Centre for Program Evaluation & Melbourne Disability Institute

Evaluating the Potential of Mixed Reality Technology at Ability Works

Prepared for Ability Works – Kew Victoria

4th September
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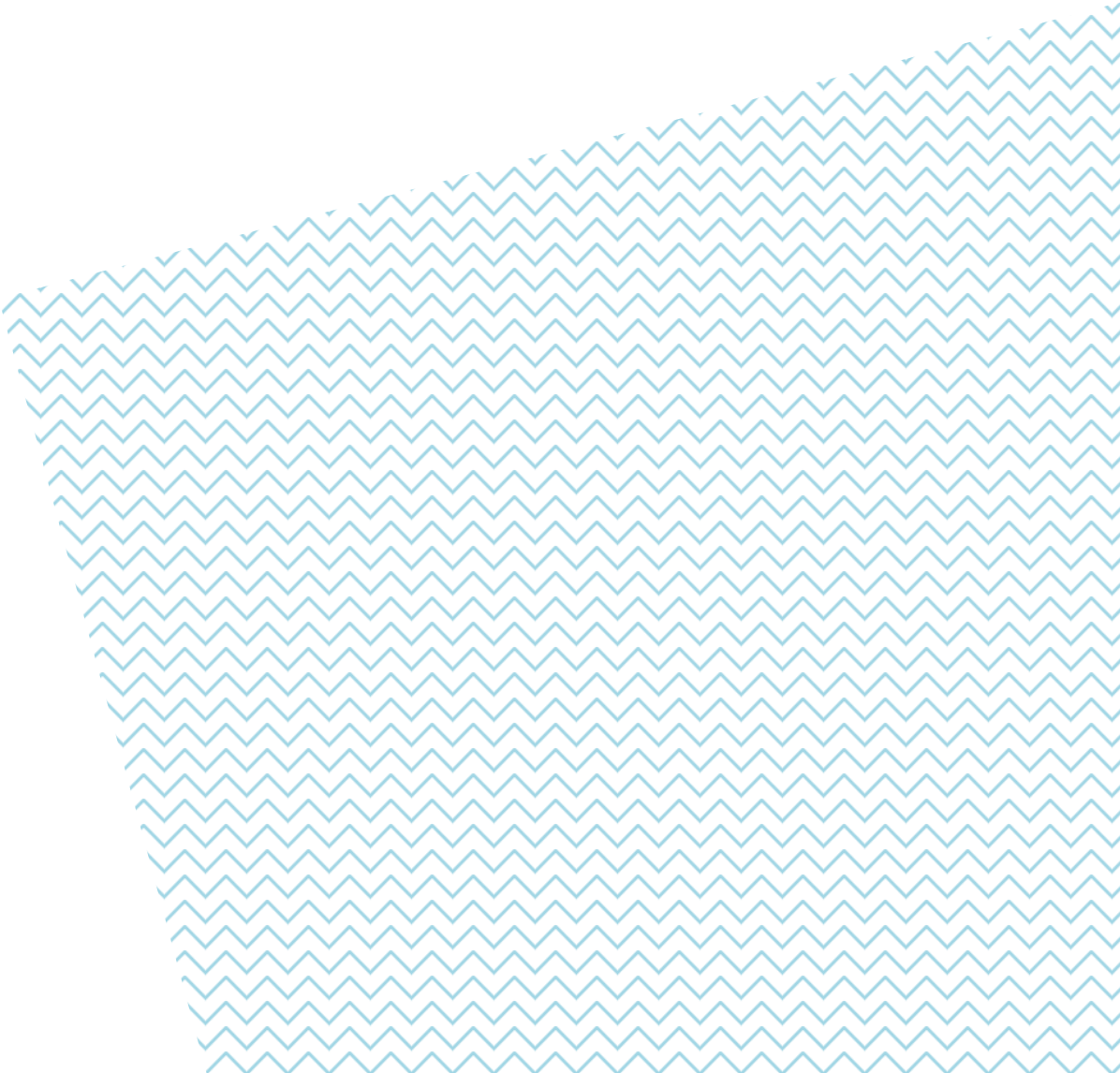

Acknowledgments

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Context

The University of Melbourne

The University of Melbourne has over 160-years of history of leadership in research, innovation, teaching and learning. It is the highest-ranked research university in Australia. Our researchers are at the forefront of international scholarship in a diverse range of fields.

Melbourne Disability Institute

The Melbourne Disability Institute (MDI) is an interdisciplinary research institute that was established by the University of Melbourne in 2018 to build a collaborative, interdisciplinary and translational research program to improve the lives of people with disability. Ultimately, the MDI research program aims to capitalise on national reforms and active partnerships with the disability sector to deliver evidence for transformation. The MDI research program is centred around providing much-needed evidence for the disability sector and broader community to address the complex problems facing people with disability, their families and carers.

Centre for Program Evaluation

The Centre for Program Evaluation (CPE) undertakes evaluations and research projects for government departments, non-government organisations and community-based agencies across a wide range of policy and program areas but particularly in the areas of education, health, the arts, social wellbeing and the community. Staff members are skilled in the use of widely known, as well as current, emerging and innovative evaluation theory, techniques, and practice, all of which aim to enhance client and stakeholder collaboration and increase the utilisation of evaluation findings.

Community Based Research Scheme

This project was conducted and funded through the Melbourne Disability Institute Community-Based Research scheme. The scheme is designed to build the evidence in the disability sector, by linking community organisations to researchers at The University of Melbourne. Projects funded through the scheme include small-medium projects suggested by community-based organisations that build social capital and improve lives of people with disability, their families or carers. The community-based research scheme is intended to support research and evaluation of innovative ideas that build social capital; to share good practice; and to replicate or scale up ideas.

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List of Abbreviations

Abbreviation	Full text
CPE	Centre for Program Evaluation
ID	Intellectual Disability
MDI	Melbourne Disability Institute

Evaluating the Potential of Mixed Reality Technology at Ability Works

Executive Summary

4 September 2020

Evaluation Summary

Ability Works, a social enterprise supporting employment for people with cognitive and intellectual disability, has been implementing a mixed reality project with Solve Disability Solutions, Enabler Interactive and RMIT University biomedical engineering students, using Microsoft HoloLens headsets.

The aim of this project is to support employees to receive technical assistance and regular reminders of how to operate the machines at times when employees may get distracted or forget the steps in operating the machine.

The evaluation found that overall, employees reacted positively to the new technology and found it helpful in completing the allocated task. Initial comparisons also indicated that production was also increased with the use of the technology. Considerations for mobility and design were also discussed.

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Background

Ability Works is a people centric, supported not-for-profit social enterprise operating commercially in Kew, Melbourne since 1963. Ability Works seeks to empower employees living with a disability who may otherwise find it challenging to secure and retain employment by improving their skills, independence, sense of achievement, and creating a meaningful, supported workplace environment.

Ability Works has been implementing a mixed reality project with Solve Disability Solutions, Enabler Interactive and RMIT University biomedical engineering students, using Microsoft HoloLens headsets.

The aim of this project is to support employees with cognitive and/or intellectual disabilities to receive technical assistance and regular reminders of how to operate the machines at times when employees may get distracted or forget the steps in operating the machine. The HoloLens headsets have been programmed to provide these reminders and assistance via holographic images on the headsets worn by the employees, which also still allow the wearer to see their surrounding environment (thus 'mixed reality' and not 'virtual reality').

The Centre for Program Evaluation was commissioned by the Melbourne Disability Institute to evaluate the initial stages of the mixed reality program at Ability Works to:

i. Establish the effectiveness (or otherwise) and potential of mixed reality headsets in enhancing employee task competency;

ii. Assess and understand the perceptions of employees' and key stakeholders' initial experience of the headset's overall value and use the early results to make changes or improvements.

Areas of Investigation/Key Evaluation Questions

1. How has the program been implemented?
2. What are the reactions of the stakeholders to mixed reality?
3. What are the benefits to the stakeholders involved?
4. Have there been any unanticipated or negative consequences of the technology?
5. What are the success factors for the project overall?

Evaluation Methodology

A mixed method approach of qualitative and quantitative data collection and analysis was employed. The evaluation team conducted individual and focus group interviews; some on site and some by zoom with the stakeholders. Output data was also collected to compare the amount of production with and without the use of the headset.

