UNIVERSITY of York

This is a repository copy of *Future Design of Accessibility in Games:A Design Vocabulary*.

White Rose Research Online URL for this paper:
https://eprints.whiterose.ac.uk/id/eprint/147517/

Version: Accepted Version

Article:
Cairns, Paul Antony orcid.org/0000-0002-6508-372X, Power, Christopher Douglas orcid.org/0000-0001-9486-8043, Barlet, Mark et al. (1 more author) (2019) Future Design of Accessibility in Games:A Design Vocabulary. International Journal of Human-Computer Studies. pp. 64-71.

https://doi.org/10.1016/j.ijhcs.2019.06.010

Reuse
This article is distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs (CC BY-NC-ND) licence. This licence only allows you to download this work and share it with others as long as you credit the authors, but you can't change the article in any way or use it commercially. More information and the full terms of the licence here: https://creativecommons.org/licenses/

Takedown
If you consider content in White Rose Research Online to be in breach of UK law, please notify us by emailing eprints@whiterose.ac.uk including the URL of the record and the reason for the withdrawal request.

White Rose university consortium
Universities of Leeds, Sheffield & York

eprints@whiterose.ac.uk
https://eprints.whiterose.ac.uk/

Future Design of Accessibility in Games: A Design Vocabulary

Paul Cairns[a,1,*], Christopher Power[b,2], Mark Barlet[c], Greg Haynes[c]

[a] *Department of Computer Science, University of York, UK*
[b] *School of Mathematical and Computational Sciences, University of Prince Edward Island, Charlottetown, PEI, CA*
[c] *The AbleGamers Charity, Kearneyville WV, USA*

Abstract

Games represent one of the most significant cultural artefacts of this century. They are a massive force in economies around the world and are enjoyed by millions of players worldwide. With their cultural significance firmly in place, it is important to ensure that all people can participate in and play games in order to feel included in our wider society. For people with disabilities, games in particular provide a cultural outlet where they can be included with everyone else, and enabled to do things on an even footing with their non-disabled peers. However, this only happens if we create the necessary design environments that provide inclusive opportunities to game alongside the rest of the player base.

Guidelines have been successful in raising awareness of accessibility in games and still function well for evaluating finished games. However, they are not the generative design thinking tools that developers need. Further in being divided to address specific disabilities, they are not capturing the diversity of needs of players with disabilities and the personalised and idiosyncratic adaptations that they make in order to play.

We therefore propose developing a vocabulary and language of game accessibility which is no longer about whether someone can perceive or operate

*corresponding author

Email addresses: paul.cairns@york.ac.uk (Paul Cairns), christopher@ablegamers.com (Christopher Power), mark@ablegamers.com (Mark Barlet), greg@ablegamers.com (Greg Haynes)

[1] Scholar-in-Residence, The AbleGamers Charity

[2] Vice-president, The AbleGamers Charity

an interactive technology, but instead as to whether they can have the experience they want to have. We propose the structure for such a vocabulary showing that it needs to distinguish between access to controls, enablement to meet the challenges of the game and the player experience itself. We show how the intermediate-level knowledge embodied in guidelines can be reformulated in this way to be more generative and so support designers to develop games that deliver accessible player experiences.

Keywords: digital games, accessibility, guidelines, design vocabulary, accessible player experiences

---

Digital games are now one of the most important sources of entertainment in our cultural media ecosystem. Digital games are played by 2.6 billion players worldwide, with an increasingly large audience of people engaging and with huge diversity in what is played, from vignette games to massive digital worlds. The population of players now has an average age of 34, over half playing with friends in a multiplayer environment (ESA, 2018). Within these communities of gamers, there is an increasing call for games to be inclusive and representative of the broader population of players, including players with disabilities.

As the number of players increases, it is also the case that there is a growing number of players with disabilities who are playing, or who would like to play, mainstream games along with everyone else. Indeed, there is a large market of potential players with disabilities and people who can benefit from accessibility options in games. For example, the United States has a population of 327.2 million players of whom 67% of play digital games (Electronic Entertainment Design and Research). Within that population, 44.1 million adults (26%) (Center for Disease Control and Prevention) and 2.1 million children (6.3%) (U.S. Census Bureau) identify as having a disability, that means there are potentially 46.3 million players with disabilities in the United States alone. Further, this number does not account for people who do not identify as having a disability who could benefit from accessibility options, meaning this number is likely a substantial underestimation of how important it is for games to have a broad range of such options.

It is therefore not surprising that platform manufacturers and game studios are seeing the commercial argument for making games accessible and are developing products that are able to include players with disabilities. In 2016, Sony included a broad set of accessibility options as part of the

operating system on their Playstation 4 console and made them available to developers to use in their games. Further, in 2018, Microsoft released the Xbox Adaptive Controller (XAC), a low-cost, commercial branded product designed specifically to help players with disabilities find new and flexible ways to control their games (Armstrong, 2018). In that same year, Electronic Arts launched an accessibility portal which houses information regarding accessibility options in their games.

There is a growing legal requirement for accessibility in games as well. In 2010, the US passed the 21st Century Communications and Video Accessibility Act (CVAA)[3] which is legislation that guarantees access for people with disabilities to technologies that connect people for communication. As of 2019, the waivers for the game industry have expired and all games that are published within the US will need their components that facilitate communication to have a minimum level of accessibility in flexibility of control and presentation. In the European Union, the European Accessibility Act further mandates that computing equipment and related operating systems also require basic levels of accessibility.

Human-Computer Interaction as a field has long championed the accessibility of interactive systems generally and specifically in games. This drive for access has been primarily motivated by social justice arguments, where people with disabilities are citizens who have the same rights to cultural life, recreation, leisure and sport as everyone else, as enshrined in the UN Convention on the Rights of Persons with Disabilities. However, increasingly, the motivation for accessibility in games is being supported by a growing empirical evidence that playing games is something that people with disabilities want to do, where play brings feelings of competence, making social connections and also, for some players with disabilities, providing a route to participate in a worldwide cultural movement, where previously such movements have often been unavailable to them (Beeston et al., 2018). These opportunities for participation are important as they give individuals the opportunity to participate in the activities that are important to their peers, giving them opportunities to engage in activities that reduce social isolation and subsequently increase the wellbeing of players with disabilities (Boniwell, 2008). This has a further advantage that peers of people with disabilities see this distinct group represented as part of their regular activities, which in

[3]available from: www.fcc.gov/accessibility

turn promotes a virtuous circle of tolerance, paving the way for more rich discussions about representation of people with disabilities in the medium itself. As such, playing digital games can be not only good for the individual, it can be good for gaming communities, and it can push the creative boundaries of the industry making it more inclusive in not only its accessibility but in its content.

