firm Quantic Foundry [9], many of our participants described how in game frustrations could be ameliorated by having some degree of familiarity with one's play partner. In contrast, when playing with strangers online, loose coupling or outright competition was preferable to cooperative play.

"*LAN games are fun if they're hard in the sense that you're relying on your friends. With online games, co-op is fun if you can do it yourself, because then you're not relying on them. But if you're trying to find a happy medium, I don't think there is one… [where] you could play online with a stranger and you're reliant on them… [but] you're not mad when they screw up. Moral of the story is I don't play co-op online.*" [P.11B]

Similarly, our participants claimed to play different types of games with different types of players. (i.e. Alanna would play BMRS with Bob but not with Cathy.)

When asked about playing games with their family or parents, participants typically said that they rarely played their favourite games with family members. Instead, family play typically consisted of more "casual" style games such as Just Dance or Wii Sports.

Participants reported that they essentially never played video games with their parents. However, many participants did play board/party games with their parents (such as *Yahtzee* or *Charades*).

When asked why, participants cited general disinterest from their family members or a lack of available time to invest in learning complex new game rules.

Interdependence and Necessity

Almost universally, players enjoyed needing to rely on each other. When discussing the drop-in-and-play secondary roles in games such as *Super Mario Galaxy* and *Rayman Legends* and how these roles neither require as much skill to play as the primary characters nor are strictly necessary to progress in the game, players typically stated they preferred to be dependent on each other rather than always being self-sufficient:

"[Playing an optional role] It's good in that sense but if you actually play video games, it's not great. You feel useless."[P.11B]

"Yeah, because you're not really doing anything. And you're not needed in any actual way. You can't contribute very much."[P.11A]

Many participants described how cooperative play was fun despite (and often even because of) the inherent frustration of coordination.

Participants described how the necessity of both the Kirk and Scotty roles ebbed and flowed depending on the different sections of the levels being encountered. During combat, the game progresses largely based on Kirk's skill. Scotty's contributions during these sections were appreciated but were not often viewed as strictly necessary. Alternatively, during "puzzle" sections such as the maze or teleportation challenges, Scotty's potency and necessity were pushed to the forefront by the game's mechanics and Kirk was often viewed as simply "along for the ride".

More generally, many players drew parallels with existing games such as modern *Super Mario* games which allow multiple players on screen simultaneously. In these games, players who fall off platforms or are defeated by enemies are relegated to a "bubble" which follows the surviving players around. Once the surviving player reaches a safe location, bubbled players can pop out and resume their normal play. However, participants complained that this often led to problems where imbalances between players' skills caused the less-skilled players to spend a majority of their time in-bubble and frustrated; essentially not participating in the game.

Hypothetical Mechanics

As part of the interview segment of the study, participants were asked to reflect on hypothetical iteration of BMRS where, instead of having distinct Kirk and Scotty characters, players both played as "Super Kirks" (a name we coin here to describe a new, super powerful Kirk character). In this configuration, both players would use gamepads to control identical on-screen characters similar to traditional Kirk play but would also having individual access to all of the abilities normally reserved for Scotty. (E.g. Super Kirk could teleport themselves and deploy their own shield wall.) While most participants stated that this configuration would be more individually potent, the majority of participants claimed to prefer the existing interdependent Kirk/Scotty relationship. Only those players who described themselves as particularly focused on achievement and high-skill gameplay expressed interest in the hypothetical Super Kirk configuration.

A second hypothetical configuration was also proposed. In this "Kirk + Spock" configuration, although players again used gamepads to control two on-screen characters, Scotty's abilities would be split evenly between them such that, for example, only Kirk could deploy Shield Walls but only the new Spock character could deploy torpedoes. This Kirk + Spock configuration was more warmly received than hypothetical Super Kirks in some cases but those players who had strong preferences for mouse interfaces still preferred the original Kirk + Scotty configuration.