After discussion with management at Ability Works and the Project Team, it was decided that the following groups and numbers should be interviewed, as shown in Table 1:

Table 1. Evaluation Participants

Stakeholder Group	Type	Number of Participants
Ability Works Staff	Individual/group interview	n=5
Employees *(two employees were involved in both the interview and the output trial**)**	Individual interviews/surveys	n=9
	Headset output trials	n=7
Developers	Individual/group interviews	n=4

Key Findings

Employees:

It appeared that the use of the headsets posed few issues for the employees. Although an observation was made that the sensation of having something on the head was different, all of them got used to it quickly and easily. All the participants interviewed felt very happy about using the headsets for their work. Two of the participants mentioned an increase in their confidence levels after their use of the headsets.

> *"It helps you by pictures and arrows – does it make it easy – yes!"* (employee)

Few changes were mentioned; The headsets calibrate to the individual user. This is done by staring at a prism whilst wearing the headsets. It was commented that this could pose a challenge for people who are visually impaired or who have an eye condition such as "lazy eye".

One employee in a wheelchair commented on the height difficulty and suggested that the addition of a bit more padding on the headsets could be an improvement; mostly they felt very comfortable. As a general comment, the employees seemed very relaxed after their initial experience with the technology.

Output Results:

> Seven employees participated in an experiment where their rate of bending wires over one hour was tested without the headset and with the headset. Apart from one employee, all had achieved a greater number of bended wires with the HoloLens headsets.

Ability Works Staff/Management:

The introduction of a technology such as mixed reality headsets were seen as a way to promote independence in the employees, and to help them to keep on task without having to regularly seek help from supervisors.

Staff members involved in the training of employees could see many benefits of the mixed reality headsets, particularly as a training tool, extending attention span, and improving confidence and independence.

The success factors for the management and staff are those related to the employees being able to wear the headsets and being able to maintain focus for a period of time. Management and staff are optimistic that this technology has a place in Ability Works and can contribute to productivity and motivation.

> *"Success for us is that our employees have greater independence, greater focus, greater sense of pride. My big vision for this is that we can adapt the headset to the individual on the job." (Management)*

There were some concerns that wearing the headsets for a considerable period may result in the employee "being lost in that world", or that the headsets may be seen as a negative by the employee. It is also important that employees do not

feel that they are just a machine. Management appear to be well aware of these possibilities and continue to act to mitigate these.

Developers:

The developers were keen to develop a product which enabled the employees to live independent lives, and to provide a technology to enhance their capabilities.

The developers indicated that this trial was mainly to see how the technology was accepted by the employees, and to see if the technology could enhance the strengths and capacities of the employees. Although the headsets have not been tested on the scale they would have wanted at this stage, mainly because of COVID-19 restrictions in the workplace, they are pleased that the reactions of the employees have been positive.

The development team share an air of optimism for building on this pilot phase for further expansion of its use.

> *"I think it has real potential – still a way to go but excited by the capacity, now we have hands on experience" (developers)*

The only cautionary note from the developers was the fact that "like all technology, you become reliant on it".

Discussion/Conclusions

The reactions from the employees have been positive and although the adoption of the technology is still in its early stages, there would appear to be few issues with the use of the HoloLens mixed reality technology. Of the few issues discussed, most involved initial discomfort that was ultimately not prohibitive to using the technology. The need to make the technology physically accessible for various body types and mobilities was also noted.

The interviews and quantitative data from employees, and interviews with developers and staff at Ability Works all indicate that the technology is providing outcomes consistent with the initial hopes outlined by the developers. There are also discussions already happening with the developers and management about expanding the use of the technology to other possible workstations at Ability Works.

Recommendations

Although in its early stages yet, the introduction of mixed reality into the workplace at Ability Works appears to have been a success. One of the earlier concerns was how the employees would accept the introduction of the new technology. These initial concerns appear to be unfounded as the employees have embraced the new technology, and early results in terms of productivity appear to suggest an upward trend in production.

The following recommendations are suggested:

- That mixed reality be made part of the organisation's future
- Further exploration be undertaken to adapting the headsets to other production lines in Ability Works
- More employees, with differing abilities are trained to use the headsets
- To encourage a co-design approach to new technology, to increase suitability for all, and also increase participant 'buy-in' to the technology
- That further adaptions are made to the headsets so that they adapt to the individual on the job, and the possibility of employing people with autism to program the headsets be considered
- That work with the developers be continued and new technologies are incorporated into the mixed reality.

Report Structure

This report presents the findings and recommendations of the Evaluation of Mixed Reality Technology at Ability Works conducted by the Centre for Program Evaluation (CPE). The document is structured as follows:

Section 1 Introduction provides a background to the evaluation, the purpose of the evaluation and the key evaluation questions.

Section 2 Literature Review provides an overview of the literature on the use of technology in the workplace for people with Intellectual and cognitive disability

Section 3 Methodology presents the rationale and design of the evaluation, the sampling, data collection, and analytical methods.

Section 4 Results and Discussion provides a discussion of key findings in relation to the evaluation questions and the review of the literature on the use of technology in the workplace.

Section 5 Conclusion is an overview of key findings.

Section 6 Recommendations provides an overview of recommendations based on the analysis and discussion of key findings.

1. Introduction

The goal of ensuring that people with disability are suitably supported and empowered to participate as fully as possible in economic and social life through engaging in gainful and stable employment is pivotal (OECD, 2003, p.16). Indeed, this goal is one that is at the heart of Ability Works Australia. Ability Works is a people centric, supported not-for-profit social enterprise. Operating commercially in Kew, Melbourne since 1963, Ability Works has a clear social mission: "Purpose, pride and belonging through inclusive employment" (Ability Works, n.d.). It seeks to empower employees living with a disability who may otherwise find it challenging to secure and retain employment by improving their skills, independence, sense of achievement, and creating a meaningful, supported workplace environment (Tonroe, Brady, Batten & Chew, 2019b). Employment opportunities, with an additional focus on building confidence, skills and providing a stepping stone to other employment, are also provided to others facing a significant barrier to employment including Aboriginal and Torres Strait Islanders, refugees, mothers returning to the workforce, mature aged workers, young entrants to the workforce, and individuals for whom English is a second language (Ability Works, n.d.). Producing and trading in goods and services with numerous businesses, Ability Works have three primary business units: wire and metal fabrication, records management, and packaging and assembly.

Ability Works has recognised that for some employees, aspects of their disability may be impinging upon their work performance, making it challenging for the required tasks to be undertaken in the correct sequence and through to completion (Tonroe et al, 2019a).

Three notable factors were identified:

a. Memory difficulties: Difficulties in recalling how to perform specific tasks with a series of steps can be challenging for some employees who experience memory impairment as part of their disability or as a stand-alone issue. Often short-term memory (where limited amounts of information can be held temporarily for quick access) or working memory (used to plan and carry out behaviour to help make use of the short-term memory) issues are further compounded when employees do not work for several days at a time, forgetting what they had previously learned, or

a new contract commences, resulting in employees needing to be retrained in a new task (Cowan, 2008, p.324; Tonroe et al, 2019b).

b. Distraction: Employees with intellectual and cognitive disabilities often find that they can become easily distracted by their environments resulting in losing the flow of the required task sequence and not being able to complete or learn how to complete the task in full. Distraction can be further amplified as a result of the facility's environment being one of noise, and constant action. This has greater implications to: 1. Staff safety where employees may release buttons prematurely before wires on the machine can be fully bent at a 90 degree angle and/or employees do not press both buttons down simultaneously to achieve the desired output; and 2. Ability Works' manufacturing aim of remaining commercially competitive and viable in fulfilling company set quotas (Tonroe et al, 2019b).

c. Feeling valued: Providing reassurance and positive reinforcement is an integral part of Ability Work's core values. Executive staff have highlighted their strong desire to ensure that all employees are acknowledged for their personal work contribution, particularly noting that given their employees experience great joy and demonstrate great pride in their work, positive reinforcement is particularly important for staff to feel valued and supported (Tonroe et al, 2019a).

1.2. Mixed Reality Project

Ability Works is seeking a training program that supports the varying needs of employees with cognitive and/or intellectual disabilities at their production facility. Through this training, the aim is to support employees to receive technical assistance and regular reminders of how to operate the machines at times when employees may get distracted or forget the steps in operating the machine. In turn, technology is hoped to free up supervisors' time to tackle more complex tasks while reducing supervisors' workloads as currently one supervisor is responsible for overseeing 12 or more employees with high support needs (Tonroe et al, 2019b).

