

Research

The Role of Assistive Technology in Enhancing Disability Arts

Gina Wong

Master's Candidate Disability Services in Higher Education
City University of New York School of Professional Studies

Abstract

Historically, disabled artists have been using assistive technology (AT) to enhance their artistic creativity, even before AT was formally defined in law in the United States (US). This exploratory study reviewed both empirical and anecdotal evidence of the impact of AT on disabled artists in their K–12, postsecondary, and professional careers as well as the impact of AT in museums and performance spaces. The literature review revealed an incremental progress in disabled artists' participation in the arts. The author conducted field visits to five museums in New York City and San Francisco and one performance venue in New York City. From observation, all five museums offered comprehensive accessibility services that included AT tools to visitors with disabilities. The performances attended brought AT into a new light as disabled artists incorporated AT as creative elements in their acts. However, the findings from the field study cannot be generalized across the US. There is a lack of empirical research that studies the unique experiences of SWDs in their K–12 and postsecondary education systems; most of the literature reviewed presents the experiences of educators use of AT to teach art. There is also a lack of empirical evidence-based practice with regard to AT devices for professional disabled artists. Presently, artists are using a combination of AT from a wide range of categories such as low-, mid-, and high-technologies. However, the decision to use a particular tool is affected by the following factors: functional capabilities, personal attitudes, prior technology knowledge and experience, affordability, and preference. There is no one-size-fits-all AT, and there is also a rapid turnover of devices. Moreover, research suggests that modern digital tools may present new complexities and barriers to the disabled artist. It is mutually beneficial for the end-user and product designer to work together to create solutions. This paper will spotlight the experiences of randomly selected visual and performance artists, and musicians with their AT. Finally, resources of mainstream software, input devices, adaptive tools, and organizations will be provided in the appendices that may be useful to end-users and educators.

Keywords: disability arts, assistive technology, accessibility

Where would humanity be without art, music, dance, and film? It would be dull and boring. There are beliefs that the arts and art education improve cultural engagement (O'Farrell & Kukkonen, 2017). Some studies link the arts to promoting literacy, math skills, memory, and critical thinking skills (Baker, 2013; Coleman & Cramer, 2015; "Integrating the Arts," n.d.). The arts are a reflection of societies and cultures (Wexler & Cardinal, 2009); therefore, everyone should have access to the arts. Historically, people with disabilities have been excluded because of ableism (Linton & Gotkin, 2019). However, over the last thirty years, social justice movements have changed the laws, empowered disabled artists, and positively boosted their identities as artists with disabilities (Sulewski, Boeltzig, & Hasnain, 2012). During this time, advances in assistive technology (AT) has allowed more artists with disabilities to partake in self-expression, to increase awareness of disability in the arts, and to advance disability inclusion in the arts and culture (Boeltzig, Sulewski, & Hasnain, 2009). The purpose of this exploratory paper is to show how AT has enhanced the participation of disabled artists to create art in their school careers, professional work, and community participation. Methods of research include a literature review, Google search, field study and the writer's analysis. These research questions guided this study:

- 1) How has AT impacted art education for students with disabilities (SWDs) in the K–12 system and in higher education today?
- 2) What factors do disabled artists consider when selecting from a range of low-, mid-, high-tech tools? Are there barriers to the implementation of their chosen AT?
- 3) How has AT revolutionized accessibility in museums and performance spaces today and what does this mean in terms of increased opportunities to showcase disability art?

This paper aims to provide examples of disabled artists and their individual experiences with a broad range of AT tools and their strategies employed to eliminate their barriers in creating, performing, or exhibiting their art. Finally, a list of AT resources will be provided in the appendices that may be useful to end-users and educators.

Historical Artists with Disabilities and Assistive Technology

"Necessity is the mother of invention" is an old proverb that captures the spirit of how AT has advanced throughout civilization (Steenhout, 2018). The history of AT is thought to be as long as that of humankind (Lewis, 1998) and has undergone its own evolution. It was during the Foundation Period, anytime earlier than 1900 when AT was discovered, researched, and defined as a tool that may assist and enhance the lives of individuals with disabilities to perform tasks that would be otherwise challenging or impossible to do (Gatchalian, 2019). Historically, disabled artists used AT that were designed and adapted specifically for their individual abilities and functional needs. Nicolau & Montague (2019) point out that, recently, there are two schools of thought about AT design: Design for All and Design for Individuals. These issues are too complex to elaborate in-depth for this study, but, it is important to mention Design for All and Design for Individuals because AT that disabled artists use today can be either mainstream products bought off the shelves that were designed

with accessibility and flexibility features that can be adapted, or they are customized to fit the individual's functional limitations. Steenhout (2018) reminds us that many of the technology available today has evolved from technology developed by or for people with disabilities. Design for All has a Universal Design concept, that is, disability-related solutions are incorporated into the design of everyday products (Steenhout, 2018; Nicolau & Montague, 2019). Some examples include adjustable height desks, pencil grips, or music instrument stands. Design for the Individual, on the other hand, is more inclusive and takes into consideration the "individual human abilities to context" and "what the user can do;" universal design focuses "on design for what everyone can do" (Nicolau & Montague, 2019, p. 319). However, product designers must always take into consideration accessibility, that is making the product open to all, and inclusivity, which means involving the diverse contributions of people with disabilities in how they arrived at that design (Holme, 2018). In particular, this study will provide examples of disabled artists who are collaborating with engineers to design their AT and disabled artists who use mainstream AT.

Ludwig van Beethoven actively participated in the design of his AT. He is arguably the most famous deaf pianist and composer, but not many realize that he used ear trumpets of varying sizes to improve his hearing and needed them for composing music. The ear trumpets were designed by his inventor friend Johann von Malzel (Ealy, 1994; Krehbiel, 1898; Shaver-Gleason, 2018). Figure 1 in Appendix A shows the various ear trumpets used by Beethoven ("Digital Archives," 2002). Ealy (1994) remarked that Beethoven also asked his friend Andreas Streicher to build a piano with the loudest volume adapted to his hearing capabilities. So, despite the worsening of his hearing, Beethoven was able to compose music at the keyboard by improvising, wearing ear trumpets that were attached to headbands that allowed his hands to play. Moreover, he used a drumstick held between his teeth to touch the distal end of his piano as the wooden drumstick conducted vibrations to the bones of his middle ear (Ealy, 1994); an adaptation that allowed him to hear with his teeth. Furthermore, Beethoven requested Conrad Graf to design a resonator that was placed on top of his piano that conveyed tone more distinctly to Beethoven's middle ear to help him compose (Ealy, 1994; Shaver-Gleason, 2018). As he lost his hearing completely, Beethoven began to write more music without having to hear, and music scholars believe that he wrote his new music going against the grain of compositional conventions of his time with increased loudness, unexpected changes, and repetition to make them easily recognizable (Mayne, 2011; Simonis, 2015). Wallace (2019) wrote that Beethoven's story is not about triumphing over adversity, but about acceptance of his irreversible hearing loss and his creative adaptation using tools. Presently, there are modern technology equivalents to the AT that Beethoven used—hearing aids and cochlear implants, music software, and sound apps. Even the design of the modern piano was influenced by Beethoven, who tried several versions with many personal adjustments for his specific needs (Shaver-Gleason, 2018). Moreover, cutting edge technology today has made it possible for musicians with severe hearing impairments to write and enjoy listening to music with the invention of wearable technology such as SUBPAC that capture the physical dimension of sound. (Grabbitz, 2016).

Henri Matisse used a manual wheelchair during the last fourteen years of his life following surgery for duodenal cancer which made him frequently weak and tired (Morgan, 2014). Nonetheless, it was remarkable that he produced more art during this period by replacing his paintbrush with a large pair of tailor scissors to cut out paper shapes drawn using chalk on the end of a stick (Morgan, 2014). Additionally, he hired assistants to place the cut-out shapes on a paper background mounted on a wall with his direction (Morgan, 2014). Today, the adaptive technique that Matisse popularized has been borrowed by art teachers, not only for their students with disabilities but for all students because the cut-out technique is so fascinating and exciting (Rhoades, 1993).

Clayton “Peg Leg” Bates was a famous rhythmic tap dancer from the 1930s to the 1970s (Escamilla, 1997). When he was twelve years old, his left leg was caught and mangled in a conveyor belt while working in a cottonseed mill and was later amputated at the knee (“Clayton,” n.d.). Clayton’s uncle made him a wooden peg leg to dance in jazz clubs around the United States and in Paris. Bates was very popular and performed with the well-known orchestras of Count Basie and Duke Ellington; he had thirteen different peg legs to match the color of suits he owned to perform in (Escamilla, 1997). Bates has inspired modern-day artists like Evan Ruggiero, a one-legged tap dancer and Broadway actor who boasted that “Peg Leg” Bates is his idol (Ruggiero, 2018). Ruggiero mentioned that before his leg operation, he posted a video of Bates dancing on the Ed Sullivan Show and believed that he, too, will be doing this after his recovery. Since becoming an amputee, Ruggiero embraces his disability and is very active in his career; he owns nine prosthetics, but instead of wood, Ruggiero’s peg legs are made of alloy or titanium (Ruggiero, 2018).