Overall then, the commercial, legal and social justice arguments point to the importance of making digital games accessible to the widest possible audience. The question then is how to increase the accessibility of games most effectively. Drawing from the analogous history of usability, it is possible to make accessible games by accident or even to retro-fit accessibility to existing games (Grammenos et al., 2006). However, the returns arise when accessibility, like usability, is integrated into the design process from the outset (Landauer, 1996). This requires that designers have tools and methods that enable them generatively incorporate accessibility as part of the wider game design process.

Much of the knowledge of how to make games accessibility has evolved from specific exemplars for creating accessible features for specific types of groups of people with disabilities. For example, there is work creating specific games for children with visual disabilities (Archambault and Olivier, 2005), and for customised controllers for people with low mobility in their hands (Fanucci et al., 2011), or adaptation of commercial off-the-shelf equipment for commercial games (Istance et al., 2009). These point solutions often inform a specific approach to accessibility that may be copied or adapted by a developer to their game if they know about it. However, they are difficult to generalise from due to their specificity to either a specific technology or to a bespoke game.

In an attempt to move this type of research into a more publicly accessible form, the field of digital games adopted the practices of older technologies. As in many areas of accessibility, whether they be physical such as designing the entryway of a shop (ADA, 2019), or virtual such as creating a shop-window website (Caldwell et al., 2008), the main tool used for accessibility are sets of guidelines and there are various sets that a designer might use (Barlet and Spohn, 2012; GAG, 2019). However, like usability, designing from guidelines remains challenging particularly as there is tension between making each guideline simultaneously general enough to be used to apply to a wide variety of games and yet specific enough to inform application to a particular game(Stewart and Travis, 2003).

In this paper, in line with the overall goals of this special issue, we look back on both the historical approaches to accessibility, and look forward to how the knowledge contained within those approaches and new knowledge can be framed in a way that is more generative than evaluative for designers. In the next section we look at the examples of accessible games before turning to look in more detail at the use of guidelines for accessible games. We make the case that what is needed for designers is a new vocabulary that enables game developers to talk about accessibility as part of their wider design processes (Anthropy and Clark, 2014). It should always be remembered that games, unlike other interactive systems, are meant to be challenging and what developers are aiming for is not to somehow diminish their games in order to make them accessible but rather to augment them so that the game delivers an intended experience to the widest audience possible. Games are meant to be difficult but not difficult to access. Thus, in Section 3, we propose a distinction that any vocabulary should acknowledge between access and challenge. As a first proposal of what such a vocabulary might look like, we analyse the accessibility knowledge already captured in guidelines, section 4, to provide the basis for a working vocabulary, outlined in Section 5, as Access and Challenge Options. As such, we make the case how this initial vocabulary reformulates the knowledge about accessible games into a more generative form. From these foundations, the goal of accessibility should evolve from merely making games that are accessible to providing accessible player experiences.

1. The Rise of (In)accessible Games

From the earliest days of digital games (or electronic games as they were then called), there have been games that were accessible. One of the earliest is the Atari *Touch Me* arcade game which was later adapted to a handheld version called *Simon*. This is a now familiar game wherein the player must reproduce an ever-growing sequence of button presses. However, because the sequence is indicated by both sound and lights, it is equally playable by people with visual disabilities, people with hearing disabilities and their non-disabled peers. However, even Simon, a simple game of 4 button presses, remains inaccessible to people with upper limb physical disabilities who cannot press hard enough on the buttons to activate them. This is not as much a lament, but instead a reflection that even the most simple game designs introduce the potential for inaccessibility.

Classic electronic games gave way to computer games, using the ever increasing computing power available to find new ways for people to engage in play. Early consoles from the Atari 2600 to the Coleco Vision added increasingly elaborate visuals, with the medium shifting to have the moniker of video games. With this progress came increasingly elaborate game controls, with switches, buttons, and joysticks, all increasingly inaccessible to different players with disabilities in different ways. Perhaps the most vivid example of inaccessibility in game design comes from classic video game arcades of the 1970s and 1980s that were found across North America and Europe. After visiting the Museé Mechanique in San Francisco in 2018, the authors reflected on how even the earliest arcade games assumed that players could work a gumball joystick and press buttons with two hands, stand for long periods of time, and see the screen clearly. In a two year period, from 1978 when *Space Invaders* was released, to *Pac-Man* in 1979, to 1980 when *Defender* came out, the player went from having to push a single button to five different buttons, which seemed astronomically large at the time.

Thus, until recently, the development of accessible games has often been a cottage industry of committed grassroots advocates and interested academics, often separate from the production of mainstream commercial games (Rovithis, 2012). Some accessible games developers looked at the issue of control and how to provide access to a range of games, at least in principle. For example, early work by Archambault and Olivier (2005) presented a game station for children with visual impairments that was a combination of commercial off-the-shelf hardware and specialised assistive technology. Istance et al. (2009) evaluated the use of eyegaze for access to massively multiplayer online games such as World of Warcraft, for purposes of giving access to players with physical disabilities who could not use keyboards. Fanucci et al. (2011) provide an example of a customised controller for players with low mobility in their hands.

These examples all present solutions to specific barriers which might work across a range of games. Beyond these, there is a collection of works that specifically build games for players with disabilities, or reimplement a particular genre of game. For example, Miller et al. (2007) created a finger dancing game for people who were blind, with Kim and Ricaurte (2011) providing a similar game on mobile, while Yuan and Folmer (2008) adapted the popular music game Guitar Hero to use haptic cues. There are multiple implementations of space invaders for the general audience of players with disabilities (Grammenos et al., 2006), and specifically adapted for individuals who use

switch interfaces (López et al., 2017).