Ability Works has been implementing a mixed reality project with Solve Disability Solutions (SDS), Enabler Interactive and RMIT University biomedical engineering students. Solve Disability Solutions specialist expertise has been engaged due to their experience in partnering with universities and providing technical guidance (along with a mentor) to engineering students undertaking assistive technology development projects. RMIT University biomedical engineering students were enlisted to set up the Mixed Reality program. After assessing multiple machines at the Ability Works facility, and post several discussions with Solve Disability Solutions and Ability Works management, RMIT students selected a wire bending machine located in the wire and metal fabrication section of the facility on which to run the pilot (Tonroe et al, 2019b). This machine is used to bend straight pieces of 330mm length wire at both ends to create two right angles, resulting in a U- shape to be formed. Often being the first machine to be used by employees when they commence in this unit due to being relatively simple to operate through six primary steps, the wire bending machine has further been made safe by Ability Works staff to prevent risk of injury. The most common problem associated with employees use of this machine is not simultaneously pressing the two buttons for the required duration resulting in the wires not becoming completely bent. Supervisors have highlighted that it is the loud noises within the facility that cause most employees to become distracted, making it challenging for them to complete the wire bending task (Tonroe et al, 2019b)

A headset using Mixed Reality has been programmed to pilot test whether this medium would assist employees to maintain their attention and focus without distraction, and to correctly use the machine through technical prompts so that they can build their skills and independence in a real-world manufacturing workplace. The headset was selected by RMIT and Enabler Interactive due to possessing the

largest support network compared with all other current solutions (Tonroe et al, 2019b, p.3). Mixed reality technology seamlessly merges digital objects within the physical world (RMIT final report, p. 4), fostering a more intuitive learning experience that would not be possible without this kind of technology (RMIT Final report, p.4). As outlined in Figure 1, mixed reality is described as being the fusion of augmented reality (AR) with virtual reality (VR). In this way, "augmented reality overlays virtual objects in a physical environment as if they existed within the physical boundaries known as 'geometric persistence', with virtual reality then immersing "the user in a digital environment through the use of a screen attached to a headset" (Tonroe et al, 2019b, p. 4). While the headset used in this project falls on the *augmented reality* side of the spectrum, *mixed reality* will be used as an inclusive term for this type of technology throughout the report.

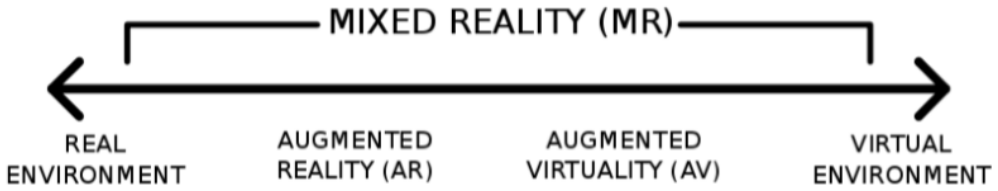

Figure 1. The Mixed Reality Spectrum (Tonroe et al, 2019b, p. 4)

Ability Works were keen to trial this technology after viewing news reports of the positive impact for people with intellectual disability in other settings. This type of technology was also chosen by Ability Works as the result of conversations with another similar organisation who had also used virtual technologies. In their experience participants had some difficulty with complete immersion in virtual reality, and thus recommended augmented reality as an option with more potential for successful uptake.

1.2.1. HoloLens Mixed Reality Headset

The Microsoft HoloLens mixed reality headset used in this project is a wireless adjustable headband device that does not require connections to a computer or other devices (refer to Figure 2). Running in the same way a small windows computer does, the headset device has its own battery, processor, storage and RAM while the front of the device contains sensors, cameras and projection lenses needed for mixed reality (Tonroe et al, 2019b, p. 5). Once the headset is placed on for use, employees are able to select for step by step instructions of the wire bending process to be given verbally via audio and/or visually through animation and text based on their individual needs. Congratulatory messages are additionally provided as a means of encouragement and positive reinforcement so that employees are aware that they are working through the process well (Tonroe et al, 2019b, p. 13).

Figure 2. Mixed reality headset (Tonroe et al, 2019b, p. 5)

1.3. The Evaluation of the Potential of the Mixed Reality Technology

1.3.1. Purpose of the Evaluation

The University of Melbourne's Centre for Program Evaluation has been commissioned by The Melbourne Disability Institute to evaluate this project by looking to:

i. Establish the effectiveness (or otherwise) and potential of Mixed Reality headsets in enhancing employee task competency;

ii. Assess and understand the perceptions of employees' and key stakeholders' initial experience of the headset's overall value and use the early results to make changes or improvements.

In particular, the evaluation seeks to obtain the views of the actual participants of the program, their key support workers and Ability Works supervisors in terms of the effectiveness and impact of this initiative.

1.3.2. Key Evaluation Questions

The following evaluation questions guided the data collection and analysis:

1. How has the program been implemented?
2. What are the reactions of the stakeholders to mixed reality?
3. What are the benefits to the stakeholders involved?
4. Have there been any unanticipated or negative consequences of the technology?
5. What are the success factors for the project overall?

1.3.3. Development and Delivery

The evaluation will look at the development and delivery of this pilot program and the effectiveness of this delivery for the employees. The outcomes of the evaluation will hopefully assist Ability Works to make improvements to the program and further develop its potential across the organisation.

1.3.4. Program Theory

The evaluation is underpinned by a program logic model or outcome model, which outlines what the program will do and how it will do it. It is a visual representation of the underlying program theory, depicting the sequence of steps by which the intended outcomes will be achieved (Owen, 2006). A program logic model is developed by collecting data from stakeholders about their vision for the project, their inputs, activities and perceived outcomes, and the factors that enable or act as barriers to the program. A thorough understanding of the program aims, objectives, inputs, processes, outputs and outcomes are essential to enable the evaluation team to effectively measure and describe the progress of an initiative, as well as make recommendations to support its ongoing development

The Program Logic exercise took place on December 10th 2019 with the participation of four Ability Works staff members; four Solve Staff members, two Enabler Interactive staff members, the Project Manager from the Melbourne Disability Institute and the Researcher from the Centre for Program Evaluation at The University of Melbourne. The results of this exercise are in Appendix B.

2. Literature Review

The following literature review aims to provide context for the Mixed Reality program and provides an overview of relevant research to the context at Ability Works.

Combinations of the following search terms were used to find literature in various databases such as Google Scholar: Intellectual disability, cognitive impairment, cognitive disability, HoloLens, augmented reality, mixed reality, Wearable Assistive Technologies (WAT), employment. Titles and abstracts were

screened for relevance to the topic; for example, articles relating to virtual reality and not mixed or augmented reality were excluded.

2.1.1. Cognitive Disability and Intellectual Disability

Cognitive disability is an umbrella term that refers to various disabilities affecting the cognitive domain, and can include conditions such as autism, intellectual disability, neurodegenerative diseases, and brain injury. People with cognitive disability typically experience difficulties in areas such as processing ability, social ability, memory and language (Garzotto, Torelli, Vona, & Aruanno, 2018; Moon, Baker, & Goughnour, 2019). This review will address research in relation to cognitive disability but will focus on intellectual disability in particular as a key group of interest to this report.

2.1.2. Intellectual Disability

Cognitive disabilities and intellectual disability are often viewed through a deficit lens in the medical model of disability, however in the social model of disability, emphasis is placed on viewing the strengths of an individual, and understanding the difference in function as a natural diversity which can, and should be accommodated for within society (Graf, 2020; Krcek, 2013).

Under the medical model of disability, intellectual disability is defined by impairment in learning and general mental abilities, resulting in difficulty with personal independence and daily functioning/participation (American Psychiatric Association, 2013). However, in the social model of disability, intellectual disability is defined by a combination of biological, psychological and social factors, and the amount of support, access, independence, and inclusion offered to the individual (Parchomiuk, 2013).

2.1.3. Employment

Recent figures show that in Australia there are approximately 700,000 people with an intellectual disability, however the majority of working-age adults with intellectual disability are not employed in the Australian labour force (39% compared to 83% of the non-disabled population). They are also less likely to be employed than people with other types of disability (Australian Bureau of Statistics, 2012). Exclusion of people with disabilities from labour markets and the cost of disability support programmes continues to be a growing concern among many countries including Australia (OECD, 2003, p.16).