Types of Assistive Technology Used by Disabled Artists

The broad definition of AT is any device, software program, or service that is used by persons with disabilities with the potential to maintain, increase, or improve their functional capabilities as defined in the United States Assistive Technology Act and the Individuals with Disabilities Education and Improvement Act (Lewis, 1998; Dell et al., 2017; “What is AT?”, “ n.d.; Coleman & Cramer, 2015). The AT that disabled artists use are categorized as low-, mid-, and high-tech devices, whether commercially bought ready to use, adapted, or customized to fit the individual’s needs (Steenhout, 2018; Gatchalian, 2019). Examples of low-tech devices are pencil grips, slant boards, adaptive pencils/erasers, adaptive scissors, rolled-up towels, and stands, (Coleman & Cramer, 2015; Dell et al., 2017). Mid-tech includes battery-operated communication devices, manual wheelchairs, adjustable height desks, touch-sensitive pads, and switches; and high-tech are more advanced and complex tools such as hydraulic lifts, electric wheelchairs, eye-tracking devices, and computer software such as synthetic speech communication tools, speech to text, sound amplification systems, Braille, and many more (Dell et al., 2017; Coleman & Cramer, 2015; Coleman & Grim, 2015.) High-tech options may be expensive and require training to use.

The focus of AT is “not on the disability but on the remaining functional capabilities that people use to accomplish their chosen objectives” (Weiner, 2010, p. 159). Disabled

artists may use a combination of tools to accomplish their objectives, and today, the choices of tools are many. Each individual must consider factors such as ease of use, preference, product availability, technology familiarity, and cost (Dell et al., 2017; Creed, 2016). Disabled artists decide which AT works best for their needs, functional capabilities, personal attitudes, prior technological skills, knowledge, preference, and budget. For a list of AT resources see Appendices B (visual artists), C (musicians), and D (performance artists). Because of the constant changes in modern technology, the lists in the appendices may also change accordingly. Therefore, a few organizations are included to give up-to-date and active links to relevant resources.

Federal disability and education laws that impact the use of AT in art education

Since the passage of the Assistive Technology Act (Tech Act), Individuals with Disabilities Education Act (IDEA), and the Americans with Disabilities Act (ADA), in the United States inclusion and access are the goals for students with disabilities (SWDs) to engage in art as learners, creators, and consumers (Bailey & Cody, 2015; Dell, Newton & Petroff, 2017; Coleman & Cramer, 2015; Yoder, 2018). The IDEA, and its 2004 reauthorization, were instrumental to SWDs because they mandated that all K–12 public schools provide AT equipment and services to SWDs in special education to gain equal access to a free appropriate public education in the least restrictive environment. The Tech Act reauthorization in 2004 also guaranteed that there will be increased funding for AT use in the classrooms (Gatchalian, 2019; Akpan & Beard, 2013; Derby, 2012; Lewis, 1998). Furthermore, the ADA and its amendment acts required that schools are responsible for recognizing students with visible and invisible disabilities that present challenges in their learning, thus AT became part of a student’s Individualized Education Plan (IEP) (Akpan & Beard, 2013; Gatchalian, 2019). In addition, Sections 504 and 508 of the Rehabilitation Act mandate that schools provide AT to SWDs (Dell et al., 2017). AT and adaptive supports have increased participation and heightened experiences for SWDs in art classes (Coleman & Cramer, 2015).

Notwithstanding the aforementioned legal mandates to provide AT, the National Endowment for the Arts conducted a survey which revealed limited arts education and training opportunities in art schools, lack of necessary accommodations, and teachers that were not adequately trained to provide support and accommodations to students with different types of disabilities, both visible and invisible (NEA, n.d.). Another barrier mentioned is the limited funding for art supplies and training opportunities (Careers in the Arts, n.d.).

Furthermore, there is a dearth in research that “demonstrates the effectiveness of assistive technology in increasing access to the art curriculum through the use of assistive technology” for SWDs (Coleman & Cramer, 2015, p. 7). However, traditional low-tech and mid-tech AT tools have been used by art educators to provide students with disabilities opportunities to create works of art in the K–12 education system (McCord & Malley, 2017).

There is a lack of empirical research on the use of AT in postsecondary education programs. Educators are familiar with using low-tech traditional tools. Traditional tools could be easily adapted to teach visual art and music to students with varying disabilities because these do not require training to use, are easily adapted in any setting, and are not expensive (McCord & Malley, 2017; Coleman & Cramer, 2015). These include large handled paintbrushes, grips attached to writing utensils, adaptive scissors, adjustable height desks, and rolled up towels placed under the arm for stabilization as well as giving assistants verbal directions to assist students and using alternate body parts such as mouth or foot to hold the brush. (Coleman & Grim, 2015; Coleman & Cramer, 2015). In the music classroom, some students have their instruments adapted or customized with Velcro straps, touch-sensitive pads, large knobs and buttons, stands that hold instruments, and large or twisted guitar picks to accommodate limited hand movement (McCord & Malley, 2017). Modern mid-tech digital technologies such as tablets and apps allow students with physical disabilities to play, create, and listen to music (McCord & Malley, 2017). However, recent research by Coleman & Grim (2015) noted that AT devices were rarely or sometimes used in the classrooms. Art teachers who work with students with physical, visual, severe, and multiple disabilities in mainstreamed classrooms feel inadequately prepared to use adaptive strategies, accommodations, and modifications or are unaware of the various types of AT available and their functions (Coleman, Cramer, Park, Bell, & Coles, 2015). One reason that can shed light on the issue of inconsistencies and underutilization of AT in the classrooms is the notion that schools across the US may have varying resources and may not have clear policies and guidelines to implement AT (Yoder, 2018). Seale (2014) established this argument in her book: "...stakeholders have to translate legislation into policies and strategies that are meaningful to them in the context in which they are working" and "stakeholders must define and agree what benchmarks of best practice might be" (p. 11).

How can a school system adapt and develop a realistic solution to implementing AT in the classroom? One solution that comes up in a few studies is to have an expert such as an adaptive art specialist in schools to adapt tools, media, and techniques so that SWDs can participate appropriately in the arts curriculum (Coleman et al., 2015; Loesl, 2012; Yoder, 2018). Preservice teacher programs addressing arts education for SWDs are emerging in more colleges, such as Kent State University, Buffalo State College, State University of New York, New Paltz, University of Iowa, and Florida State University (Malley, 2012). Teachers who have extensive knowledge in using technology could make a world of difference for students with significant disabilities. With comprehensive preservice teacher programs, teachers can feel more comfortable teaching an adaptive arts curriculum (Coleman et al., 2015; Loesl, 2012; Malley, 2012). MyTalkTools is a type of communication software that music teachers use to personalize learning for non-verbal students by using pre-recorded sounds that are attached to pictures and videos which has been found useful in improving music literacy and introducing learners to the emotions that are projected through music (McCord & Malley, 2017). This classroom application is possible with high technology, but teachers need to be aware of these types of AT, know where to get them, and learn how to use them (Gatchalian, 2019). One program that has invested in training teachers and students

is the Berklee Institute for Arts Education and Special Needs. It trains teachers to work with students with autism spectrum disorders. See Rhoda Bernard, managing director of the Boston Conservatory Program for Students with Autism, in this video interview *Training Students & Music Teachers in the Gifts of Autism-Meet Dr. Rhoda Bernard* at <https://youtu.be/vuGC1E4sTsQ> (Evans, 2010).

In addition, there are art colleges in the US with a strong commitment to supporting disabled students. One college worth noting is the School of the Art Institute of Chicago (SAIC). Alumnus and current faculty Riva Lehrer, an individual with spina bifida, recalls the lack of resources for SWDs in the 90s, when she was a student, in a *Chicago Magazine* interview (Voon, 2018). Lehrer and other disabled college peers Jude Conlon Martin, a sculptor with spinal cord disability, and Bill Shannon, a dancer with a hip disorder, started a disability in the arts awareness movement that resulted in the creation of a robust SAIC Disability and Learning Resource Center (Voon, 2018). Recently, Bri Beck, a disability artist alumnus at SAIC organized a Disability Arts Showcase titled *Sixty Inches From Center* “to share the varied story of disability and to bring together those that are disabled and those that work within this community to further grow and define a collective voice and community” (Art Therapy, n.d., para. 2). Linton & Gotkin (2019) are strong proponents for disabled students’ access to the arts rooted in disability identity and would like to see the education system at all levels hire disabled artist-teachers who can share their unique experiences to help design innovative disability arts pedagogies.