For many of the above examples, the approch is firmly rooted in the first wave of human computer interaction (Power et al., 2018), grounded primarily in the perceptual, cognitive or physical disabilities of individuals and in how they can manifest with accessibility barriers. First wave research can advance technology such that it can be reused more broadly in design, as seen in Gerling et al. (2013) with an API for replacing motion controls with key-presses, or in Vallejo-Pinto et al. (2011) where a set of earcons for use in game environments is proposed. However, much of the work is at the level of point solutions, where researchers choose a disability as a characteristic of players, and then apply a specific technology to overcome and address that barrier.

This type of approach has a number of issues. First, and perhaps most importantly, players with disabilities are immensely diverse as a user group. While players may identify as being part of a group of people with disabilities the range and variation within each group is immense. For example, players who identify as having physical disabilities could have a low range of motion in their arms, lack arm strength for lifting, lack hand strength to grip, have tremors that prevent precision, or have limbs that are missing. Each person may have one or more disability, each of which has potentially multiple adaptations that could address incompatibilities with game design, the selection of which will be up to the individual as to what they need and prefer.

Further, there is a growing recognition that people who identify as having a disability go beyond the traditional definitions of perceptual, physical and cognitive disabilities. The social model of disability establishing disability as a mismatch between how our society is designed and the characteristics of individuals has dramatically expanded the group of people that may consider themselves as having a disability, and likewise many nations are expanding their protected characteristics accordingly (Government, 2019). This process of widening participation in society in particular in games lags behind more visible disabilities. For example, people who are neurodiverse, such as those with autism, participate in the community of gamers playing commercial games but are under-represented in the game accessibility research space (Mazurek et al., 2015). Though such players are actively playing some games, strong emotional challenges of surprise or fear can render a game unplayable for them.

Finally, game accessibility research often sits separate from the commer-

cial game industry. While it might benefit a small number of players to be able to play space invaders, there are thousands more who want to play the wide variety of commercial games. Translation of the techniques outside of their specific games is often difficult, as the point solutions are tied to the design factors embedded in the games themselves. As a result, even when accessibility research finds its way into commercial game production, if often cannot be translated into other game designs. This difficulty led to the rise of the public face of accessibility in games, namely guidelines.

2. Accessibility guidelines

Guidelines are well-established in HCI as a way to capture knowledge on the design of interactive systems in a concise and digestible way. Sometimes these are captured out of research projects as a way to advance user-centred design knowledge, for example Kurniawan and Zaphiris (2005)'s guidelines for designing for older people, or as specific implications for design when studies produce complex qualitative data (Dourish, 2006). Often though, they are a form of collected wisdom, drawing across studies, experiences and literature, that can be used as a set of complementary aspects of usability and that can feed into design. Usability guidelines vary from the classic Nielsen heuristics that work at a very high-level of abstraction (Nielsen, 1994) to in-house style guides that ensure a consistent look and feel at the level of specific components of software and how they are used and presented, such as Apple's Human Interface Guidelines.[4]

Game accessibility guidelines similarly vary in depth and complexity. The IGDA Game Accessibility Top Ten[5] are clearly about raising awareness and helping developers address "quick wins" that make games accessible. The BBC's Accessible Game Standards[6] are part of a larger framework for addressing accessibility across all of the BBC's media formats.

The two most extensive, and probably therefore well-known, sets of guidelines are Includification from the AbleGamers Charity (Barlet and Spohn, 2012) and the Game Accessibility Guidelines (GAG) (GAG, 2019), the latter of which is maintained as a growing set.[7] Both emerged as the distilled

[4] developer.apple.com/design

[5] igda-gasig.org/about-game-accessibility/game-accessibility-top-ten

[6] www.bbc.co.uk/guidelines/futuremedia/accessibility/games.shtml

[7] gameaccessibilityguidelines.com

knowledge of many people and organisations and their experiences of making games accessible and advocating for game accessibility. It is therefore not surprising that they have common features and have arrived at similar recommendations.

Both Includification and GAG break down accessibility by considering the type of disability, specifically visual, hearing, motor and cognitive and different levels of abstraction. Includification, for instance, recommends that there need to be "sensitivity sliders" that allow players to adjust controls to suit their needs. Similarly, GAG has the guideline to "Include an option to adjust the sensitivity of controls." Further, both sets of guidelines divide into three levels with Includification progressing from what might be considered the minimum expectation up to an ideal world of accessible games while the GAG levels move from the easy to implement to the hard to implement or niche requirements. Not surprisingly, these levels have a degree of agreement because the more ideal the accessibility, in theory the harder it is likely to be to implement.

It is also notable that both sets point to how similar guidelines can have multiple benefits. For instance, Includification indicates that Speed Settings can be of benefit both to those with mobility and cognitive disabilities. Similarly, GAG's guidelines to "Use simple clear text formatting" supports people with both vision and cognitive disabilities.

From these guidelines, it is relatively straightforward to identify games that are aiming to be accessible. For example, *Call of Duty: Black Ops 4*, *Shadow of the Tomb Raider* and *Forza Horizon* all include a large number of different accessibility options, such as captioning, sensitivity controls and game assists.

This ability to identify the parts of a game that make it accessible indicates the real strength of guidelines, in games and technology more widely. By having a list of desirable attributes in the concise form of guidelines, it is a relatively simple task to evaluate a game, whether existing or in development, as to whether it meets the guidelines and therefore is more likely to be accessible. Guidelines function well as a checklist.

However, while a checklist can give reassurance that a game is in some ways accessible, it can give very little help when a game fails to meet the guidelines. And more importantly during the development process, while the intention might be to design from the outset a game that meets the guidelines, what is the right way to do that for your particular game? This problem is more clearly seen if we move away from the basic or minimal criteria of ac-

cessibility to the higher levels of the guidelines. For example, Includification recommends using Puzzle Assists to help people with mobility disabilities. An excellent example of this is found in *Shadow of the Tomb Raider*. The game has "adjustable paint" that can tell players where to climb and hence make progress in the game. This assist has been well received. However, what if your puzzles do not just rely on knowing where to look? When does a puzzle assist stop being enabling and become patronising? When does a puzzle assist remove the player experience of solving a puzzle for themselves? And when does that matter? Clearly *Shadow of the Tomb Raider* succeeded, but it was through careful, thoughtful and playtested design, not through the sole application of a guideline.