Yet, a plenitude of benefits unfolds for employers of people with disabilities with research highlighting that employees with disability often exhibit lower absenteeism and workplace injury, and increased tenure in environments that have built in capability for inclusion (Australian Network on Disability, 2020). A longitudinal study closely following 21 participants over a five-year period demonstrated that personalised and tailored support was highlighted by participants as being the most effective method at meeting the needs of individuals with disability in a variety of sectors (McGinley & McKeown, 2019). For employees with disability, in addition to improving their financial security and independence, employment may further play a crucial role in maintaining one's sense of self and confidence (particularly in fostering positive mental and physical wellbeing), future aspirations, productivity and connectedness to others (McGinley & McKeown, 2019). Assistive technology may represent a medium through which to provide tailored support for people with cognitive disabilities in their employment, and therefore hopefully contribute to these positive outcomes (Morash-Macneil, Johnson, & Ryan, 2018).

2.2. Assistive Technology and Employment for People with Intellectual and Cognitive Disability

Assistive technology refers to any product designed to enhance and/or maintain an individual's functioning and well-being. Assistive technology can include things like videos or iPads, as well as wearable assistive technologies such as smartwatches, smart glasses or mixed reality headsets (discussed later in the review) (Moon, Baker, & Goughnour, 2019).

Multiple reviews have confirmed the positive benefits of assistive technology for people with intellectual disability, and in employment settings in particular.

2.2.1. Interview Preparation

One area that mixed reality assistive technology can be used for is interview training for employment. For example, in a study by Walker, Vasquez, and Wienke (2016) TLE TeachLivE ™, (another type of mixed reality technology), was used to train participants with intellectual disability for job interviews. While this type of technology has been used for education purposes, this is the first time it was used for job training. The advantages of the technology are that it allows for the scenario to be reset, allowing the participant to make a new first impression each time. It also allows the participant to experience multiple different scenarios to build confidence in new situations. The US study included 5 participants with an intellectual disability aged between 18 and 22. Each participant took part in six interview training sessions, which consisted of a mixed reality interview scenario using the TLE TeachLivE ™, and was followed by a live coaching session immediately after. Participants were scored on their performance in an interview scenario pre- and post-intervention, and results indicated a strong improvement in performance across all five participants, with participants recording up to 45% increase in interview scores. This study did not differentiate the impact of the mixed reality and the subsequent coaching sessions, however, and the authors suggest that the unique contribution of mixed reality training should be explored in further detail. Further, it would be useful to link this training to real life outcomes, to explore if the training does improve the likelihood of securing employment.

In a further review, Walker, Lee, Wienke, and Tan (2019) found that there was strong evidence that mixed reality was extremely effective in training participants for an interview in comparison to real life training. The authors strongly indicated that this type of technology should be pursued in further applications for people with intellectual disability, as they perceived a number of benefits and applications for the technology, especially in terms of employment which then flows on to improve independence, self-esteem, and general well-being.

2.2.2. Vocational Tasks

The review by Morash-Macneil et al. (2018) looks further into the use of various assistive technologies in the workplace for people with intellectual disability. These technologies include handheld computers, portable electronic devices such as iPads, and wearable technology such as smartwatches, but would also include technology such as the HoloLens, being wearable by the user. The review analysed 10 studies involving adolescents and young adults aged between 16 to 24 years old. The number of participants in each study ranged between 1 and 6, and were conducted in a variety of school and vocational settings including using a wearable watch to assist with timeliness for ordering, checking and re-shelving books in a library, or using a handheld computer to assist with completion of tasks in a grocery store such as gathering carts and restocking. The review found that overall, the various assistive technologies resulted in effective improvement of employment outcomes. The review further found that of the various uses for the technology, the assistive technologies were most effective in studies that involved work task completion (e.g. scanning, photocopying, etc.). When analysing the impact of the different types of assistive technologies however, wearable technologies were not as effective as other types of technology. This might be explained as it was a single case study on one individual, and only measured timeliness and not work completion. The authors note that assistive technologies of all kinds have promising potential in the workplace, given the overall positive effect of assistive technologies on a variety of work-based tasks, as well as the emerging new technologies available.

Further recent reviews by Blattgerste, Renner, and Pfeiffer (2019) and Baragash, Al-Samarraie, Moody, and Zaqout (2020) again reiterate the positive uses for assistive technologies in various tasks and skill for various users with cognitive disability from children to adults.

Recent examples include a US study by Randall, Johnson, Adams, Kiss, and Ryan (2020), which looked at using assistive technologies via an iPhone app to assist with task completion in a work setting. The app assists users by providing a picture, audio and video breakdown of each step of the task, as well as a continuous video of the complete task with all steps combined if needed. Participants comprised four males with intellectual disability aged between 19 and 20 who completed three different office-related tasks with the assistance of the smart phone app: shredding paper, copying documents and scanning documents. Participants were asked to complete the tasks at a baseline phase, with no access to the app and no prior training. Participants were then shown the app and how to use it during a training phase. The participants then used the app to complete the tasks during a daily session, and were then followed up two weeks after using the app to see if the skills could be maintained without the app. All four participants showed a dramatic increase in task completion across all three tasks, with one participant going from 0% task completion to 100% task completion with the app. All participants also maintained 100% task completion in the maintenance phase, meaning that they did not require the use of the app to complete the task successfully two weeks after the intervention. While this provides strong evidence for the use of assistive technologies in a workplace setting, it should be noted that the results are not given in comparison to non- assistive technologies training, which would further demonstrate the unique input of the technology to the outcomes.

Assistive technologies can be used in a variety of workplace settings, including in food preparation, as was demonstrated by Chang, Kang, and Huang (2013). This study used a program called “ARCoach” for three participants with intellectual disability aged between 20 and 25 seeking to learn vocational skills in short-order food preparation. Participants were asked to assemble various meal orders, containing four items each. The assistive technology was set up using a web camera which overlooked the table where food preparation took place and used unique machine-readable codes (QR codes) to represent food items. These codes were used by the system to provide alerts when the food items were incorrect so that corrections could be made in real time. All three participants showed significant improvement in task completion following the training, with each participant achieving between 98-100% success rate at the task during intervention. The skills were also maintained to the same level at the four week follow up stage in which they completed the task independently and did not use the assistive technology.

While these results are promising, there may be some limitations to the application of certain types of assistive technologies in some workplace environments. For example, in the case of a Czech Republic study by Benda, Ulman, and Šmejkalová (2015), it was found that a handheld tablet interface was not effective in assisting participants with intellectual disability in horticultural activities, and was reported to be confusing and disorienting for the users to work with effectively. This highlights the need for the technology to be suited to the user, and also to the task being performed. Especially in physical work environments, wearable assistive technologies such as smart glasses might provide a more practical solution.

2.3. Wearable Assistive Technology, Smart Glasses and HoloLens Technology

Smart glasses such as Microsoft HoloLens technology project holographic images onto the clear glasses, creating an integration of the real world and the virtual world. The headset uses cameras and sensors to gather information about the user’s movements and their immediate environment. From these sensors, the device is able to determine where the user is looking in order to integrate the appropriate holographic image, and to interpret movements that give commands to the device, such as using eye gaze or gestures (Aruanno & Garzotto, 2019; de Belen, 2019).

Aruanno and Garzotto (2019) describe multiple benefits for using mixed reality smart glasses for people with cognitive disability. The primary benefit is that it allows the user to continue to engage with the real world, which maintains a connection to reality and could provide a safer experience as users are still aware

of their surroundings. de Belen (2019) also consider a further benefit of wearable assistive technologies is not requiring items which could be cumbersome such as keyboards and computer display screens, making for a more natural user experience. A further benefit is the capacity to use the device to gather data, which can be useful for monitoring how the user is going with a given task (Aruanno & Garzotto, 2019).