These examples illustrate how disabled artists are positioning their disability in their work (Linton & Gotkin, 2019). More disabled artists are enrolling in college programs today and there are also increased opportunities for grants and scholarships in the arts such as the VSA Young Emerging Artists Program for SWDs ages 16–25 living in the United States (Boeltzig et al., 2009; Kennedy Center, n.d.). Jessy Yates is an actor with cerebral palsy studying drama at Yale University. She is a performance artist, a comedian, and wheelchair user (Holmes, 2019). In January 2019, she was the recipient of the Ruderman Family Foundation Scholarship, the first recipient for actors with disabilities at Yale (Holmes, 2019). There is a rise in SWDs enrolling in higher education pursuing undergraduate and graduate programs such as Bachelor of Fine Art, Bachelor of Science in Art, or Master of Fine Art (Boeltzig et al., 2009).

Creed’s Research on AT Used by Disabled Visual Artists

For professional disabled visual artists, “[t]raditional assistive tools such as mouth sticks, head wands, and custom-designed grips (for holding brushes) can make creative work somewhat accessible” (Creed, 2018, p. 1104). However, Creed (2018), citing the research of Perera, Eales, and Blashki (2007), pointed out that traditional approaches have led to complications in health for some artists. Traditional assistive tools were “slow, tedious, and tiring” for individuals with disabilities leading to chronic neck strain and teeth damage (p. 1106). In Creed’s research, he established that traditional tools also contributed to stiffness in hands/fingers and increased fatigue in many of the artists in his study. On the other hand,

digital assistive tools were game changers and were more commonly used by visual artists with disabilities in Creed's (2018) study. Modern mainstream artistic software and apps such as Photoshop, Illustrator, Sketchbook Pro, Manga Studio, and Procreate, and hardware such as an alternative mouse, keyboards, trackballs, and switches could be easily purchased (Creed, 2018). Moreover, modern tools can be customized to support the artist's functional capabilities such as voice recognition software, eye gaze tracking devices, and motion tracking devices (Creed, 2018). However, Creed's research ultimately found that modern AT tools do not "completely remove the need for personal supports" to accomplish their artistic goals (p. 1110). Equally important is the need for individuals to evaluate their needs and skills for AT, have training on how to use AT, and have personal supports to trouble-shoot and repair technology. Cook (2009) describes these as soft technologies "without which the hard technologies [tangible AT] are ineffective," and points out that "they are highly dependent on human knowledge" (p. 129). The artists in Creed's (2018) study complained about difficulty controlling a stylus; repetitive strain injuries from difficulty operating multi-touch tablets, the use of trackballs as a mouse replacement, and equipment that are too big and heavy; difficulty in selecting small icon targets with eye gazers; and frustratingly poor voice recognition of speech to text software. "It is not yet clear whether technologies such as eye gaze tracking and speech recognition can genuinely enhance the practice of disabled artists more widely or whether they simply introduce more complexities and challenges" (Creed, 2018, p. 1117). However, disabled artists may be successful in using these devices if they invest time and effort to get training on how to use them and seek product support. For example, Sarah Ezekiel, a professional artist, uses an eye gazer called Tobii PCEyes to create her art and for communication ("Paralyzed Artist," 2015). Before motor neuron disease, Ezekiel was a successful painter and had full command of her speech (Ezekiel, 2019). Ezekiel remarked that TobiiPCEyes is a game-changer but admitted that the process of creating artwork with this high-tech tool can still take a long time. However, she noted that her artwork using this tool is quite similar to the work she used to do with her hands ("Paralyzed Artist," 2015). Watch Ezekiel in this video <https://youtu.be/-kpgKO6EMoU> (Tobii AAC, 2013).

Factors that Influence AT Selection

Do disabled artists have a preference for traditional tools vs. modern digital tools? Creed's (2018) study found that disabled visual artists who use both traditional tools and digital technology have adapted working methods and patterns such as working on a smaller scale, working for shorter periods, and using tech-savvy personal assistants. Despite modern technology's appeal and easy access, disabled artists utilize both traditional and digital tools that are useful to them. The choice is very individual. Modern digital tools are not necessarily better for the individual artist who cannot afford it, finds it too complicated to learn, and has negative attitudes about technology in general (Creed, 2018). It is also worth considering the individual's openness to emerging technology—younger individuals with disabilities may have been using sophisticated AT since early in their educational careers as a result of the IDEA and ADA, while the older artists with newly acquired disabilities may take longer to

perceive the value of investing more time and effort to learn how to use complex modern tools. To the novice, technology can be overwhelming, and without product support and adequate training the experience is likely to be negative (Seale, 2014). Furthermore, “costs associated with ATs are highlighted as one of the major barriers to the equal access of devices,...[and] “that purchase costs not only include the price of a device but also costs for services and training needs associated with the technology” (European Parliamentary Research Service, 2018, p. 9). However, the silver lining is prices will drop over time as more technological innovations enter the market, perhaps related to the increased number of competing companies. And, if disabled artists are given opportunities to have their voices heard on the usability of mainstream AT, the training cost could be significantly decreased. One suggestion is for companies to recruit artists with varying disabilities in surveys to get ideas of what they need and involve them in the beta testing stage of software. Disabled artists must not hold back in giving their honest feedback in order to fix issues in accessibility and usability.

Disabled Artists Involvement in AT Design

How can users and developers of AT work together to create products that are inclusive? In the past, artists collaborated with design engineers just like Beethoven had worked with inventors to make ear trumpets, resonators, and pianos. This participatory design is apparent in creating AT that takes into account the individual’s lifestyle, functionality, and usability of the device, as well as aesthetic (Newell, Gregor, Morgan, Pullin, & Macaulay, 2011. Clayton “Peg Leg” Bates had his uncle customize his wooden limbs in different colors, and Evan Ruggiero has different prosthetics made for dancing and walking. Below, there are other examples of artists who were involved in the development of computer software; prosthetic limbs, some with sophisticated artificial intelligence; and motorized wheelchairs to engage in their art form as musicians, tattoo artist, and dancers. However, it is important to note that the opportunity for participatory design is not common. There should be a push for user-sensitive inclusive design when creating AT. This concept focuses on the users of AT firstly as people with a specific disability instead of subjects, and this new paradigm could lead mainstream engineers to efficiently design equipment that is sensitive to the varying needs of people with disabilities (Newell et al., 2011. Technology companies should take the initiative to conduct product satisfaction surveys to ascertain whether the AT is effective to the users.

Impact of AT on Disability in the Arts

Presently, AT has boosted the presence of disability in the arts. Because of AT, there is more representation of people with disabilities in the visual arts, in music, and in dance. AT tools help promote inclusion and provide opportunities to people with all types of disabilities. Inclusion, according to Shelly (2019), is broader than accessibility and diversity; accessibility and diversity are focused on disability while inclusion is about “making the experience of marginalized people... straightforward, enjoyable, and fair” (p. 302). AT has increased disabled artists’ participation in the local, national, and international art scene, and

it has led them to advance on a professional level (Boeltzig, et al., 2009). Thus, the advancement of AT has impacted the emergence of disability in the arts (Boeltzig et al., 2009). The US Bureau of Labor Statistics (BLS) 2006 data revealed that there were 218,000 disabled artists employed and BLS projected that there will be a 16 percent growth through 2016 (Boeltzig et al., 2009). Furthermore, AT has also impacted inclusive arts education. Boeltzig et al. (2009) remarked that the majority of the artists in their study who were attending or had completed postsecondary education had benefited from arts education in their early school years and developed their own strategies such as painting with their mouth and feet, using computer graphics or digital photography, and employing an art assistant under their direction to create art. These authentic stories of disabled artists may be instrumental in raising public awareness of artistry rooted in disability (Linton & Gotkin, 2019). Disability artistry has a long history, but most of its existence has been on the margins. But in the past several years, disability arts have achieved greater recognition. More artists are also using accessibility tools as part of their art (Linton & Gotkin, 2019). For example, the dance production by Kinetic Light titled *Descent* includes “a sonic immersive experience designed for non-sighted audience members,” and the “set piece is a wildly designed curving ramp, truly usable only by a wheelchair user;” furthermore, the disabled artists were actively involved in the set design (Linton & Gotkin, 2019, p. 25). Lastly, AT has also impacted full physical access to museums, stage arenas, and other venues for cultural programs, which has increased access to all audiences (John F. Kennedy Center, n.d.). Inclusion can lead to inspiring many more disabled individuals of any age to pursue art and identify with other disabled artists socially and culturally, further advancing disability in the arts.

AT Increases Access: Museums, Theaters, and Cultural Programs

Since the passage of the ADA, our society is moving toward the direction of “social participation, with the goal of equality in opportunity through universal design” (Steinfeld, Maisel, & Levine, 2012, p. 21). A universal design (UD) focus demands that designers change their perspectives beyond accessibility regulations and create products, buildings, and interiors to be usable by a large majority of people. The Guggenheim Museum in New York City was one of the first buildings designed with the UD principle where Frank Lloyd Wright designed the interior as one continuous ramp (Steinfeld et al., 2012). The ADA requires that any new constructions or alterations of public accommodations structures must meet accessibility standards, with the exception of historically landmarked or older buildings that are very challenging to adapt. UD is only required to provide a minimal level of access (28 C.F.R. § 35.151). Thus, UD in architecture has made it more possible for individuals with disabilities to have full physical access to museums, stage arenas, and other venues for cultural programs (John F. Kennedy Center, n.d.). But accessibility services and AT devices offered at museums and performance spaces are largely dependent on the financial costs of accessibility initiatives. The John F. Kennedy Center has the resources (financial and staff) to design its performance space with designated accessible seating for disabled audiences, and the stage, backstage, orchestra pit, and other production areas are made accessible to

performers, artists, employees, volunteers, and interns with disabilities (John F. Kennedy Center, n.d.).