There is also the problem of the inherent limitations of guidelines which is two-fold. First, for each new game technology that comes along, whether that is touchscreens, virtual reality (VR) or brain-computer interfaces, new guidelines need to be developed because these technologies interact with disabilities in new and different ways. We already recognise the limitations of Includification for VR because it does not consider the issues of wearing a heavy headset or the specific arm and head movements needed to interact in VR environments. One solution is to grow the guidelines but with GAG already numbering near 100 guidelines, the problem then is that they grow so much that they become unmanageable. The concise and communicable nature of individual guidelines is overwhelmed by the sheer size of the overall set.

The second limitation is that while guidelines can tell you whether a feature is present or not, they cannot tell you whether the technology will be accessible to a particular individual. And even if accessible, the guidelines do not tell you what the impact on player experience might be. There is a genuine concern that adherence to guidelines means to "dumb down" or dilute the player experience (Garber, 2013). This problem has already been seen in the web, where despite concerted efforts to develop useful and extensive guidelines, there is good evidence that even websites that comform to guidelines can still be inaccessible to some (Power et al., 2012) or while accessible in terms of interaction, still not delivering a satisfactory user experience (Savva, 2017). This tension between guidelines and accessibility for an individual manifests itself when there are attempts to create scorecards saying how accessible a game is or is not. For example, it is possible to construct a top ten list and score 9 out of 10 on accessibility by incorporating everything but remappable buttons. For those who need remappable buttons, which is a

substantial portion of the population, the scorecard does not represent that they simply cannot play.

From our conversations with game developers, through AbleGamers, we are hearing a similar story about the practice of using guidelines. There is support and appreciation for guidelines in the games industry, essentially because they are a way to identify whether a game has features or not, and can serve as an entry way for discussions for raising awareness. However, when it comes to actual game design, developers are having to fall back on craft practice and the mastery of individual developers rather than the application of design thinking for accessible games.

One further problem is also emerging. Implicitly in almost all guidelines and explicitly in both Includification and GAG, the guidelines are broken down to address specific disabilities. However as noted, this break down is not clean and there are overlapping concerns and benefits where different disabilities are enabled by common solutions. Though it may intuitively make sense to design a game for a particular audience, it seems that in games, disability does not define the audience. This fault line in the formulation of game accessibility guidelines is supported by growing evidence from the players themselves (Beeston et al., 2018). For example, subtitles are only mentioned in GAG and Includification as ways to support players with hearing loss. However, in Beeston et al. (2018)'s sample of players, only 27 had any hearing impairment but 83 reported using subtitles to support their access to games. We cannot really explain why this is (though we might have plausible speculations) but it highlights that what experts are proposing as solutions to one particular problem are being appropriated by the players in personal and possibly idiosyncratic ways. Beyond merely appropriating solutions, there are situations where experts hold that some solutions are impossible and yet nonetheless are being used by players. In particular, Beeston et al. (2018) found that some players are using screenreaders to play digital games, something that has recently been dismissed as not supported by current technology (Westin et al., 2018). This disjunct between what experts and players are saying highlights the importance of working directly with players to improve accessiblity.

The issue, therefore, is one of evaluation versus generation. Guidelines are very useful for evaluating games and interactions but, as Stewart and Travis (2003) noted, are either too high level to be useful in informing design or too low-level to be widely applicable to new situations, such as game designers might be looking to do. To advance accessibility in games, how

should we promote generative design that is forward thinking to the needs of users with disabilities, in a way where designers and developers can generate accessibility solutions specific to their games? Considering the limitations of guidelines, this needs to be a way of talking about accessible games that is not couched in specific technologies, specific disabilities nor specific games. It also needs to retain the communication aspects of guidelines and therefore needs to be expressive enough to generate new ideas but concise enough to be easily used.

In the next section, we therefore consider how to arrive at an accessible game design language that closes this gap in generative design.

3. A Design Vocabulary for Game Accessibility

There are many ways of conceptualising digital games and therefore talking about them. For instance, Salen et al. (2004) defined digital games as forming a cybernetic loop, that is, a feedback loop of the player, actions in the game, the game world and the game acting back on the player. The Mechanics-Dynamics-Aesthetics (MDA) framework is intended to formalize how games are consumed (Hunicke et al., 2004) and highlights that game developers can only really influence the mechanics in the design process but that this is what leads to the dynamic interaction that players have and their subsequent aesthetic response to it.

Others have perhaps focused on specific aspects of games that lead to a better understanding of how games generally function as engaging but challenging activities. For instance, Costikyan (2013) focuses on uncertainty (also discussed by Salen et al. (2004)) as a central driver of gameplay. Juul (2013) has also discussed the importance of failure as a constituent of gameplay both to be enjoyed and to be overcome.

These formulations whether broad brush or narrowly focused are useful analytical tools to help us think about the interaction of players with a game and its design. However, they do not necessarily inform the processes of design and how to begin to think about designing a new game. This might be because game design, like any design process, is an open-ended task with negotiable success criteria that ultimately rely on the response of users. What game designers are trying to do is to design a certain experience (Fullerton et al., 2008) but there is no simple way to ensure that players have that experience (McCarthy and Wright, 2004).

Other game designers therefore have tried to expose the process of game design that enables others to both learn the craft but also to identify what it is that goes into a game, for example Fullerton et al. (2008). Probably the most comprehensive of these is Schell (2014)'s set of lenses. The use of the term lens itself reflects the fact that there is no privileged way of seeing games. Instead, different lenses bring different aspects of the game and its development into focus. In this framing, game accessibility could be (but currently is not) another lens for thinking about a diversity of players and the disabilities they have that might unnecessarily exclude them from playing. However, this then begs the question of what should go into that lens that is both generative and productive for the game design process.

Though these and many others are writing about the nature of digital games and the processes involved in digital game design, Anthropy and Clark (2014) argues that game designers still lack a language that would allow them to share, analyse and critique each others' work in a constructive setting or even within a single design team. She advocates for a particular vocabulary, not as the only way to talk about games but as the start of a way to talk about games that supports game design. We would argue that this vocabulary needs to extend to talk about what it means to access a game for a diverse audience of players.