Garzotto et al. (2018) explored the use of the HoloLens technology for people with cognitive disability through an application called "Hololearn", which teaches the user how to perform certain tasks, in this case, laying a table and garbage collection. The user interacts with real life environments (e.g. the table) and the HoloLens uses sensors to interact with this real environment and projects images onto the lenses (e.g. projected plates and cutlery). The user can interact with the images by 'air-tapping' to select, or by 'tap and hold' to drag and move the image. The HoloLens also tracks the gaze of the user, updating the images based on the new environment the user is looking at. The Hololearn program also includes an interactive assistant, in this case a projection of a well-known and loved cartoon character, as was recommended by therapists, who indicated that the assistant should be familiar to the users. The assistant supports the user through the tasks and makes the tasks fun through gestures and sounds. The authors noted that one of the benefits of the technology was that it was easily customized to the individual need of the users in terms of difficulty settings and also the responses of the virtual assistant. The study found that in a pilot trial of 20 users with cognitive disability, the users liked the Hololearn experience (largely due to the interactive assistant), however the authors noted that there was some difficulty for some users in executing the 'air tap' and 'tap and hold' hand gestures required for the program.

Aruanno and Garzotto (2019) further conducted an exploratory study investigating the suitability of HoloLens with people with Alzheimer's Disease, seeking to assist domains of memory and cognitive impairment. The study developed an application used on the HoloLens called "MemHolo" as a cognitive training tool for short term and spatial memory using spatial and memory games, and found that while there were considerations to be accounted for in the design, the findings were positive that it could also be used for this demographic.

2.3.1. Smart Glasses in the Workplace

Head mounted displays and smart glasses have the capacity to be particularly useful in employment settings, with very early adoption by German industry which found the augmented reality in a head mounted display improved both the speed and accuracy of the workers completing order-picking tasks (Reif & Günthner, 2009). This technology could also be applied to assist users with intellectual or cognitive disability in the workplace, and some evidence already exists for the use of smart glasses in this context.

For example, Wright (2016) conducted an evaluation of Google Glass smart glasses technology using the 'What's Next' application, which is designed to assist users using what is called 'context-aware augmented reality'. This type of augmented reality is able to assess the context of the user and provide information appropriate to that context. In this instance, the participants were using the device while completing a photocopying task. If the participant did not know what to do next while completing the task, they could say "what's next" which would activate the technology to take a snapshot to figure out where the user was (at the photocopier), and then deliver appropriate, contextual instructions that appear on the smart glasses. A key aspect of this application is that the instructions are only provided when asked for, which helps to support independence and self-directed learning. The study participants were three young adults aged between 18 to 29 years old, diagnosed with intellectual disability or both intellectual disability and autism. Each were assigned to unfamiliar tasks such as photocopying, and measurements were taken at baseline, during the smart glasses training, and then post-training using the smart glasses independently to complete the task. The study found that all three participants made notable improvements in their performance of the task, and all participants were able to complete the task completely independently within between one to four trials after the training. While this study shows that the technology is effective

in training for vocational skills and supporting independent task completion, the authors noted that further evaluation is needed to determine if the skills are maintained over time.

2.4. Design Considerations for Mixed Reality Assistive Technology

2.4.1. Safety and Comfort

With any wearable technology, it is important to consider the safety and comfort of the user. For example, the HoloLens manual indicates some possible risks of side effects such as dizziness, eye strain, and headache (Sahin, Keshav, Salisbury, & Vahabzadeh, 2018). To explore this, a study of 18 children and young adults with autism (up to 21 years of age) conducted interviews with the participants and their carers about their experiences or using the smart glasses technology. While some minor complaints of dizziness and initial discomfort were noted, the most common comment was that the glasses become warm to touch over time, however this did not result in any negative effects or feedback. Overall, there was limited negative feedback for the safety and comfort for HoloLens, and any comments that were made were mild or able to be solved quickly. de Belen (2019) surveyed older adults using HoloLens technology and noted that there were some comments that the headset could be heavy and disorientating and might become uncomfortable when worn for a long time. Physical considerations are important in wearable technology design, as it may preclude users from use. Some suggestions for solutions include the customisability of the technology's responsiveness to head movement, for example, to reduce the need to move the head quickly or sharply which might cause discomfort (Carter & Egliston, 2020).

2.4.2. Accessibility, Inclusivity, and Co-Design with Users

A recent review of literature on the development of inclusive wearable technology by Moon et al. (2019) found that technology design is increasingly moving towards active co-creation with the users in mind, which also improves the likelihood that the technology will be adopted and continue to be used. The findings strongly encourage that users should not be positioned as passive receivers of technology, and that participatory design processes should be utilised throughout all design phases. It is also important to acknowledge social and cultural factors in the adoption of technologies, as well as keeping mind that disability is not linear, and holds many variations for all users which should be accommodated for, along with relevant regulations, standards and guidelines.

This is echoed by Carter and Egliston (2020) who advocate for the provision of individual customisation and optimisations to be built into the technology in order to improve accessibility. These include being able to change text size to be easier to read and allowing for different types of gestural input that is suited to the user, especially in the case of limited mobility. The authors also note that technology often requires the body to be positioned in a specific way in order to function properly, which may not meet the unique needs of different bodies and different levels of mobility. Again, the author also recommends including users in the design process to ensure any accessibility design issues are not overlooked.

Torelli (2019) and Garzotto et al. (2018) implemented these practices in their development of the HoloLearn application for HoloLens, engaging in a collaborative design process with experts in cognitive disability, and indicating the need for a co-design process with the users. Their research also reiterated the importance of making the design of the application modular, so as to be easily customised to individual needs. Another finding from their research was that the use of an 'interactive assistant' – a familiar recognisable character (such as a cartoon character from a well-loved movie) that provided instructions, feedback and reinforcement - was a key successful feature and added to the enjoyment of the users.

2.5. Summary

From the literature reviewed here, there is strong evidence for the use of assistive technology such as mixed reality to assist people with intellectual or cognitive disability for vocational tasks, as is demonstrated by multiple reviews in the area (Baragash et al., 2020; Blattgerste et al., 2019; Morash-Macneil et al., 2018; Walker et al., 2019). Wearable assistive technologies such as smart glasses show multiple benefits for use in employment settings, and research has found technology such as the HoloLens is compatible for users with intellectual disability (Aruanno & Garzotto, 2019; Wright, 2016). While some limitations were noted in the research, most commonly small sample sizes and limited generalisability, the literature indicates positive possibilities for the use of assistive technology to improve workplace participation and independence for people with cognitive or intellectual disability.

3. Methodology

3.1. Evaluation Design

Based on the resources available for this evaluation, and in collaboration with the committee regarding the most appropriate approach, it was decided that a mixed method approach of qualitative and quantitative data collection and analysis would be employed.

The use of multiple data sources, data collection methods and literature will help to enhance the evaluation's findings in relation to their: a. credibility (extent to which the evaluation's findings are trustworthy and believable); b. transferability (extent to which the findings can be applied to alternative settings); c. dependability (extent to which the findings are consistent in relation to the contexts in which they were generated), and d. confirmability (extent to which the findings are based on the evaluation's participants/settings instead of researchers' biases) (Frambach, van der Vleuten & Durning, 2013).

3.2. Evaluation Participants

After discussion with management at Ability Works and the Project Team, it was decided that the following groups and numbers should be interviewed, as shown in Table 1:

Table 1. Evaluation Participants

Stakeholder Group	Type	Number of Participants
Ability Works Staff	Individual/group interview	n=5
Employees *(two employees were involved in both the interview and the output trial**)**	Individual interviews/surveys	n=9
	Headset output trials	n=7
Developers	Individual/group interviews	n=4

3.2.1. Ability Works Staff

A number of staff members were involved in the interviews. Firstly, the CEO who initiated the project to introduce mixed reality into the workplace. Two shop-floor supervisors, one of whom had been in the organisation for over 15 years. A support worker whose role it is to support the employees during their workday; as well as a worker who is involved in the maintenance and modification of the shop-floor

machinery to suit employees. He also has a training role. The Operations Manager whose role is to oversea the day to day operations of Ability Works was also interviewed.

3.2.2. Employees

All of the employees tested on the technology were already experienced with this particular wire-bending machine. Two employees who were interviewed were also involved in the comparison trial of wires bent with and without the mixed reality headset. (Fig. 3) Apart from one female, all employees were male. All had intellectual disability.

3.2.3. Developers

Interviews were held (by zoom) with Enabler Interactive. They are involved with designing solutions for employees with disability in the workplace. Included in that interview were two RMIT students who worked on the development of the mixed reality technology. Solve Disability Solutions project managed the mixed reality project to get the product working successfully at Ability Works.

The evaluation team has visited Ability Works a number of times during the course of the pilot program. The evaluation team conducted the individual interviews; some on site and some by zoom with the stakeholders. In addition, the support worker at Ability Works conducted some interviews with employees. All interviews were audio-recorded (with participant consent) and transcribed prior to analysis. Data was collected in two phases, as described below.