The types of AT that are currently offered by museums and performance venues include assistive listening devices, sign language interpreters, captioning, audio description, labels and texts in Braille, large print programs, touch tours, and sensory-friendly performances (“About Accessibility,” n.d.; Art Beyond Sight, n.d.). The Metropolitan Museum of Art, Museum of Modern Art, Whitney Museum of American Art, New Museum in New York, and San Francisco Museum of Modern Art were visited in this field study and the author observed that visitors with disabilities had straightforward physical access to the museum space; however, a disabled individual may require staff assistance for other communication-related services and touch tours and may need to schedule accessible tours in advance. However, the field study was only limited to observation; an interview survey would have determined whether these services offered in the museums met the disabled individuals’ physical and sensory needs.

Another venue that was visited was the Performance Space New York. Through a collaboration with Whitney Museum of American Art and Arika (a political arts organization based in the United Kingdom), the Performance Space New York held a three-day show, April 11–14, 2019, created by and for disabled artists, writers, and their supporters: <https://bit.ly/2EHIQCS>. The play, titled *Nearly Sighted/Unearthing the Dark*, by Kayla Hamilton used an ASL interpreter, real-time captioning, and audio descriptions as part of the show. The author observed the enjoyment on the faces of audience members with visual impairments in adjacent seats as they listened to the audio descriptions of the props used, actions on stage, and facial expressions of the actors. Furthermore, a dance performance by Alice Sheppard, a disabled dancer, titled *Where Good Souls Fear*, offered a new technological innovation called SUBPAC. Audience members with hearing impairments wore this low-profile backpack that transmits pulse sound through the body and allows individuals to feel the base. SUBPAC is also used by artists with severe hearing impairment to write music (Grabitz, 2016, 1:00). See this video (<https://youtu.be/z60Dp958iEA>) titled *Meet Mitchell*, a young musician with hearing and vision impairments and autism spectrum disorder who uses various AT such as SUBPAC, hearing aid, and the app Garage Band to write and play his music on his bass guitar (Grabitz, 2016, 3:12). See Appendix 3 for AT resources for performance artists.

Examples of Exciting Practice

This section will give examples of artists—visual, musicians, dancers, performers—and the AT that they use to create their art. The selection includes disabled artists who are established professionals and new emerging artists; their disability categories are varied and include paralysis, amputations, and learning and developmental disabilities. Some of the disabled artists featured in the paper are collaborating with designers and engineers to create customized AT. However, most disabled artists use a combination of store-bought technology

that ranges from traditional low-, mid-, and high technology. What is clear from these anecdotal examples is that AT enhances their creation of art.

Visual Artists. One of the advantages of visual art is to convey thoughts, show skills, and portray emotions. According to a Brooklyn Rail interview, Chuck Close (Brooklyn Rail, 2008) remarked: “In the 7th grade, I made a 20-foot long mural of the Lewis and Clark Trail while we were studying that in history because I knew I wasn’t going to be able to spit back the names and the dates and all that stuff on a test.” In this same interview, Close revealed that he has dyslexia, but it was not diagnosed in the 1940s. Nonetheless, he pursued his passion for visual art and graduated from Yale University. He became famous for his works in photorealism using a large Polaroid camera to create giant pixelated portraits that are based on photographs in the 1970s. He also has prosopagnosia, or face blindness, which impairs his recognition of faces (Martin, 2018). In 1988, Close became a quadriplegic but did not give up creating portraits using the same techniques. In addition to a Polaroid camera, Close used a brush strapped to his wrists and adapted his studio to include a hydraulic lift that helped him in to position to paint (Latchem, 2004; Phillips, n.d.). He also employs art assistants to help him work; he shares his process of making art in this video interview:

https://www.sfmoma.org/artist/chuck_close/ (SFMOMA, 2005). Today, it is not uncommon for museums to have a collection of Close’s artworks before and after his disability, and they could be hung side by side. The author of this paper had visited the San Francisco Museum of Modern Art and saw the collection of Chuck Close portrait paintings. Many art experts find it very difficult to differentiate work before and after his paralysis (Ravin, J & Odell, P., 2008). Three photographs were taken at the museum that is shown in Figure 2 (Appendix E): *Phyllis*, 1983-1984, *John II*, 1993, and *Roy I*, 1994. It is, indeed, very difficult to notice any difference in quality between the works. He continues to paint in the same style as before, the only difference now is he no longer works standing, learned to use a brush differently, and replaced the ladder with a hydraulic lift (Latchem, 2004; Phillips, Smith, Farrell & Morant, n.d.).

JC Sheitan Tenet is an example of a young emerging tattoo artist who lost his lower right arm when he was ten years old. He collaborated with Jean-Louis Gonzalez, an artist-engineer in the creation of a prosthetic arm that doubles as a tattoo machine (Jozuka, 2016). Tenet uses his shoulder to move the device that is described as having a “terminator-esque aesthetic” (Jozuka, 2016, para. 6). Both Tenet and Gonzales discuss the creation and the use of this device in this video interview *The Cyborg Artist: Tattooing with a Custom Prosthesis* (Great Big Story, 2016: <https://youtu.be/LB7Ljo2iFnU>

Sometimes AT is designed by disabled artists educators. In the following example, Tim Lefens conceptualized the Artistic Realization Technologies (A.R.T) program when he was teaching students in the community with cerebral palsy or quadriplegia (Purdy, 2001). Tim Lefens became progressively blind in his career, but before he lost most of his vision, he found that he could improvise a target laser, which was commonly used for aiming guns, to function as a virtual brush that was placed in the hand of his student or attached to their head (Purdy, 2011). With the help of trained trackers (assistants), artists who only had eye control

were able to point the laser to a brush, color, brush size, and textures of paints, and the tracker would support the creative process as the ‘hands’ of the students (“A.R.T.”, 2007). Tim Lefens captured the spirit of A.R.T. in this statement:

“When you have no means of expressing yourself, the whole world going on around you, without you, and all of a sudden you can place the exact amount of the exact color you want, where you want it on the canvas, a lifetime of pent up energy comes out through a very concentrated channel. For the individual we work with, painting is not recreation. It’s life” (“Community Access to the Arts,” n.d. para 2).

Today, the mid-tech A.R.T. techniques are used by art teachers across the United States (Khmara, 2017). This video (<https://youtu.be/jpUfiSKJPfc>) of an amateur visual artist Rafael Garcia and Tim Lefens (Only Good TV, 2017).

Musicians. AT has come a long way since Beethoven’s time, but the experience of feeling the vibrations of notes still provides inspiration for modern technology that is available today. Since there are varying levels of deafness and different causes of hearing loss (i.e., problems with inner, middle, and outer ear; infection-related; noise-induced hearing loss; tinnitus; hyperacusis; deafness from birth, childhood, teens, or adulthood), there are also different types of AT used by deaf or hard of hearing musicians (Fulford, Ginsborg, & Goldbart, 2011, pp. 447–464). Fulford et al. (2011) mentioned that there is academic audiology and psychology literature about how cochlear implants and digital hearing aids can make pitch perception worse; however, analog and digital hearing aids can be optimized through customization of the following: frequency compression, amplification, and noise reduction parameters. But the caveats of customization are the costs in time and money (Fulford et al., 2011).

Richard Einhorn, a successful professional music composer for operas and film soundtracks, has severe hearing impairment in his right ear. He has been composing music on his computer with music software since the mid-1980s, and he uses a “custom-fitted single in-ear monitor that features four proprietary speakers and sums a stereo signal to mono” (Einhorn, 2012, p. 180). Einhorn wrote that he has also used his “good musical imagination” when writing to compensate for his inability to “perceive all the antiphonal effects” that he likes to incorporate in his music (p. 180). He uses music editing software and the help of a talented music assistant to “look out for bad-sounding splices and other problems” (p. 180). For him, music rehearsals are challenging because of difficulty understanding sound in the ambient space. However, Einhorn uses what he calls his “portable sound rig” that consists of his iPhone with sound apps such as SoundAmp R or Fire 2, in-ear-style earphones, a stereo cardioid microphone from Blue Microphones called Mikey that connects to the iPhone power jack. He uses this personal assistive listening system minus his hearing aid so he can hear well in rehearsals (pp. 180–181). And, he uses a good earphone instead of his hearing aid to listen to a music recording because, for him, the combination of a Bluetooth coupling over his hearing aid gives a very unpleasant, grainy, and hollow quality sound. However, Einhorn

wears his hearing aid, ReSound LiNX2 t-coil when he attends performances in venues with hearing loops installed (p. 182).