What then is the goal of a game accessibility vocabulary? The consensus is that games are intended to deliver particular experiences to players, in which case our vocabulary should allow us to talk about delivering accessible player experiences (APX). However, as with other user experiences, player experiences are idiosyncratic to the player (McCarthy and Wright, 2004) and moreover situated in the context of play (Power et al., 2018). This context includes, amongst many other things, players' previous play experiences, who they play with, their expectations of a particular game, the controls they use, and all alongside their abilities and disabilities.

If APX is the goal, like all player experiences, it cannot be explicitly designed for (Hunicke et al., 2004) but designers can orient the game so that the desired experience is more likely to be experienced. The first step to having any experience is being able to have access to the game through its interfaces. What we mean by this is that players are first able to interact with the game and then receive information about how their actions have affected the game. In the language of games, access is about players entering the cybernetic loop (Salen et al., 2004) or, in the language of HCI, players need to be able to engage in the task-action cycle (Norman, 1998).

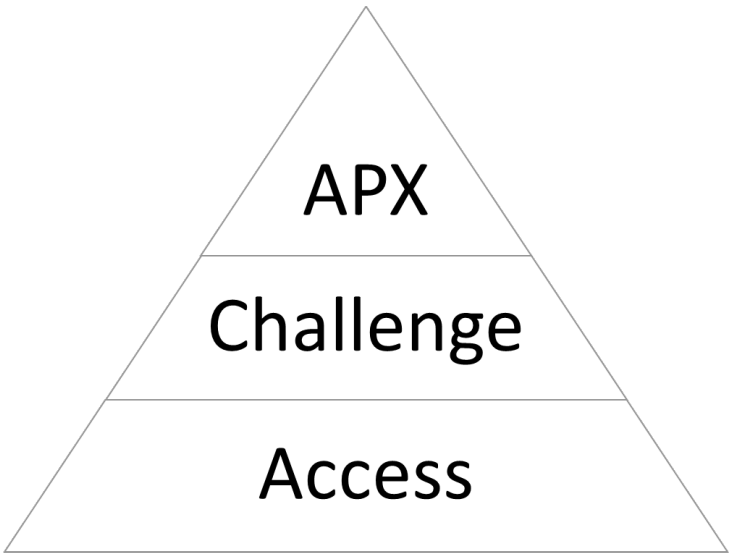

Figure 1: The APX triangle: first players having access to the game which then allows them to be enabled to meet the challenges of the game and where that is successful, leads to them having an accessible player experience (Power et al., 2018).

Once players have access to the game world through its interfaces, it still may not be the case that the game is accessible. Some players simply cannot, and may never be able, to respond quickly enough to in-game actions even though they can make those actions then perceive and understand the consequences. The challenge presented by the game, while core to the game play, can never be overcome by players because of their disability and some games will prevent those players from progressing beyond that point. Thus, to continue to play in the face of different challenges requires that the players are enabled, to a desired degree to overcome the challenges. Once the players are enabled, then it becomes possible for them to have access to the player experience, as illustrated in Figure 1.

Thus, making accessible player experiences is about supporting designers design for access to their games and after that to enable players to meet the challenges of their games. The risk, though, is to rely on expert judgment about what access and enablement means, with the problem found in guidelines that what experts say and what players experience are not aligned. We hold that the key step to making games accessible is to hear the voice of the players with disabilities who are playing or who want to play digital games.

The ideal situation would be to have players with disabilities involved in the design process. While the avenues for this are improving, the budgets and opportunities for this are low. Further, there is a minimum level of accessibility that will be required for some players to participate in any kind of playtest. This means that developers need some means of discussing and generating accessible designs alongside such inclusive playtesting regimes.

It is for this reason that we advocate a design vocabulary. We are now beginning to be in a position to hear from a relatively large number of players with disabilities (several hundred) about who they are, what they play and what they need (Beeston et al., 2018). This represents a much larger number of players than many of the previous studies discussed in Section 1. The goal for a design vocabulary would be to distil what players with disabilities are saying and capturing it in design thinking tools that communicate the players' voices to the designers.

4. Creating a Vocabulary

Currently, we are a long way from having that deep understanding of players that would provide us with a rich vocabulary for accessibility. However, there is a need now for the language of accessibility to be included in game design. We, therefore, propose here a vocabulary that builds out of the existing body of knowledge in game accessibility. The goal of this work is to produce a collection of terms (words, language) representing key concepts in accessibility in digital games that can be used for design. However, like Anthropy and Clark (2014), the proposed vocabulary is not intended to be *the* game accessibility vocabulary but to be *a* vocabularly that breaks the silence and stimulates a larger and evolving discussion.

4.1. Analysed Corpus

A collection of guidelines was compiled from the two leading guideline sets used in the games industry(Barlet and Spohn, 2012; GAG, 2019). This resulted in a list of 122 guideline statements. Due to the structure of existing guidelines, there were several duplicated entries across the different groups of people with disabilities. After merging these guidelines together, this resulted in 101 distinct accessibility guidelines.

As with many such guideline sets, the guidelines function at different levels of abstraction, from very low level interaction components (e.g. *Include a cool-down period (post acceptance delay) of 0.5 seconds between inputs*)

to the very general (e.g. *Allow the game to be started without the need to navigate through multiple levels of menus*). Further, several of the existing guidelines were identified as not being related to the design of games, but instead to the process by which games are made (e.g. *Solicit accessibility feedback*) or the marketing of a game (e.g. *Provide details of accessibility features on packaging and/or website*). These items were removed from the set as they do not fulfil the purpose of forming a vocabulary for accessible design. Finally, there were a small number of guidelines that are difficult to operationalise without designers having a substantial amount of further design information (e.g. *Avoid VR simulation sickness triggers* and *Avoid placing essential temporary information outside the player's eye-line*) which were also removed from the set.

In order to have a comparable set of design statements, the research team collaboratively rewrote each guideline statement in terms of what the outcome for the player is if the guideline is followed. For example, consider the design guidelines of:

- Provide signing
- Provide subtitles for all important speech
- Provide subtitles for supplementary speech

Each of these guidelines allows players to replace or enhance speech dialogue with information in another modality. For guidelines at a level of abstraction quite close to game interfaces, this transformation was relatively straightforward. However, some guidelines integrated several options for players into a type of meta-guideline. For example, consider the guideline: *Offer a means to bypass gameplay elements that aren't part of the core mechanic, via settings or in-game skip option.* This guideline encompasses a large number of different aspects of bypassing content such as:

- Quick time events
- Performance challenges relating to precision
- Combat scenarios
- Narrative and/or dialogue

Each of these meta-guidelines was analysed against the existing game space to extract and make explicit how they could potentially help players.