3.2.4. Preparation Phase

Two Ability Works' supervisors were interviewed just prior to the initial piloting of the Mixed Reality Project in order that any initial glitches or issues, whether it be with the headset technology itself or the running of the project could be rectified before rolling the project out to employees. A semi-structured qualitative interview (please refer to Appendix A – Suggested Stakeholder Questions) was conducted between the evaluator and the supervisors.

3.2.5. Testing phase

Quantitative data collection

To assess the effectiveness (or otherwise) and the potential of Mixed Reality headset in enhancing employee task competency, bended wire output data was collected for seven employees. This involved collecting data around how many wires each participant is able to bend without the use of the headset compared with how many wires can be bent through the use of the headset. The bended wire output data was collected by Ability Works operations staff and forwarded to the evaluator.

Qualitative data collection

To further assess short-term outcomes, the evaluation team conducted individual and focus group interviews; some on site and some by zoom with the stakeholders. These interviews were conducted to assess and understand the perceptions of employees' and key stakeholders' experience of the overall value and effectiveness of the headset in fostering positive behaviour change in task competency. It will further support improvements to be made to the program (whether it be with the headsets themselves or in the actual use of the headset.

3.3. Data Analysis Methods

The analysis of qualitative data followed a general inductive approach, where data collected through interviews is condensed and thematically analysed using the evaluation questions as focus areas.

4. Results and Discussion

4.1. How has the Program Been Implemented?

The introduction of Mixed Reality has had a long lead time at Ability Works. For several months there was a concerted public relations campaign aimed at informing the employees of the introduction of the mixed reality headsets. Leaflets on the technology were distributed throughout the tea-room, posters were displayed around the organisation, and videos explaining the technology were run at various times of the day. It was marketed as something "cool" as well as being a fun way to work. An earlier prototype of the headset was trialled, although this one was felt to be too heavy to wear comfortably for long periods.

The present version of the mixed reality technology has been trialled over several periods with a number of employees, as well as staff. In general the reactions of the participants have been positive, and conversations are already taking place as to further possibilities for the deployment of the technology in Ability Works.

4.2. What are the Reactions of the Stakeholders to Mixed Reality?

Employees

Four employees were interviewed face to face shortly after using the mixed reality headsets. It appeared that the use of the headsets posed few issues for the four participants. Although an observation was made that the sensation of having something on the head was different, all of them got used to it quickly and easily. They all understood that the headset helped them to remember the steps involved in using the wire bending machine. The use of the arrows, pictures, emoji's and the growing of trees all contributed to making the task of bending wires enjoyable as well as productive:

> *"It helps you by pictures and arrows – does it make it easy – yes!" (employee)*

Few changes were mentioned; one person in a wheelchair commented on the height difficulty and suggested that the addition of a bit more padding on the headsets could be an improvement; mostly they felt very comfortable. All the participants interviewed felt very happy about using the headsets for their work. Two of the participants mentioned an increase in their confidence levels after their use of the headsets. As a general comment, the employees seemed very relaxed after their initial experience with the technology. However one participant noted:

> *"Do they come in different colours – why does everything have to be black!" (Employee)*

A further four employees were interviewed by an Ability Works staff member (one of whom had already been interviewed by the evaluator). All four appeared to be content in their work, and also had adapted to the use of the headsets, and found it an enjoyable experience:

> *"Didn't mind wearing HoloLens (headsets) – enjoy doing work so I'm not bored" (employee)*
>
> *"HoloLens (headsets) has never happened here at Ability Works and would benefit other employees" (employee)*
>
> *"I liked it because it was like a telescopic lens" (employee)*

Staff

The **CEO** spoke about the tensions experienced in a workplace like Ability Works, where the primary aim is to keep employees with intellectual disability happy and content in their work, as well as the necessity of a commercial enterprise to get out contracted jobs on time and within budget. The introduction of a technology such as mixed reality headsets were seen as a way to promote independence in the employees, and to help them to keep on task without having to regularly seek help from supervisors. One of the issues

experienced with employees with intellectual disability is that they forget what they have just been taught, and mixed reality headsets provide the gentle prompts and pictures to keep them focussed on the task.

> *"Our social mission is to provide people with disability meaningful work, a sense of pride and a sense of belonging to the community. So the positives are to give them greater independence, not always waiting for a supervisor. We don't have the resources to give them the intensity of the training. We have to pitch for business in a competitive environment" (CEO)*

Staff members involved in the training of employees could see many benefits of the mixed reality headsets:

> *"For employees who lack focus and easily distracted – so good to extend their attention span – the important thing is to get them to their full potential" (Trainer)*

> *"Fantastic training tool. A lot of the time you have to repeat training all of the time" Trainer)*

For the supervisors whose task it is to keep employees focussed on the job, their reaction was cautious but positive. For one experienced supervisor, he was anxious that the headset is not seen as the "dunce's hat". Although the extensive marketing of the technology has actually resulted in the headset being seen as something special for the employees.

> *"This should boost employees' confidence and to be offered something special and new (the headset)" (Supervisor)*

Developers

The developers were keen to develop a product which enabled the employees to live independent lives, and to provide a technology to enhance their capabilities. Although the headsets have not been tested on the scale they would have wanted at this stage; mainly because of COVID restrictions in the workplace; they are pleased that the reactions of the employees have been positive.

> *"Employees don't have to rely upon supervisors, the technology empowers them to do it themselves. As it is used more frequently it will help their confidence levels". (Developers)*

> *"This trial was more to observe to see if this project was successful, and will the employees accept it" (Developers)*

> *"I think it has real potential – still a while to go, but excited by the capacity – now we have hands on experience" (Developers)*

4.3. What are the Benefits to the Stakeholders Involved?

Employees

It should be remembered that the introduction of mixed reality into the workplace at Ability Works is in its infancy. However comments from the employees are encouraging as they show an early adoption of this technology. Observations noted by the evaluator during the initial testing period with the employees included an immediate acceptance of the headsets. One employee had never used the wire bending machine for a while, but with the assistance of the instructions, pictures and symbols built into the headset he was able to use the machine successfully. Others commented enthusiastically on the sound effects, arrows and "smiley" faces. All of these effects assist in keeping the employee on track;

> *"(the headset) helps you to remember the steps (employee)"*

Seven employees participated in an experiment where their rate of bending wires over one hour was tested without the headset and with the headset. As can be seen from the data below in Figure 3, apart from one employee, all had achieved a greater number of bended wires with the HoloLens headsets.