Jason Barnes owns two prosthetic arms that were custom designed for him so he could play the drums and piano through collaboration with the engineers at Georgia Tech College of Design (Leary, 2017). The process of creating a prosthetic limb is complicated, especially when it involves artificial intelligence. Barnes' piano playing arm required sophisticated technology so that each individual finger had the dexterity to play notes on the piano with the ability to add the intended dynamics of the music (Leary, 2017). This new prosthetic limb is called Skywalker Hand and a demonstration is seen in this video (<https://youtu.be/8t8p43m1Iuw>) (Georgia Tech Center For Music Technology, 2017).

Additionally, it is worth mentioning the available high-tech AT used by visually impaired or blind musicians. The dominant technologies preferred by these musicians and used with various combinations for recording, editing, mixing audio, and composing music are Cakewalk software, Goodfeel, CakeTalking for Sonar studio software, Sound Forge or Cool Edit for audio editing, Window-Eyes and Jaws screen readers, Braille display, Dancing Dots Braille music software, Optican and SADIE's jog wheel for tactile and physical controls, physical-digital audio workstations such as Roland VS, and Tascam DAWS (Metatla, Stockman, & Bryan-Kinns, 2011; Kent, & Mandel, 2001; Ingber, 2012). To illustrate, Raul Midon, a Grammy-nominated blind jazz songwriter, singer, and record producer and an alumna of Frost School of Music at the University of Miami, uses Dancing Dots and Cake Talking products (Contreras, 2018; "Raul Midon," 2019; "Songwriter Raul Midon," 2010). Dancing Dots is a Braille software company that was founded by a blind musician and programmer, Bill McCann (Ingber, 2012). Watch how Midon applies the technology of Dancing Dot's CakeTalking in this video <https://youtu.be/pDRuj5Od4y8> (Raul Midon, 2009).

Dancers. Today, disabled dancers are challenging normative dance by using their disability as a form of art, and at times the customized wheelchair seems to be another dancer in the performance. Moreover, the usual choreography of using the wheelchair as an aid while the "wheelchair dancer sat rather passively" has been challenged and reworked so that the wheelchair dancer is expressing creative movement outside the traditional expectations (Morris, 2015, p. 5). Also, both assistive and adaptive technology design has undergone a metamorphosis from the traditional "medical" function to be an aesthetically creative movement instrument "to better match identity, interests, and desires" of users (Morris, 2015, p. 6). Merry Lynn Morris, a dance choreographer and inventor, has designed a 'smart' Rolling Dance Chair while working with dancers with disabilities at the University of South Florida. Through a complicated programmed algorithm, the chair can decode the user's movements and follows the dancers. The base of the chair hides the wheels to prevent costumes from getting caught (Ferro 2016; Leibach, n.d.). Watch this video <https://youtu.be/DdfUJHQPqec> that demonstrates the Rolling Dance chair in a dance studio (Arts and Disability, 2016).

Another trailblazer in disability dance is Kitty Lunn. In an interview with Michelle Vellucci of the Brooklyn Rail (2009), she discussed how her life changed from being a soloist dancer for the Washington Ballet to becoming a paraplegic dancer in her customized wheelchair. Lunn and her husband collaborated to design a wheelchair that is lightweight, with a sports chair base and a low back, purposely not equipped with brakes to facilitate easier movement for dancing. In 1995, Lunn started the Infinity Dance Theatre, a mixed ability dance company, and has taught dance to disabled students at Hunter College and completed teacher training workshops at New York University and National Dance Education Organization in Washington, D.C., to name a few (“Infinity Dance Theatre: Education,” n.d.; New York State Dance Education, 2019).

Conclusion

The promise of efficiency that AT brings can be alluring. Disabled artists have been using AT to create their art forms throughout history, but the artists of the past did not have the variety of tools available today. Therewithal, the fast-paced turnover of low-, mid-, and high-tech tools can be overwhelming and intimidating for users and art educators. In addition, the more high-tech AT tool requires a significant amount of time to learn how to use before the user can become adept. For example, the eye gazer or Photoshop software will require practice and persistence to learn how to use their applications productively. The length of time to become adept at using AT varies for every disabled artist because of the differences in technological skills, knowledge, and functional capabilities. However, disabled artists have developed their own strategies, such as using a combination of tools or adapting working methods like working for shorter periods and using personal assistants to create art.

More SWDs are now using mainstream technology such as the iPad to create art, too, and art educators have to become comfortable with exploring how AT can be used in the classroom, how it can be customized for the SWD, and how to evaluate whether the tool is the right fit for the individual. Besides these, educators must be familiar with the different categories of disabilities and functional limitations associated with the disability and must realize that an AT that is effective for one student may not be the best for another. There is no one-size-fits-all AT. It is vital that educators receive pre-service training addressing arts education for SWDs to integrate the use of AT in the arts. It is necessary for schools to hire disabled artists to teach in schools and impart their unique disability perspectives. The IDEA, ADA, and Sections 504 and 508 of the Rehabilitation Act have been instrumental in advancing the use of AT in education settings to level the playing field. The IDEA, which applies to the K–12 setting, mandates that schools must provide AT to SWDs as part of their IEPs and, as a result, teachers should be trained to use and implement technology in the art classroom so students succeed. This could only lead to more SWDs enrolling in postsecondary schools to pursue art programs and as a result, higher education faculty in the arts could get more experience working with SWDs. Furthermore, this snowball effect could lead to more money invested in developing inclusive programs for disabled artists. However, there is a need for empirical research on issues such as the effectiveness of pre-service

training and evaluation of best practices in the adaptive art curriculum, which include the voices of SWDs, educators, and education administrators.

Over the last three decades, museums and performance spaces have invested more money in attracting disabled audiences through accessibility services and AT. Exposure to the arts can be empowering to individuals with disabilities who want to pursue their creative talents, and even more when the art, music, or performance they are viewing, or hearing are created by disabled artists. However, not all museums and performance spaces have the same budgets allocated to accessibility initiatives, and there is no one-size-fits-all solution to inaccessibility for a heterogeneous group of disabled individuals. But there is a trend towards integrating AT to enhance engagement in disability artistry.

There is not one perfect AT for all individuals with disabilities. However, product designers can learn how to think of new ways to improve the usability and effectiveness of their products from artists with disabilities. Factors that are important to users are whether products are easy to use, easy to adapt and customize, reflect the individual's preference, and affordability. User-sensitive inclusive design is not only ideal but necessary to develop or improve AT for individuals with varying functional limitations. Some types of AT, such as prosthetics with artificial intelligence, require active participatory design, other software products can be beta-tested on the disabled artists, and other AT tools can be created by the artist with disability through collaboration. Professionals working with disabled students, such as educators or art therapists could also be instrumental in the design and improvement of AT. Technology companies should consider inviting professionals who work with SWDs and disabled artists to share their experiences with the AT products that they use or give ideas about new products that they need. One of the barriers disabled artists and educators face is not having the support to learn how to use the AT. For both disabled artists and professionals, this could lead to frustration and a waste of valuable time. If they are given opportunities to communicate with product support, the training cost could significantly decrease. This could also increase persistence and confidence in using AT. If users are abandoning the tools because of a lack of training, this is costly. Some mid-and high-tech tools can be expensive to purchase. However, as technology is becoming more ubiquitous and there seems to be a constant influx in the market, prices may drop over time. Although funding for AT was not at all discussed in this study, resources are included in the appendices that could provide grants, scholarships, and AT device loan programs and financing services to artists with disabilities.

Lastly, this study found a lack of scholarly research done on the perceptions of professional disabled artists regarding the benefits of using AT to create art. But there was more anecdotal evidence that supports how AT has enhanced the productivity, access, and engagement in the arts for this group. One supposition for the lack of evidence-based research could be related to the fast turnover of technology. Another factor could be related to difficulty in recruiting a sample group from a heterogeneous group of disabled artists with varying characteristics such as age, preferences, attitudes, learning styles, and types of AT used. Given these factors, the research results may also be difficult to generalize. However,

despite these limitations, it is important to develop new approaches to study the efficacy and usability of emerging AT.

Gina Wong, RN is a public health school nurse in New York City working in the Office of School Health as a staff development coordinator. She is passionate about disability issues, promoting inclusion and equitable access for individuals with disabilities in the K–12 and higher education system. She is currently pursuing the Master of Science in Disability Services (MSDSH) in Higher Education at the CUNY School of Professional Studies.