At the end of this process of rewriting the guidelines there were 75 player centred statements identifying how accessibility options helped players in a myriad of different ways. These statements were then used for purposes of undertaking a content analysis to identify higher level groupings that could be used as terms in a vocabulary.

4.2. Content Analysis

In the context of the APX triangle, we undertook a conventional content analysis (Krippendorff, 2004) on these 75 user centred statements in order to extrapolate an initial vocabulary that can be used as a basis of discussions of accessible game design. Furthermore, it was clear that these statements could be framed as options, that players could, in principle, choose to switch on or off to meet their particular needs and preferences.

One author undertook an open coding which resulted in 10 distinct codes covering different aspects of players engagement with games. A codebook was prepared with these 10 codes with descriptions of both what aspects of game design were included within it, and which were not. This codebook was then provided to another author, along with the complete set of 75 statements, and asked to code independently. The resulting intercoder reliability was $\kappa = 0.79$ with moderate agreement. After reviewing the disagreements, there was a definite pattern and 1 code was eliminated from the codebook, with the statements covered by it being represented by existing codes.

The first set of options that were extracted from the corpus led to a preliminary vocabulary for Access. These options help players get around the player-loop (Schell, 2014), and deal with the input and output of information from the game. These options largely do not require the modification of the game world or its mechanics, but instead focus on ensuring the players are at least able to interact with the game and its interfaces.

- **Input Options**: These are options that allow players to customise the controller(s) they use. This is distinct from Control options which are about remapping or tuning the controls in the game in different ways on a particular controller.

- **Control Options**: These are options that allow players to remap controls, add new controls, tune the reaction of the game and its interfaces

to the controls. Includes adding macros or other interfaces to reduce button presses. Distinct from Input Options which are about replacing the devices by which input is put into the game. Distinct from options that change the actual speed of the game.

- **Presentation Options**: These are options for choosing the modality and/or formatting of information being communicated to the player. This includes control over the amount of information being presented within a channel (such as sudden flashes or moving backgrounds, or variable audio channels). It also includes modification of the the user interface components within the game.

- **Output Options**: These are options to choose output devices and modify their attributes. This is distinct from, but can interact with, presentation options (e.g. resolution of screen could make text too small). Specifically about replacing or modifying the device itself, for example using a large screen, versus a mobile screen such as proposed in the new Google Stadia platform, or more radical changes to form factors such as those found in in virtual and augmented related headsets and displays.

Further, a set of options were identified as forming a preliminary vocabulary for Challenge, which are characterised by the need to modify the game for the player to tune their experience within the game world.

- **Performance Options**: These are options that allow players to change the types or level of reactions they would need to have in the game. Slowing down events in the game, providing options to pause or queue up actions, or changing/removing timers from content are examples of changing performance. These are distinct from Control options in that they require changing the game mechanics.

- **Training Options** These are options to train different skills in games, such as having tutorial or sandbox levels, or to give just-in-time help in game through visual cues or overlays.

- **Progress Options** These are options that allow people to continue to progress in the game when they encounter an obstacle that is too difficult or uncomfortable for them. Includes retaining progress they

have achieved, return previous points in the game, or bypass in places where they may/have become stuck in the game for a variety of reasons. Any option where the players are skipping an obstacle in the game, either in terms of reaction, dialogue, cutscenes belongs in this code. Hints to puzzles, autopass detection, tracking of objectives also belong here, as they all help the player to continue progressing through a helping hand from the game itself.

- **Social Options** These are options that allow the player to change the way they participate, collaborate and compete with others. This is specifically about changing the game, such as the amount of chattiness allowed on a team, looting rules, or the house rules by which points are scored, and do not include things such changing presentation or method of input by which players communicate.

- **Moderation Options** These are options that help players manage different aspects of emotional challenges that come from game content. This could include trigger warnings, gore settings, sexual content settings or other means of modifying the types of emotional content the player encounters.

The final code that was eliminated from this list was Aesthetic Options. This code was intended to capture aesthetic choices made by designers regarding the style or genre of the game. Of the places where the coders disagreed, this code was used by only one coder in 7 different statements, and not used elsewhere in the coded corpus. When looking at those statements, it was found that they were either items connected to changing presentation aspects of the game that would have an impact on aesthetics (e.g. ambient sounds, moving backgrounds), or they were related to design choices around content (e.g. gore, sexual content). As a result, these statements were recategorised as being Presentation Options or Moderation Options as appropriate.

5. A Preliminary Vocabulary

Through careful analysis of existing practices, we have proposed an initial vocabulary for accessible game design. This vocabulary consists of 2 broad types of options in access and challenge, which focus on the player-loop and

the game world respectively. Within those, there is a set of 9 different categories of options that can be discussed, which are as follows:

- Access Options
  - Input Options
  - Control Options
  - Presentation Options
  - Output Options
- Challenge Options
  - Performance Options
  - Training Options
  - Progress Options
  - Social Options
  - Moderation Options

This emergent categorisation supports the proposed framework for an APX vocabulary because the guidelines were already capturing a distinction between Access and Challenge when it comes to making games accessible. However, previous guidelines had not been presented or organised in this way. It further emerged in the analysis that all the guidelines could be framed as options, things that could be selected or not according to the particular needs and abilities of players. Rather than being things that should have been done in order to make a game accessible to someone with a specific disability, when reframed as options the guidelines present a suite of possibilities that designers could consider including. Further, these variations to a game acknowledge that disability is rarely just one thing.

We would argue that these categories of options provide a way to talk about the different aspects of accessibility that could act as different lenses to be incorporated into the game design process. A designer could choose to focus on, say, performance options whilst thinking about the timing and accuracy needed in a puzzle platform game. This would draw on the knowledge encapsulated in guidelines but might also point to the type of puzzle experience the designer is hoping to engender, whether that is a raw frustration at persistent failure or a satisfying elegance in neatly combining actions. At

another point, a different option category could be considered to help think about the controls needed to bring about the desired performance.