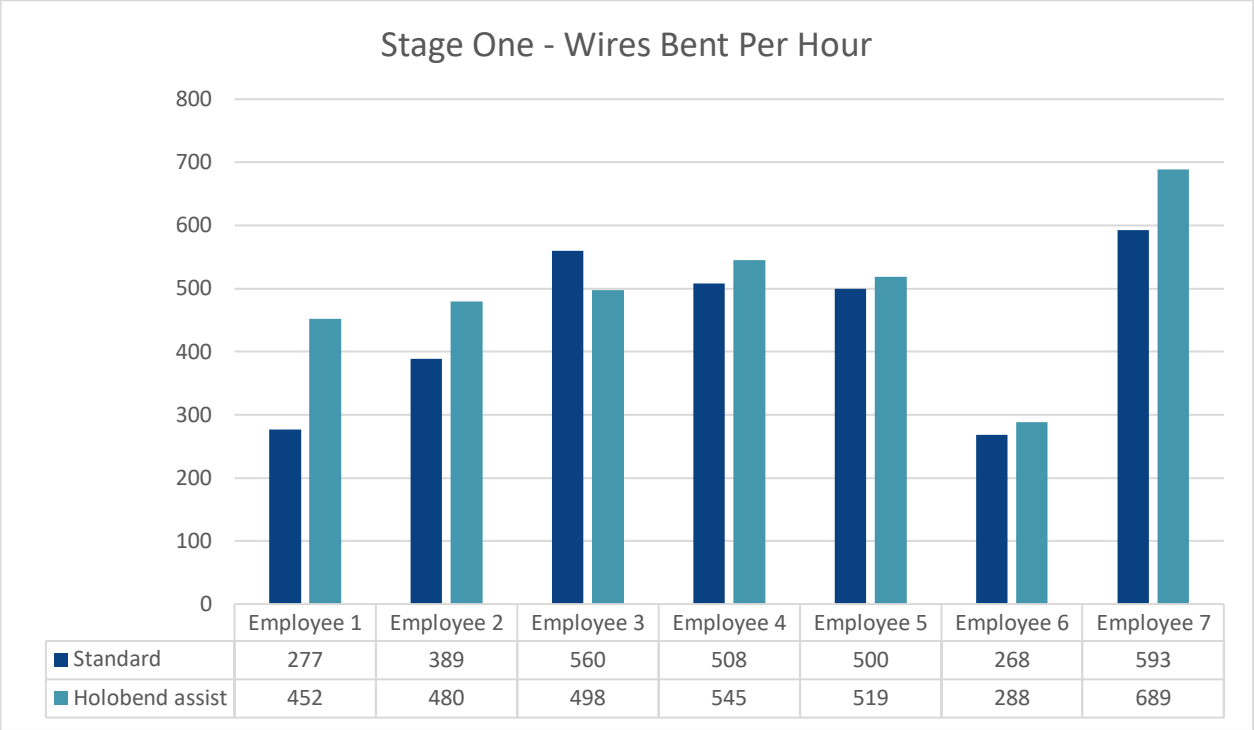

Figure 3. Comparison of Wires Bent with Headset

Staff

The staff commented on the many benefits they saw from the introduction of missed reality:

> *"This would be a great training tool for people with Intellectual Disability. It provides spatial awareness; it may improve productivity (prompts etc.)" (Support Worker)*

> *"Headsets can be seen as a partner to the person – to remind them of the steps they forget so easily" (Trainer)*

As pointed out by the management of Ability Works, a major issue in the employment of people with Intellectual Disability is that their attention span and short-term memory is limited, and as a commercial enterprise they cannot provide supervisor support on an immediate basis. The headsets provide the prompts and direction,

> *"Because of the nature of the business, we cannot afford to have the resources needed on the level which is required. So there are times when people are waiting for supervisors to help them. Sometimes they lose focus, so they need the supervisors to jolly them along. Cannot solve this issue by more people and wages." (management)*

Developers

The mixed reality project started as a prototype, developed and engineered by students from RMIT. Then it grew to a product, specifically to assist employees working on the wire bending machine at Ability Works. A number of goals provided the impetus for the development of the mixed reality headsets;

> *"Can this technology give the capabilities to an individual, not where it is filling a deficit, but enhancing their capabilities" (Developers)*

Although the testing of the technology is in its early stages the development team share an air of optimism,

> *"I think it has real potential – still a way to go but excited by the capacity, now we have hands on experience" (developers)*

The development team sees the introduction of the technology as an enhancement to the participants work life;

> *"It gives them the capabilities and skills to enhance their goals. Gives people options – giving them more satisfaction with their work". (developers)*

4.4. Have There Been Any Unanticipated or Negative Consequences of the Technology?

Employees

The trial has produced very few unanticipated or negative consequences for the employees. Most appeared to have enjoyed the experience, and no-one has reported feeling uncomfortable or stressed by the experience. For one of the employees in a wheelchair, her major issue was getting into a suitable position to operate the wire bending machine. However this has more to do with accessibility rather than the technology.

Management

The headsets calibrate to the individual user. This is done by staring at a prism whilst wearing the headsets. It was commented that this could pose a challenge for people who are visually impaired or who have an eye problem such as "lazy eye".

There is also a concern that wearing the headsets for a considerable le period may result in the employee "being lost in that world". It is also important that employees do not feel that they are just a machine. Management appear to be well aware of this possibility and will try to ensure that this does not happen.

Developers

The only cautionary note from the Developers was the fact that "like all technology, you become reliant on it".

4.5. What are the Success Factors for the Project Overall?

There are a number of success factors for this project, viewed by all stakeholders with their particular emphasis.

Employees

Even after this short pilot introduction to the technology the employees can see a difference in their abilities and their confidence levels. All of them, without exception appear to be happy with the introduction of this technology into the workplace.

Management/Staff

The success factors for the management and staff are those related to the employees being able to wear the headsets and being able to maintain focus for a period of time. Management and staff are optimistic that this technology has a place in Ability Works and can contribute to productivity and motivation.

> *"Success for us is that our employees have greater independence, greater focus, greater sense of pride. My big vision for this is that we can adapt the headset to the individual on the job. May be good for autism and then we could employ people with autism to do the programming for mixed reality." (management)*

"To be included and to be seen as included, to be part of the community. To be seen as just part of the community and not seen as people with disability. Just people with different abilities" (Support Worker)

Developers

The developers see the use of mixed reality as a way to enhance the individual's capabilities. It is seen as a means to an end, the end focussed on the reactions of the user.

(they were looking for) "Happiness and positive reaction from the user, as well as acceptance. If it helps with productivity, then that is success". (developers)

5. Conclusion

This evaluation has been focussed on the introduction of the mixed reality technology into the workplace at Ability Works and the reactions of the stakeholders involved in the promotion, development and use of this technology.

The reactions from the employees have been positive and although the adoption of the technology is still in its early stages, there would appear to be few issues with the employees. Similar to results found in the literature, common issues involved initial discomfort that was ultimately not prohibitive to using the technology, and also the need to make the technology physically accessible for various body types and mobilities (Carter & Egliston, 2020; Sahin et al., 2018).

The technology was introduced to improve motivation in the employees, and to improve concentration. Although the technology is still in its pilot stages, there are hopeful signs that wearing the headsets can have an effect on productivity.

The Interviews and quantitative data from employees, and interviews with developers and staff at Ability Works all indicate that the technology is providing outcomes consistent with the initial hopes outlined by the developers. There are also discussions already happening with the developers and management about other possible workstations at Ability Works, and the possibility of adapting the headsets to those environments. This could provide some variety of occupations for the employees.

Most of the studies covered in the literature review were focused on coaching to acquire a task skill, and measuring to see if the task was completed successfully. This evaluation is different, as it is focused on the outputs of that learned skill as well as improvements to the strengths and skills of the employees.

The findings from this pilot mixed reality project are in alignment with the literature on assistive technology and provides valuable new evidence for the applications of mixed reality in employment settings for people with intellectual or cognitive disability.

5.1. Limitations

Limitations found in this evaluation are common to those found in literature relating to the introduction of new technology; most notably a small sample size. Due to the limited scope of the evaluation, and the problems encountered with the COVID restrictions, the employees were not exposed to the technology in the full manner as planned. However we can confidently say that the initial results are very promising.

It would be wonderful to interview and observe the employees six months down the track, to see how this mixed reality technology has been embraced and extended by the organisation.

6. Recommendations

Although in its early stages yet, the introduction of mixed reality into the workplace at Ability Works appears to have been a success. One of the earlier concerns was how the employees would accept the introduction of the new technology. These initial concerns appear to be unfounded as the employees have embraced the new technology, and early results in terms of productivity appear to suggest an upward trend in production of bent wires:

The following recommendations are suggested:

- That mixed reality be made part of the organisation's future. That more employees, with differing abilities are trained to use the headsets.
- That further adaptions are made to the headsets so that they adapt to the individual on the job, and the possibility of employing people with autism to program the headsets be considered
- Further exploration be undertaken to adapting the headsets to other production lines in Ability Works
- That work with the developers be continued and new technologies are incorporated into the mixed reality.
- To encourage a co-design approach to new technology, to increase suitability for all, but also increase participant 'buy-in' to it. (*as discussed by Moon et al. (2019*)

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Appendices

Appendix A: Suggested Questions for Stakeholders

Supervisors /Staff Members– Pre-testing phase

Name:

Date:

1. Tell me about your current role in the organisation and what this involves? ***(If support worker, how many employees does she support.)***

2. What do you as the **benefits** of the Mixed Reality Project for employees, supervisors, and Ability Works as a whole?

3. Can you see any drawbacks of this project for employees, supervisors and Ability Works – if so what are they?

4. Tell me about any challenges that you perceive the employees will experience in using the headsets?

5. (**Have you tried the headsets**) How would you describe your experience of undertaking the training through the headset? What issues, if any, did you experience in: a.) Using the headset? b.) The information presented? c.) The overall project?

6. How well do you believe that the training presented through the headset compares with individualised/one-to-one training between a supervisor and employee?