References

- About Accessibility. (n.d.). <https://www.kennedy-center.org/visit/accessibility/>
- Akpan, J., & Beard, L. (2013). Overview of Assistive Technology Possibilities for Teachers to Enhance Academic Outcomes for All Students. *Universal Journal of Educational Research* 1(2), 113-118.
<http://www.hrpub.org/download/201308/ujer.2013.010211.pdf>
- Art Beyond Sight General Tools Overview (n.d.).
<http://www.artbeyondsight.org/handbook/acs-audiodescribed.shtml>
- Arts and Disability. (2016, May 22). Rolling Dance Chair Experimentation Merry Lynn Morris & Jessica. [Video File]. <https://www.youtube.com/watch?v=86pp62N4vYk>
- Art Therapy. (n.d.) <http://www.saic.edu/news/saic-student-bri-beck-organizes-disability-art-showcase>
- Artistic Realization Technology. (2007, January 16). *A.r.t. On CBS Evening News* [Video File]. <https://youtu.be/kBM3VdWmHXY>
- Bailey, N., & Cody, A. (2015, December 31). The Importance of the Arts to Students with Disabilities. *Living in Dialogue*. www.livingindialogue.com/the-importance-of-the-arts-to-students-with-disabilities/
- Benefits of Theatre Education. (n.d.). <https://www.acttooperators.com/benefits-of-theatre-education>
- Baker, D. (2013). Art Integration and Cognitive Development. *Journal for Learning through the Arts*, 9(1), 1–15. <https://escholarship.org/uc/item/9wv1m987>
- Boeltzig, H., Sullivan Sulewski, J., & Hasnain, R. (2009). Career development among young disabled artists. *Disability & Society*, 24(6), 753-769.
- Brooklyn Rail. (2008, June). *Chuck Close with Phong Bui* [Interview Transcript].
<https://brooklynrail.org/2008/06/art/chuck-close-with-phong-bui>
- Brooklyn Rail. (2009, June 2). *Dance in the Body You Have: An Interview with Kitty Lunn*. [Interview Transcript]. <https://brooklynrail.org/2009/06/dance/dance-in-the-body-you-have-an-interview-with-kitty-lunn>
- Careers in the Arts - National Endowment for the Arts. (n.d.).
www.arts.gov/sites/default/files/careers-in-the-arts-brief-rev3_0.pdf
- Chung, A. (2011, November 24). A virtual virtuoso takes to the stage.
http://www.thestar.com/news/canada/2011/11/24/a_virtual_virtuoso_takes_to_the_stage.html

- Clayton 'Peg Leg' Bates American Memory: Remaining Collections. (n.d.).
<https://memory.loc.gov/ammem/index.html>
- [SFMOMA]. (2005, November). *Chuck Close on painting with both hands* [Video File].
https://www.sfmoma.org/artist/chuck_close/
- Coleman, M. B., & Cramer, E. S. (2015, March 01). Creating Meaningful Art Experiences with Assistive Technology for Students with Physical, Visual, Severe, and Multiple Disabilities. *Art Education*, (68) 2, pp. 6–13.
<https://doi.org/10.1080/00043125.2015.11519308>
- Coleman, M.B., & Grim, J. (2015). Making Art Accessible for Students with Physical, Visual, Severe, and Multiple Disabilities. [PowerPoint slides].
<https://www.slideserve.com/lane-beard/making-art-accessible-for-students-with-physical-visual-severe-and-multiple-disabilities>
- Coleman M.B., Cramer, E.S., Park, Y.J., Bell, S.M., & Coles, J. (2015). Art Educators' Knowledge, Attitudes, and Experiences Working with Students Who Have Physical, Visual, Severe, and Multiple disabilities. *Art Education*, 57(1), pp. 6–20.
<https://doi.org/10.1080/00393541.2015.11666279>
- Contreras, F. (2018, March 22). Raul Midón: NPR Music Tiny Desk Concert [Video File].
<https://www.youtube.com/watch?v=x9qEmmPSHs8>
- Community Access to the Arts. (n.d.). <https://cataarts.org/overview/art-workshops/>
- Cook, A. (2009). Ethical Issues Related to the Use/non-Use of Assistive Technologies. *Developmental Disabilities Bulletin*, vol. 37, no. 1 & 2, 127–152.
- Creed, C. (2016). Assistive Tools for Disability Arts: Collaborative Experiences in Working with Disabled Artists and Stakeholders. *Journal of Assistive Technologies*, vol. 10, no. 2, 121–129. <https://doi.org/10.1108/JAT-12-2015-0034>
- Dell, A., Newton, D., & Petroff, J. (2017). Assistive Technology in the Classroom: Enhancing the School Experiences of Students with Disabilities, Enhanced Pearson eText with Loose-Leaf Version ... Edition) (What's New in Special Education).
<https://www.amazon.com/Assistive-Technology-Classroom-Experiences-Disabilities/dp/0134170415>
- Derby, J. (2012). Art Education and Disability Studies. *Disability Studies Quarterly*, (32)1.
<http://www.jstor.org/stable/41407936>
- Digital Archives of the Beethoven-Haus Bonn (2002, April 1). *Digital Archives of the Beethoven-Haus Bonn*.
<https://www.beethoven.de/en/media/view/5217893683822592/Beethovens+Hörrohre,+gefertigt+von+Johann+Nepomuk+Mälzel,+1813?fromArchive=6609072782573568>

- Ealy, G. (1994). Of Ear Trumpets and a Resonance Plate: Early Hearing Aids and Beethoven's Hearing Perception. *19th-Century Music*, 17(3), 262-273.
<https://www.jstor.org/stable/746569>
- Einhorn, R. (2012). Observations From a Musician With Hearing Loss - Richard Einhorn, 2012. *Trends in Amplification*, 16(3), 179-182.
<https://doi.org/10.1177%2F1084713812468513>
- Escamilla, B. (1997). Bates, Peg Leg 1907-. *Contemporary Black Biography*, 14, 17-19.
http://link.galegroup.com/remote.baruch.cuny.edu/apps/doc/CX2871600013/GVRL?u=cuny_baruch&sid=GVRL&xid=13b5533a
- European Parliamentary Research Service. (2018). *Assistive Technologies for people with disabilities: Part 111 Perspectives, needs, and opportunities*. (IP/G/SToa/FWC/2013-001/Lot 6/C3).
[http://www.europarl.europa.eu/RegData/etudes/IDAN/2018/603218/EPRS_IDA\(2018\)603218_EN.pdf](http://www.europarl.europa.eu/RegData/etudes/IDAN/2018/603218/EPRS_IDA(2018)603218_EN.pdf)
- Evans, C. (2010, May 27). *Training Students & Music Teachers in the Gifts of Autism—Meet Dr. Rhoda Bernard* [Video file]. <https://youtu.be/vuGC1E4sTsQ>
- Ezekiel, S. (2019 April 23). The Life-Changing Power of Assistive Technology. *PathPoint*, www.pathpoint.org/news/the-life-changing-power-of-assistive-technology/
- Ferro, S. (2016, November 03). A New Type of Wheelchair Is Designed for Dancers.
<http://mentalfloss.com/article/88268/new-type-wheelchair-designed-dancers>
- Fulford, R., Ginsborg, J., & Goldfarb, J. (2011) Learning Not to Listen: The Experiences of Musicians with Hearing Impairments. *Music Education Research*, 13(4), 447-464.
https://www.researchgate.net/publication/232924023_Learning_not_to_listen_The_experiences_of_musicians_with_hearing_impairments
- Gatchalian, C. (2019). Assistive Technologies in the 21st Century (Chapter 25). In R. Power (Ed.), *Technology and the Curriculum Summer 2019*.
<http://techandcurr2019.pressbooks.com/chapter/21st-century-assistive-tech/>
- Georgia Tech Center for Music Technology (2017, December 6). *Skywalker Hand* [Video File]. <https://www.youtube.com/watch?v=8t8p43m1luw&feature=youtu>
- Grabbitz. (2016). *Meet Mitchell* [Video File]. <https://youtu.be/z60Dp958iFA>
- Great Big Story (2016). *The Cyborg Artist: Tattooing with a Custom Prosthesis* [Video File]. <https://youtu.be/LB7Ljo2iFnU>
- Holme, K. (2018, October 16). “The No. 1 thing you’re getting wrong about inclusive design.” <https://www.fastcompany.com/90243282/the-no-1-thing-youre-getting-wrong-about-inclusive-design>