Our intent for this vocabulary, therefore, is not to supplant guidelines but to reformulate the knowledge that they embody in a form that better suits the practices of game developers (Schell, 2014). Frmo this perspective, the various game accessibility guidelines could be understood to be a form of intermediate-level knowledge (Löwgren, 2013). This is knowledge that can be useful for design but sits between particular instances of designs, in our case games that are accessible, but does not claim to be a general theory of design (Höök and Löwgren, 2012). We certainly do not currently have a general theory of accessible game design but the industry as a whole does seem to be looking for these intermediate-level knowledge forms that could be used when making accessible games.

This may explain the uncomfortable fit of guidelines for game design. Guidelines can be understood as evaluative intermediate-level knowledge, that is, knowledge that can be used to assess the qualities of a finished design. Though guidelines are a widely popular form of intermediate-level knowledge in HCI (Gray and Kou, 2017), what designers and developers need to exploit when developing a game is knowledge in a form that is suited to the generation of ideas. Such generative forms include strong concepts, annotated portfolios, methods and tools, and patterns (Höök and Löwgren, 2012).

Our vision of a vocabulary, in this sense, aims to support designers by providing a form of intermediate-level knowledge suited to ideation in the development of accessible games. However, this vocabulary is different from existing forms of intermediate-level knowledge. Strong concepts (Höök and Löwgren, 2012) and annotated portfolios (Gaver and Bowers, 2012) are intended to capture the products of design research and to provide a vehicle by which design research might move out of the domain of academics and into the toolkits of designers. These forms of knowledge are grounded in the design research of particular researchers and used as a way to communicate the substance of that research. By contrast, this vocabulary has taken the existing knowledge arising from the established practice of making games accessible and reformulated it as a set of generative options. In many ways, in thinking of a vocabulary, we are most closely approximating the form of patterns which were originally conceived of as forming a language for design (Alexander, 1979). However, in our analysis we have not gone so far as to formulate the vocabulary as a pattern language and indeed we are further

still from having the maturity to represent the intermediate-level knowledge as methods and tools that game developers could adopt.

Of course, this is only *a* vocabulary. It provides the basis for further work in the area of inclusive design of games. In particular, there is room for differentiation and decomposition in each of the categories. For examples, within Presentation Options there are features of games that deal with alternative channels of information, versus features that help people customise their presentation so channels and text are clear. Similarly in Progress Options we can identify options that are game assists, versus those that are about bypassing content. While it is tempting to do this type of decomposition now in this paper, there is an opportunity to involve players in identifying what that decomposition should look like. For example, questions about what are the most important options across the player population, or which options are most prevalent or absent in games, are best left to empirical work with players with disabilities. Based on the findings of such work, we might develop a new vocabulary that more resembles one of the existing forms of intermediate-level knowledge or a vocabulary may remain as simply a way of talking about accessibility more in line with Anthropy and Clark (2014)'s view.

Another direction would be to develop the vocabulary from a design research perspective of building accessible games and capturing the intermediate-level knowledge from them. Much as Gaver and his colleagues have developed a substantial set of significant interaction designs from which they have defined annotated portfolios (Gaver and Bowers, 2012), we might draw on the expertise of developers who have successfully and repeatedly developed accessible games to capture their vocabularies for use by other designers. However, we are not aware of researchers into accessible games taking such an enduring design research approach comparable to Gaver and his colleagues.

Regardless of how we generate a better vocabulary, there is also the question of whether there are other vocabularies that encourage designs that are good for all players. Just as some civic buildings offer the options of steps or ramps as ways for people to enter, and others provide a gently sloping plaza outside the building that removes the need for either, are there similar solutions for common patterns in games that would remove the need for optionality in some cases?

When looking across different fields of accessibility, we find that this type of vocabulary, a design language that can be applied by designers, is absent. Drawing parallels with the APX triangle, accessibility design vocabularies

might represent a way to frame the general problem of accessibility in HCI. Basic access to a technology must always be solved for every new technology but it is only once enablement has also been addressed do we arrive at good accessible technology that delivers the user experiences that we all are seeking.

For now though, we focus on games and propose thinking about design vocabularies leading to ideation in accessible player experiences. This does not mean replacing everything that has gone before. Indeed, guidelines have been important in raising awareness of accessibility and will continue to be important in evaluating the accessibility of games. As such, they form the underpinning for this initial vocabulary. However, we would hold that by developing further the vocabulary that games designers need to develop accessible games, we will be able to present the voice of the players with disabilities, which is currently not easily heard. By putting the players at the centre of the game design process, we hope to uphold the traditions and values of HCI of putting people first in all of our technology including digital games.

References

ADA, 2019. Americans with disabilities act standards. URL: https://www.access-board.gov/guidelines-and-standards/buildings-and-sites/.

Alexander, C., 1979. The timeless way of building. Oxford University Press.

Anthropy, A., Clark, N., 2014. A game design vocabulary: Exploring the foundational principles behind good game design. Pearson Education.

Archambault, D., Olivier, D., 2005. How to make games for visually impaired children, in: Proc. of the 2005 ACM SIGCHI International Conference on Advances in Computer Entertainment Technology, ACM. pp. 450–453.

Armstrong, S., 2018. Adaptive controller is getting people with disabilities back into gaming. Wired URL: https://www.wired.co.uk/article/microsoft-xbox-adaptive-controller.

Barlet, M.C., Spohn, S.D., 2012. Includification: A practical guide to game accessibility. Charles Town: The Ablegamers Foundation .

Beeston, J., Power, C., Cairns, P., Barlet, M., 2018. Accessible player experiences (apx): The players, in: International Conference on Computers Helping People with Special Needs, Springer. pp. 245–253.

Boniwell, I., 2008. Positive psychology in a nutshell. Open University Press.

Caldwell, B., Cooper, M., Reid, L.G., Vanderheiden, G., 2008. Web content accessibility guidelines (wcag) 2.0. WWW Consortium (W3C) .

Center for Disease Control and Prevention, . Disability impacts all of us. Retrieved from https://www.cdc.gov/ncbddd/disabilityandhealth/infographic-disability-impacts-all.html on May 1, 2019.

Costikyan, G., 2013. Uncertainty in games. Mit Press.

Dourish, P., 2006. Implications for design, in: Proceedings of the SIGCHI conference on Human Factors in computing systems, ACM. pp. 541–550.