7. At this stage, do you perceive any gaps in the training?

8 **Risk Management** – Even though risk assessments have been undertaken, have you identified any immediate/notable risks associated with the use of the headset in the training? If so, can you please describe these?

9. What goal/target has Ability Works' set as a desirable amount of bended wires **with** the use of the headset/and through this project?

10. In your opinion/experience, how many bended wires would be considered: a.) An excellent/outstanding output amount, b.) An average output amount, and c.) A low output amount **without** the use of Mixed Reality?

11. What are your thoughts on this technology assisting people with disabilities in obtaining other jobs?

12. Is there anything further you wish to add?

Employees

1. Do you find the Mixed Reality headset easy to use? If not, what do you find challenging about it?
2. What types of things does the headset help you to do?
3. In what ways does the headset help you to use the wire bending machine?
4. Do you find that the headset helps you to remember to do each step of your tasks more easily?
5. Are there any parts to the training you receive through the headsets challenging?
6. What is your favourite thing(s) about the headset?
7. What are the things that you do not like about the headset?
8. If you could change something about the headset, what would it be?
9. How comfortable is the headset?
10. Do you feel a difference in terms of your ability and confidence when using the headset?
11. Anything else you want to tell me?

Key support workers

1. How long have you been involved with Ability Works?
2. What activities does the person you support take part in at Ability Works?
3. What do you see as the benefits of the program for him/her?
4. Are there any drawbacks to using the Mixed Reality headset?
5. Have you noticed any changes in the person you support during the time the headset has been in use? (what are those changes)
6. What, for you, are the positives of the headset and the program?
7. What, for you, are the negatives of the headset and the program?
8. Would you like to see any changes to the headset and the program here?
9. If this technology wasn't being tested to see if it benefitted the person you support, do you think that there would be something else that would be more helpful for them to carry out their required work task?
10. What are your hopes for the person you support in terms of their future?
11. Do you think the use of technology in this way through Ability Works will play a role in achieving those hopes?
12. Any other comments?

CEO Ability Works

1. What were your initial thoughts about the possible benefits of the mixed reality technology?

2. (apart from the present Co-VID situation) is the program being implemented as planned?

3. Do you think that the mixed reality will be more effective for some participants than for others?

4. What for you are the **positives** of the Mixed Reality Technology?

5. What for you are the **negatives** of the Mixed Reality Technology?

6. What goal/target has Ability Works' set as a desirable output of bended wires **with** the use of the headset? What would be considered a low/undesirable amount of bended wire output?

7. What factors/improvements/changes signal to you that this program is worth implementing and is seen to make a difference (whether it be to changes within employees behaviour/satisfaction for work, supervisors' behaviour/workloads, increase in financial profits) ?

8. Are there any factors, aside from safety concerns, that would signal to you that the program may not be worth implementing? (E.g. Possibly - no change in bent-wire output with headset use, increased workload for supervisors, financial costs to maintain program, no change in revenue)

9. In terms of Ability Works, what are the future uses of this technology?

10. Sustainability/Expandability – How do you see the likelihood of this program continuing after donor funding has been withdrawn?

11. What information are you hoping to gain from this evaluation?

11. Have you any other thoughts on the mixed reality project that I have not addressed?

Questions to Developers

Context: Need to bear in mind that the main focus of this evaluation is in the effects of this new technology on people with disabilities. We are not evaluating the technology itself.

1. Tell me about your role in the development of the mixed reality?

2. Has your understanding of people with disability changed?

3. What were your main intentions when you undertook this project?

4. Has the program been implemented as planned?

5. To what extent does this technology create a more "enabling" workplace allowing people with more significant disability to participate?

6. Do you think that the technology works better for some employees than others?

7. What are you hoping will be the long-term impact on the employees using this technology? *(probe for skill development, retention of knowledge, confidence, socialising?)*

8. Are there any unintended consequences of the mixed reality project?

9. Could you comment on the sustainability of the project?

10. What are your thoughts on this technology assisting people with disabilities in obtaining other jobs?

11. What are the plans after this pilot trial?

12. What for you are the success factors?

13. Any other comments?

Appendix B: Survey Questions

LMCF Grant – Lord Mayors Charitable Foundation Project

Date: _____

Employee Name & Surname: _____

Before using HoloLens:

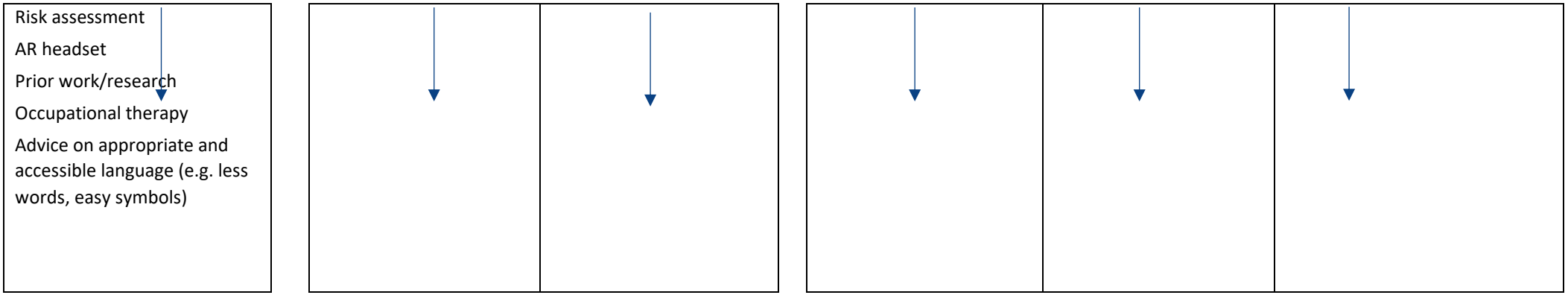
	Not	Neutral	Very
	☹	😐	☺
"How satisfied are you by your work?"			
"How confident do you feel doing your job?			
"How much do you like this job?"			
"Does the HoloLens help you do your job better?"			

After using HoloLens:

	Not	Neutral	Very
	☹	😐	☺
"How satisfied are you by your work?"			
"How confident do you feel doing your job?			
"How much do you like this job?"			
"Does the HoloLens help you do your job better?"			

Appendix C: Program Logic

Inputs	Outputs		Outcomes - Impact		
	Activities	*Participation*	**Short**	**Medium**	**Long**
Skills and Knowledge transfer Disability expertise - staff Parents/Carers/support workers Teachers/instructors Funding NDIS Lord mayors charitable fund Other funding Staff time, both paid and unpaid Volunteers Machinery and equipment Occupational Health & Safety training & resources Information and resources and support Mixed reality technology Programming expertise Software Establish what students have developed Co-workers Employees with intellectual disabilities	Training Develop scope Personal wellbeing skills Workshop with employees before programming – scope Develop selection criteria Regular meetings with project team Discrete measurement of production Develop wish list Employment representative council Knowledge transfer Disability support supervision	Participants with a range of disabilities Disability providers Families/carers Ability Works customers Partnerships with mainstream employers Health workers AWA workplace trainers/supervisors/support OT Enabler Microsoft RMIT Engineering Students Solve disability Solutions	Increased knowledge and skills /competencies Greater independence for participants Job opportunities Relationships formed Deliver quantifiable personal & organisational benefits At least one employee of Ability Works using mix reality Engagement, motivation Pride in work Receive scaling grant Understanding the positive & negative impacts of the technology e.g. more tired Increased productivity – reduced cost of waste.	Increased knowledge and skills Greater empowerment for individuals Job opportunities Increase in coping mechanisms Opportunities to further upskill or educational possibilities Internal expansion to other workstations Identify barriers/advantages to use of mixed reality Ability Works becoming a more inclusive workplace	Job opportunities Maximum potential reached for participants Increased self-confidence/self esteem Upscaling of model Participants can do tasks in future without the mixed reality technology/headset Participants to use their own customised mixed reality headset – NDIS funded? Improve perception of people with disability (people see they are able to work) Inclusion Increased mainstream employment Marketability of product – revenue stream Increased competitiveness of Ability works More diverse workforce



Purpose, pride and belonging through inclusive employment

Assumptions

e.g. that employment enterprises are willing to employ people with disabilities

That employment is good for people and society

That there are jobs for people who need work

That people with disabilities want to work

That technology is beneficial

External Factor

Perception of the community as to the value of the program

Perceptions of Industry as to the projects value

Reputation of Ability Works

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