- Holmes, H. (2019, January 17). Meet Jessy Yates, the First Recipient of Yale's New Scholarship for Actors with Disabilities. *Observer*.
<https://www.observer.com/2019/01/meet-jessy-yates-the-first-recipient-of-yales-new-scholarship-for-actors-with-disabilities/>
- How Beethoven Coped with Hearing Loss (2018, December 10).
<https://www.audicus.com/beethovens-hearing-loss/>
- Infinity Dance Theatre Education (n.d.) <https://www.infinitydance.com/education.html>
- Ingber, J. (2012, June). Learning to play a musical instrument: resources for people who are blind or visually impaired. <https://www.afb.org/aw/13/6/15804>
- Integrating the Arts with Technology: Inspiring Creativity (n.d.)
<http://www.ldonline.org/article/30245/>
- The John F. Kennedy Center for the Performing Arts (n.d.). <http://www.kennedy-center.org/>
- Jozuka, E. (2016, June 10). This Badass Prosthetic Arm Doubles as a Tattoo Machine.
https://www.vice.com/en_us/article/xygaza/this-badass-prosthetic-arm-doubles-as-a-tattoo-machine
- Kennedy Center.org (n.d.). VSA Emerging Young Artists Program. <https://www.kennedy-center.org/VSAEmergingYoungArtists>
- Kent, G., & Mandel, M. (2001, March). Feel the Music: A Review of Music Production Software. <https://www.afb.org/aw/2/2/15042>
- Khmara, Danyelle. (2017 May 8). Artist Direct 'Human Paintbrushes' in Tucson Program. *Arizona Daily Star*. <https://binged.it/3hLMrQT>
- Krehbiel, H. (1898, 05). The Beethoven Museum at Bonn. *Century Illustrated Magazine* (1881–1906), *Lvi*, 3. <https://remote.baruch.cuny.edu/login?url=https://search-proquest-com.remote.baruch.cuny.edu/docview/125517416?accountid=8500>
- Latchem, C. (2004). Challenges of teaching with technology across the curriculum. *British Journal of Educational Technology*, 35(2), 253–254. https://doi.org/10.1111/j.0007-1013.2004.386_9.x
- Leary, K. (2017 December 12). Georgia Tech's New Prosthetic Arm Enables Amputees to Control Each Individual Finger. *Futurism*. <https://futurism.com/georgia-techs-new-prosthetic-arm-enables-amputees-control-individual-finger>
- Leibach, J. (n.d.). A Chair Fit for Dancing. *Science Friday*.
www.sciencefriday.com/articles/a-chair-fit-for-dancing/
- Lewis, R. (1998). Assistive Technology and Learning Disabilities: Today's Realities and Tomorrow's Promises. *Journal of Learning Disabilities*, 31(1), 16–26.
<https://doi.org/10.1177/002221949803100103>

- Linton, S., & Gotkin, K. (2019). Disability Equity in NYC's Arts and Culture Landscape. <http://disabilityarts.nyc/report>
- Loesl, S. (2012). The Adaptive Art Specialist: An Integral Part of a Student's Access to Art. In S. Malley (Ed.), *The Intersection of Arts Education and Special Education: Exemplary Programs and Approaches* (pp. 47–68). https://education.kennedy-center.org/pdf/Professional_Papers_Vol_1.pdf
- Malley, S. (2012). Introduction. In S. Malley (Ed.), *The Intersection of Arts Education and Special Education: Exemplary Programs and Approaches* (pp. 47–68). <https://bit.ly/3g9ec5y>
- Martin, E. (2018). Disability Studies in Art History. *The Lantern*. <http://web.colby.edu/thelantern/2018/04/26/disability-studies-in-art-history/>
- Mayne, K.W. (2011, November 8). Beethoven's Deafness: For Better or Worse-Or Neither? Metatla, O., Stockman, T., & Bryan-Kinns, N. (2011). AMuST: Accessible Music Studio-Feasibility Report. <https://core.ac.uk/download/pdf/30696796.pdf>
- McCord, K., Malley, S. (2017). The Impact of Technology Innovations at the Intersection of Arts Education and Special Education. In J. Crockett & S. Malley (Eds.), *Handbook of Arts Education and Special Education* (pp. 32–44). <https://doi.org/10.4324/9781315618135>
- Morgan, J. (2014.). Henri Matisse: Cutting into Colour. *The Lancet*, 383(9932) 1878. [https://doi.org/10.1016/S0140-6736\(14\)60903-X](https://doi.org/10.1016/S0140-6736(14)60903-X)
- Morris, M. (2015). The dance lens: A New Paradigm for Envisioning Assistive Devices and Technology. http://scholarcommons.usf.edu/cgi/viewcontent.cgi?article=1013&context=the_facpub
- NEA. (n.d.). <https://www.arts.gov/>
- Newell, A., Gregor, F., Morgan, P., Pullin, M., & Macaulay, G. (2011). User-Sensitive Inclusive Design. *Universal Access in the Information Society*, 10 (3), 235–243. <https://doi-org.remote.baruch.cuny.edu/10.1007/s10209-010-0203-y>
- New Construction and Alterations, 28 C.F.R. Section 35.141 (2009).
- New York State Dance Education. (2019). Wheelchair Dance Technique Workshop for Teachers (Free) Kitty Lunn, Infinity Dance Theatre. <http://www.nysdea.org/events/115-wheelchair-dance-technique-workshop-for-teachers-free-kitty-lunn-infinity-dance-theater>
- Nicolau, H., & Montague, K. (2019, June 4). Assistive Technologies. In S. Harper, & Y. Yesilada (Eds.) *Web Accessibility: A foundation for Research* (pp. 317–335). https://doi.org/10.1007/978-1-4471-7440-0_18

- O'Farrell, L., & Kukkonen, T. (2017). Transformative Action on Arts Education: Reinvigorating the Seoul Agenda. <https://www.eduarts.ca/sites/default/files/publication/Position%20Paper.pdf>
- Only Good TV (2017, September 14). *Disabled Artists Use Technology to Tap Into Creative Power*. [Video File]. <https://www.youtube.com/watch?v=jpUfiSKJPfc&feature=youtu>
- Paralyzed artist creates artwork using just her eyes. (2015, May 03). <https://www.bbc.com/news/uk-england-london-32573909>
- Phillips, R., Smith, A., Farrell, K., & Morant, K. (n.d.). Artists with Unwavering Perseverance and Courage. <https://www.healing-power-of-art.org/artists-with-unwavering-perseverance/>
- Purdy, M. (2001, May 23). You Don't Need Hands to Paint, or Eyes to Inspire. *New York Times*. www.nytimes.com/2001/05/23/nyregion/our-towns-you-don-t-need-hands-to-paint-or-eyes-to-inspire.html
- Midon, R. (2009, September 30). *The Making of "Synthesis."* [Video File]. <https://www.youtube.com/watch?v=pDRuj5Od4y8&feature=youtu>
- Midon, R. University of Miami. (2019, December 20). <https://www.alumni.miami.edu/news-and-media/alumni-stories/2019/raul-midón/index.html>
- Ravin, J., & Odell, P. (2008, August 11). Pixels and Painting Chuck Close and the Fragmented Image. *JAMA Ophthalmology* (126) 8, 1148–1151.
- Rhoades, J. (1993). "Drawing" with scissors and paper. *Teaching Pre-K–8*, 23(8), 70.
- Ruggiero, E. (2018, June 8). Experience: I am a one-legged tap dancer. <https://www.theguardian.com/lifeandstyle/2018/jun/08/experience-i-am-a-one-legged-tap-dancer>
- Seale, J. (2014). *E-Learning and Disability in Higher Education: Accessibility Research and Practice*. (2nd Ed.) Routledge.
- Shaver-Gleason, L. (2018, October 19). Would Beethoven Prefer a Modern Piano If He Had One? *Not Another Music Cliche*. notanothermusichistorycliche.blogspot.com/2018/10/would-beethoven-prefer-modern-piano-if.html?m=1
- Shelly, C (2019, June 4). Inclusion. In S. Harper, & Y. Yesilada (Eds.) *Web Accessibility. Human-Computer Interaction Series* (pp. 301–313). https://doi.org/10.1007/978-1-4471-7440-0_17
- Simonis, L. (2015). *The last Beethoven* (dissertation). Universite Pantheon—Sorbonne, Paris. [Pdf]. Retrieved from: <https://tel.archives-ouvertes.fr/tel-01825801/document>

- Songwriter Raul Midon Produces Music with Cake-Talking Technology [Web log post]. (2010, April 15). noelborthwick.com/cakewalk/2010/04/15/songwriter-raul-midon-produces-music-with-cake-talking-technology/
- Steinfeld, E., Maisel, J., Levine, D. *Universal Design: Creating Inclusive Environments*. <https://ebookcentral.proquest.com>
- Steenhout, N. (2018). "The Evolution of Assistive Technology into Everyday Products." [NZ ICT Innovation Conference]. <https://incl.ca/the-evolution-of-assistive-technology-into-everyday-products/>
- Sulewski, J. S., Boeltzig, H., & Hasnain, R. (2012). Art and Disability: Intersecting Identities Among Young Artists with Disabilities. *Disability Studies Quarterly*, 32(1). <http://dx.doi.org/10.18061/dsq.v32i1>
- [Tobii AAC] (2013, November, 27). *EyeGaze artist Sarh Ezekiel on TV show London Tonight* [Video]. <https://www.youtube.com/watch?v=jpUfiSKJPfc&feature=youtu.be>
- Voon, Claire. (2018, October). How Artists Helped Propel Chicago's Disability Rights Movement. *Chicago Magazine*. www.chicagomag.com/arts-culture/October-2018/How-Artists-Helped-Propel-Chicagos-Disability-Rights-Movement/
- Wallace, R. (2019, July 28). Why Beethoven's Loss of Hearing Added New Dimensions to His Music: Essay, <https://www.zocalopublicsquare.org/2019/07/28/why-beethovens-loss-of-hearing-added-new-dimensions-to-his-music/ideas/essay/>
- Weiner, I. B. (2010). Assessment Psychology in I. B. Weiner and E. Craighead (Ed.). *The Corsini Encyclopedia of Psychology*, 4th ed. 1. 158–159, Gale Reference Library [http://link.galegroup.com/remote.baruch.cuny.edu/apps/doc/CX1942000090/GVRL?u=cuny_baruch&sid=GVRL&xid=c67fbc4e](http://link.galegroup.com/remote/baruch.cuny.edu/apps/doc/CX1942000090/GVRL?u=cuny_baruch&sid=GVRL&xid=c67fbc4e)
- Wexler, A., & Cardinal, R. (2009). *Art and Disability: The Social and Political Struggles Facing Education*. New York: Palgrave Macmillan.
- What is AT? (n.d.). <https://www.atia.org/at-resources/what-is-at/>. Accessed 7 April 2019.
- Yoder, G. (2018). Adapted Art Curriculum: A Guide for Teachers of Students With Disabilities. *Graduate Education Scholarship*. https://mosaic.messiah.edu/gredu_st/1

Appendix A

Figure 1.