Electronic Entertainment Design and Research, . Gamer segmentation 2018 syndicated report. Retrieved from https://www.eedar.com/free-reports, May 1, 2019.

ESA, 2018. Essential facts about the computer and video game industry. URL: www.theesa.com/about-esa/essential-facts-computer-video-game-industry/.

Fanucci, L., Iacopetti, F., Roncella, R., 2011. A console interface for game accessibility to people with motor impairments, in: Consumer Electronics-Berlin (ICCE-Berlin), 2011 IEEE International Conference on, IEEE. pp. 206–210.

Fullerton, T., Swain, C., Hoffman, S., 2008. Game Design Workshop: a playcentric approach to creating innovative games. Morgan Kaufmann Publishers, Burlington.

GAG, 2019. Game accessibility guidelines. URL: gameaccessibilityguidelines.com.

Garber, L., 2013. Game accessibility: enabling everyone to play. Computer , 14–18.

Gaver, B., Bowers, J., 2012. Annotated portfolios. interactions 19, 40–49.

Gerling, K.M., Mandryk, R.L., Kalyn, M.R., 2013. Wheelchair-based game design for older adults, in: Proceedings of the 15th International ACM SIGACCESS Conference on Computers and Accessibility, ACM. p. 27.

Government, U., 2019. Uk equality act. URL: www.gov.uk/guidance/equality-act-2010-guidance.

Grammenos, D., Savidis, A., Georgalis, Y., Stephanidis, C., 2006. Access invaders: Developing a universally accessible action game, in: International Conference on Computers for Handicapped Persons, Springer. pp. 388–395.

Gray, C.M., Kou, Y., 2017. Ux practitioners' engagement with intermediate-level knowledge, in: ACM DIS 2017 Conference Companion, ACM. pp. 13–17.

Höök, K., Löwgren, J., 2012. Strong concepts: Intermediate-level knowledge in interaction design research. ACM Transactions on Computer-Human Interaction (TOCHI) 19, 23.

Hunicke, R., LeBlanc, M., Zubek, R., 2004. Mda: A formal approach to game design and game research, in: Proceedings of the AAAI Workshop on Challenges in Game AI, p. 1722.

Istance, H., Vickers, S., Hyrskykari, A., 2009. Gaze-based interaction with massively multiplayer on-line games, in: CHI'09 Extended Abstracts on Human Factors in Computing Systems, ACM. pp. 4381–4386.

Juul, J., 2013. The art of failure: An essay on the pain of playing video games. Mit Press.

Kim, J., Ricaurte, J., 2011. Tapbeats: accessible and mobile casual gaming, in: The proceedings of the 13th international ACM SIGACCESS conference on Computers and accessibility, ACM. pp. 285–286.

Krippendorff, K., 2004. Reliability in content analysis. Human communication research 30, 411–433.

Kurniawan, S., Zaphiris, P., 2005. derived web design guidelines for older people, in: Proceedings of the 7th international ACM SIGACCESS conference on Computers and accessibility, ACM. pp. 129–135.

Landauer, T.K., 1996. The trouble with computers: Usefulness, usability, and productivity. MIT press.

López, S.A., Corno, F., Russis, L.D., 2017. Design and development of one-switch video games for children with severe motor disabilities. ACM Transactions on Accessible Computing (TACCESS) 10, 12.

Löwgren, J., 2013. Annotated portfolios and other forms of intermediate-level knowledge. Interactions 20, 30–34.

Mazurek, M.O., Engelhardt, C.R., Clark, K.E., 2015. Video games from the perspective of adults with autism spectrum disorder. Computers in Human Behavior 51, 122–130.

McCarthy, J., Wright, P., 2004. Technology as experience. interactions 11, 42–43.

Miller, D., Parecki, A., Douglas, S.A., 2007. Finger dance: a sound game for blind people, in: Proceedings of the 9th international ACM SIGACCESS conference on Computers and accessibility, ACM. pp. 253–254.

Nielsen, J., 1994. Usability engineering. Elsevier.

Norman, D., 1998. The design of everyday things. MIT Press.

Power, C., Cairns, P., Barlet, M., 2018. Inclusion in the third wave: Access to experience, in: New Directions in Third Wave Human-Computer Interaction: Volume 1-Technologies. Springer, pp. 163–181.

Power, C., Freire, A., Petrie, H., Swallow, D., 2012. Guidelines are only half of the story: accessibility problems encountered by blind users on the web, in: Proceedings of the SIGCHI conference on human factors in computing systems, ACM. pp. 433–442.

Rovithis, E., 2012. A classification of audio-based games in terms of sonic gameplay and the introduction of the audio-role-playing-game: Kronos, in: Proceedings of the 7th Audio Mostly Conference: A Conference on Interaction with Sound, ACM. pp. 160–164.

Salen, K., Tekinbaş, K.S., Zimmerman, E., 2004. Rules of play: Game design fundamentals. MIT press.

Savva, A., 2017. Understanding accessibility problems of blind users on the web. Ph.D. thesis. University of York.

Schell, J., 2014. The Art of Game Design: A book of lenses. AK Peters/CRC Press.

Stewart, T., Travis, D., 2003. Guidelines, standards, and style guides, in: Jacko, J.A., Sears, A. (Eds.), The Human-computer Interaction Handbook. L. Erlbaum Associates Inc., Hillsdale, NJ, USA, pp. 991–1005.

U.S. Census Bureau, . Quick facts report. Retrieved from https://www.census.gov/quickfacts/fact/table/US/PST045218 on May 1, 2019.

Vallejo-Pinto, J.Á., Torrente, J., Fernández-Manjón, B., Ortega-Moral, M., 2011. Applying sonification to improve accessibility of point-and-click computer games for people with limited vision, in: Proceedings of the 25th BCS Conference on Human-Computer Interaction, British Computer Society. pp. 449–454.

Westin, T., Ku, J.J., Dupire, J., Hamilton, I., 2018. Game accessibility guidelines and wcag 2.0–a gap analysis, in: International Conference on Computers Helping People with Special Needs, Springer. pp. 270–279.

Yuan, B., Folmer, E., 2008. Blind hero: enabling guitar hero for the visually impaired, in: Proceedings of the 10th international ACM SIGACCESS conference on Computers and accessibility, ACM. pp. 169–176.