DISCUSSION

In the previous section, we discussed several of the recurring themes we observed based on gameplay recordings and player interviews from our in-lab study of BMRS. Much of that insight directly informed the MDA-centric "Elements of Asymmetric Play" section presented earlier. Next, we discuss potential design implications and recommendations for asymmetric games based on our observations.

Leadership and Primacy

Future asymmetric game designs could leverage our observations by deliberately altering the balance of leadership and primacy between different players. Consider mechanics which introduce an asymmetry of information between players. If the imbalance were strong enough, it would become prohibitive for the less informed player (even if they were the stronger personality and the de facto leader in a particular player pairing) to constantly ask to be kept informed enough to make leadership decisions.

In theory, leadership would default to the player with the most information. If the normal social dynamic of the pair were deliberately reversed (e.g. a child in the leadership role with their parents as subordinates), such an asymmetric game could be employed as a role-taking exercise.

Familiarity

We interpret the consistency between participants' controller preference *prior* to the study and their character preference *after* the study as a mixed result. It both underscores the importance of designing games for diverse preferences as well as highlights the dominant influence of participants' previous familiarities and the limited nature of single laboratory studies.

In terms of asymmetric design and family members' hesitation to play new games together, our results speak to a need for new players to be able to intuitively osmose the game's rules, mechanics, and controls to overcome some of the likely psychological barriers at play in these scenarios. While the average age of video game players continues to rise as the first generation of "gamers" age, there are still a large number of people for whom video games remain a foreign and intimidating concept. No matter how suitable and intuitive a role a well design asymmetric game affords them, some people may still not be sufficiently enticed to participate with their friends/family.

The Difficulty of Tuning Asymmetric Mechanics

The same diversity of inputs, obstacles, information, and aesthetics that can make asymmetric games appealing can cause the playtesting, debugging, and tuning of individual play mechanics to be a significantly more complex task in asymmetric games.

Consider participants' requests to use their left hand (on the keyboard) to select abilities and their right hand (on the mouse) to deploy them. While Scotty players' ability to respond to overwhelming amounts of enemies would be greatly increased, this would also bring Scotty's aesthetic experience closer to Kirk's already action-oriented play style. Employing our conceptual framework for designing asymmetric experiences, consider instead a mechanic where Kirk throws handheld beacons throughout the environment that request specific forms of assistance which Scotty would need to manage and prepare in advance. Scotty then "authorizes" the deployment of each ability request with a single button. In this way, we can generate a cleaner and stronger asymmetry of challenge: with planning falling to Scotty and reflex/targeting falling solely to Kirk instead.

LIMITATIONS AND FUTURE WORK

The exploration and study of asymmetric games as a design paradigm is still in its infancy. This paper presents an early framework for more specific design and discussion of asymmetric games but there is still much more work to be done. For example, while related work [5] and our own exploratory observations suggest that tighter coupling or more exacting synchronization between players' action will be more engaging for highly skilled players, we have not specifically tested or quantified such experiences.

Similarly, our current work focuses primarily on mechanical asymmetries of ability, challenge, and interface but our framework has identified several other potential forms of asymmetry. We suspect each will reveal its own unique dynamic and aesthetic interactions when studied in depth.

Further, many player experience metrics have focused on individual measures such as feelings of competence and flow. Asymmetric cooperative experiences involve unique interpersonal phenomena (e.g. leadership, synchronicity, negotiation) that allude to what Kaye et. al. [18] refer to as "group flow" and a "shared aesthetic". Future work will benefit from incorporating and expanding upon these emerging, group-centric experience metrics.

CONCLUSION

Games are powerful, but many are not particularly cooperative or socially beneficial. Asymmetric games may be suitable for bridging the gaps between the psychosocial benefits of playing with pre-existing friends and finding mutually enjoyable games well-suited to everyone's preferences and capabilities.

In this paper we have presented several elements of asymmetric games that can serve as useful design tools when creating interdependent player experiences and described our application of these elements in our prototype asymmetric game *Beam Me 'Round, Scotty!* We conducted a player study to explore our theories and the thematic analysis of our participant's experiences has contributed to an initial conceptual framework for the future design, discussion, and study of asymmetric games.

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