Beethoven's Ear Trumpets

<https://www.beethoven.de/en/media/view/5217893683822592/Beethovens+Hörrohre,+gefertigt+von+Johann+Nepomuk+Mälzel,+1813?fromArchive=6609072782573568>



Appendix B (Visual Artists) Mainstream software, input devices

Adobe Products (<https://www.adobe.com/accessibility/products/indesign.html>)

Photoshop Sketch (<https://www.adobe.com/products/sketch.html>)

Photoshop After Effects (<https://www.adobe.com/products/aftereffects.html>)

Adobe Illustrator (<https://adobe.ly/2TuAghY>)

Flash Player (adobe.com/products/flashplayer)

Lightroom (<https://lightroom.adobe.com/>)

GIMP (<https://www.gimp.org/>)

Artrage (<https://www.artrage.com/>)

Sketchbook Pro (<https://sketchbook.com/>)

Manga Studio (<https://manga-studio-ex.en.softonic.com/#tab-review>)

Infinite Painter (<https://www.infinitestudio.art/discover.php>)

Tablets (<https://www.toptenselect.com/top-10-best-tablets-artists/>)

Wacom Pen Tablets (<https://www.wacom.com/en-us/products/pen-tablets>)

Apple iPad Pro (<https://www.apple.com/ipad-pro/>)

Trackball mouse replacements (Different trackball models are [available](#).)

Eye gaze trackers (<http://www.eyewriter.org/>)

Tobii (<https://www.tobii.com> › Tobii Group › About)

Eyetribe (theeyetribe.com/)

Dragon NaturallySpeaking (www.nuance.com/)

Virtual Reality Tools and Motion Tracking

MS Kinect technology (<https://bit.ly/2He1SSx>)

Tiltbrush (<https://www.tiltbrush.com/>)

Cameras with easy use shutter release port, mounting system, camera switch)

[Canon Eos Rebel T3 digital SLR: https://www.usa.canon.com/internet/portal/us/home](https://www.usa.canon.com/internet/portal/us/home)

Ultimate Switch: <https://advopps.org/ultimate-switch-offers-ultimate-accessibility/>

Magic Arm: <https://enablingdevices.com/product/magic-arm-mounting-system/>

MovieMaker (<https://www.topwin-movie-maker.com/>)

iMovie (<https://www.apple.com/imovie/>)

Surface adaptations (slant boards, desk liners, PVC pipe paintbrush, mouth sticks, velcro straps)

Organizations

Art Beyond Sight (<http://www.artbeyondsight.org/sidebar/aboutsite.shtml>): Provides educational resources, handbook for museum practitioners, teacher resource center provides lesson plans and curriculum ideas for K–12 teachers and museum educators, and career guidance for the blind, visually impaired

A.R.T./New York (<https://www.art-newyork.org/accessibility>): Provides support to theatres that are developing accessibility programs for their own companies

Augsburg University: (<https://www.augsburg.edu/class/groves/assistive-technology/everyone/>): Provides a comprehensive list of the latest information on a variety of AT

Disability Arts International (<https://www.disabilityartsinternational.org/artists/>): Developed by the British Council, promotes the work of disabled artists, disabled-led companies, and inclusive arts organizations

Infinitec (<http://www.infinitec.org/adaptive-artists>): Provides information on hundreds of devices that promote disability arts

Mouth and Foot Painting Artists of the World (<https://mfpausa.com/>): Brings together artists who have lost the use of their hands to paint with a brush and paint with their mouth and feet; markets, exhibits, and sells works done by artists; gives financial assistance

National Endowment for the Arts (<https://www.arts.gov/>): Independent federal agency that funds, promotes, and strengthens art opportunities and participation to all Americans

Assistive Technology Act Training and Technical Assistance Center (AT3) (<https://www.at3center.net/stateprogram>): Provides information and resources on state Tech Act such as demonstration opportunities, device loan programs, AT reutilization, and AT financing services

Appendix C (Musicians) Mainstream artistic software

Apple GarageBand (<https://www.apple.com/mac/garageband/>)

Digital Ear (<https://www.digital-ear.com/>)

MIDI controllers (<https://ehomerecordingstudio.com/midi-controllers/>)

Skoog (<https://skoogmusic.com/>)

Virtual Reality Systems (https://youtu.be/_cNJI_fSURM_)

Dancing Dots low vision and blind performers
(<https://www.dancingdots.com/main/index.htm>)

JAWS: <http://www.freedomscientific.com/Products/software/JAWS/>

Goodfeel: www.dancingdots.com/main/goodfeel3.htm

Sound Forge: <https://sound-forge-pro.en.softonic.com>

Breath and head powered instruments

Jamboxx: https://youtu.be/x_eIRX7hHpl

Yamaha breath powered keyboard: <https://pianoandsynth.com/yamaha-pianica-p37e/>

Bite switches and page turners

Conceptus (www.conceptusinc.com/spneeds.htm)

Adaptive Tech Solutions (<https://www.adaptivetechsolutions.com/bite-switch/>)

Airturn (<https://www.airturn.com/products/categories/Bite+and+Tongue+Switches>)

Tilt switch pedal control (<https://www.enablemart.com/adaptation-dipsy-tilt-sensitive-switch>)

Jam Studio (<http://www.jamstudio.com/Studio/index.htm>)

Rock Our World (rockourworld.pbworks.com/)

Organizations

Coalition for Disabled Musicians (<https://disabled-musicians.org/links/>): Non for profit volunteer ran organization dedicated to supporting physically disabled musicians

Drake Music (<https://www.drakemusic.org/about-us/>): UK based enables disabled musicians to create music, develop outreach, training and education

Appendix D (Adaptive Tools and Organizations for Performance Artists)

American DanceWheels Foundation: [ADF's website](#)

Augmentative and Alternative Communication:
<http://www.everyonecommunicates.org/stories/individualstories.html>

Axis Dance: <http://www.axisdance.org/>

Boston Ballet Adaptive Teacher Training: <https://bit.ly/2W4Nch6>

Gibney Dance: <https://gibneydance.org/disability-arts-nyc-task-force/>

Infinity Flow: <http://www.infiniteflowdance.org/home>

REVolutions Dance: <http://www.revdance.org/>

Infinity Dance Theatre (classes, instructional videos):
<https://www.infinitydance.com/shop.html>

Integrating Deaf Performers in Live Musical Theatre: <https://bit.ly/2WzMfKE>

Mellon Foundation Grants in the Performing Arts (<https://bit.ly/2JhGDkY>): Grantmaking in the performing arts

National Arts and Disability Center (<https://www.semel.ucla.edu/nadc>): leading consultant in the arts and disability community

National Theatre for the Deaf (www.ntd.org/): Touring theatre company of Deaf artists

Rolling Dance Chair: <https://www.sciencefriday.com/articles/a-chair-fit-for-dancing/>

Shadow Interpreting in Theatre Stage: <https://bit.ly/2vQFpVf>

Appendix E

Figure 1.

Phyllis, 1983–1984 [Photo] Original work at SFMOMA



Figure 3.

John II, 1993 [Photo] Original work at SFMOMA

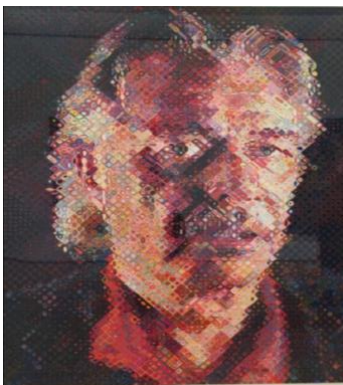



Figure 4

Roy I, 1994 [Photo] Original work at SFMOMA



 The Role of Assistive Technology in Enhancing Disability Arts by [Gina Wong](#) is licensed under a [Creative Commons Attribution 4.0 International License](#). Based on a work at <https://rdsjournal.org>. Permissions beyond the scope of this license may be available at <https://www.rds.hawaii.edu>.