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MOBILE BODIES: REIMAGINING DESIGN THROUGH A DANCE LENS

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This article delves into the ways in which dance practice revises traditional approaches to assistive technology design, adding a productive dimension to current momentum in the design field at large. Based upon research with dancers who have disabilities that was approved by an Institutional Review Board, as well as practice-based research, the author examines the art of dance as a catalyst for reframing design thinking for assistive technology. Specifically, attention is drawn to the interpersonal and embodied facets of assistive technology. This research-based analysis expands the creative landscape in design thinking through attending to the disabled dancing body while carving an innovative space for dialogic intersections between the fields of dance, disability, and assistive technology design.

Key words: Design; Assistive technology; Dance; Disability; Innovation

INTRODUCTION

In the 1980s, mixed ability or physically integrated dance companies in the U.S., such as AXIS Dance Company and Dancing Wheels, began with professional performance goals, aimed at producing high-quality choreographic work involving individuals with and without disabilities. Professional integrated dance companies and programs that encompass dancers with disabilities often have performers who use manual wheelchairs, power chairs, or other assistive mobility devices. As a dance choreographer and educator, I have worked extensively with dancers who have disabilities and use assistive mobility devices. My long-time work in the field of dance, as well as my personal history as caregiver to my disabled father, prompted my interest and research pursuits in the area of assistive technology design. Ultimately, these interests in design led to a patented wheelchair invention, which came to fruition in 2012 (1-4). The focus of this article is not on the development of my specific design innovation; rather, it is a research-based analysis of the concepts undergirding and driving the innovation: an examination of how dance can enliven and provoke habitual ways of seeing to lead towards a re-visioning of the design of technology, specifically assistive technology. The following sections probe how the assistive device is reimagined through the dance and

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disability dyad, ultimately suggesting new notions for assistive technology design theory/practice. First, I will discuss the methods informing this analysis.

METHODS

This research draws upon a qualitative, phenomenological mode of inquiry. Data for this work has been derived from the following: 1) literature drawn from the fields of dance, disability studies, and assistive technology/product design to situate the research and theorize body-device-environment relationships, 2) observations of and discussions with research participants about disability, dance, and assistive device experience, 3) observations and choreographic analysis of contemporary integrated dance choreography and performers, both performing live and through video/internet resources, and 4) my own professional participation in the dance and disability community. This article is part of a larger doctoral research study in which participants also tested the prototype chair innovation, "Rolling Dance Chair" (4).

Through a literature review, I surveyed varied dance, sociology, psychology, disability, philosophy, and design literature in search of ideas or theories about bodily relationships to devices or bodily relationships to the environment and vice versa. I gleaned insight from multiple sources, including Sherry Turkle's text *Evocative Objects: Things We Think With* (5); Mark Johnson's *The Meaning of the Body* (6); Bruno Latour's actor-network theory (7-9); Maurice Merleau-Ponty's philosophies of embodiment and tool use (10-12); design theorists' writings about emotional design, interaction design, and human-centered design (13-23); and geography scholarship dealing with bodies and materiality, specifically disabled bodies (24-31).

Eight assistive device users in dance from different geographical locations (Canada, China, Belarus, Australia, Israel, and the U.S.) were recruited to participate in this research under an approved Institutional Review Board meeting the standards necessary for ethical qualitative research. The bulk of the live interview/observation research data with these eight participants was gathered during a week-long integrated dance event held at the University of South Florida. This event offered the opportunity to interview participants about disability, dance, and device experience as well as to observe participants. The participant sample chosen for this research was particularly unique in that I was seeking assistive device users with disabilities who also possessed professional dance experience and, therefore, could speak to their combined experiences of disability, device use, and dance. I also sought a cross-section of individuals who were diverse and unique in terms of disability type, professional dance training and performance experiences, and cultural background.

The data collection primarily took place in a natural field setting, a dance studio on the University of South Florida campus. However, follow-up dialogue through email and phone also occurred. All sessions were video recorded, with participants providing verbal feedback to the researcher. Additionally, participants filled out a questionnaire asking them to discuss how they view and experience their mobility devices as well as how dance has impacted those experiences.

In the choreographic analyses of dance performance and the research participants' movement experiences, I drew from Foster's *Reading Dancing* (32) and Laban Movement Analysis (LMA). Foster identifies five broad categories for discerning choreographic meaning: the frame, the mode of representation, the style, the vocabulary, and the syntax (32). I placed emphasis on the style (i.e., quality of movement), vocabulary (i.e., specific movements), and syntax (i.e., relationships of one movement to the next) to educe meaning. Drawing from both Foster's approach and the LMA framework, I looked for how parts of the body were held or released; how parts were sequenced; how Effort elements, such as Space, Time, and Weight, were utilized; and how the body was generally oriented in space (32-35). The term Effort is capitalized due to its specific referential meaning in the LMA framework. Space, Time, and Weight are also capitalized for this reason. Effort is defined as the dynamic quality of the movement as manifested through four Effort Factors: Space, Time, Weight, and Flow. For additional reference, see Hackney (35).

Also important was observing how relationships were negotiated between dancers and between the dancer and the device. From descriptive observations of how the body occupied space, utilized time,

initiated and sequenced movement, and enacted qualitative nuance in relation to the assistive device, inferences could be drawn. For instance, an analysis of several professional integrated dance works revealed the way the strategic use of time and space changed binary representations of ability and disability while creatively expanding the role of the assistive device.

DEFINITION OF TERMS AND CONTEXT

Assistive technology (AT), considered in its broadest sense, may be anything an individual makes use of to enable extended or supportive possibilities for mental and/or physical capacities and needs. We all, in fact, utilize assistive aids to live our lives. This means the pencil, the phone, the computer, the toothbrush, as well as cooking utensils, wrenches, bicycles, cars, and planes; all fall into the category of AT. In the construct of disability, AT may encompass a vast array of possibilities. For the purpose of this article, I will specifically place emphasis upon assistive technology devices (ADs), meaning "any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain or improve functional capabilities of individuals with disabilities" (36). Further, I will focus upon the wheelchair as a prevalent AD.

Innovations in wheelchair technology have been largely driven by changing social and political contexts, including the economies and ideologies of war, as well as rehabilitative practice and medicine, capitalism, sports, and disability activism (37). In the process of this evolution, disabled bodies moved from social positions of passivity, dependency, and inequality to positions of improved independence and empowerment (38). However, AT/AD design and development still have further to go with regard to effective use, broader reach, and attention to quality of life (39,40).

Researchers in AT point to an entire system of variables that need to be synchronized in order to achieve a successful person-device relationship (40,41). These variables include environmental, personal, and psycho-social concerns. I propose that the use of AT/AD within a dance performance context may add a relevant, complementary, and effective lens, or even a type of methodology, for future research into how these multiple environmental, personal, and psycho-social variables coalesce in vivid and corporeal ways for the user of an AD. On the dance stage, ADs, such as wheelchairs, are being refashioned through performance rigor and creativity, signaling new potentialities for design.

In the fairly recent developments in interaction design, the body in motion has become a central topic of discussion (15-17). Interaction Design (ID) is generally defined as the design of user interfaces for machines and software, such as computers and electronic mobile devices. It focuses upon the design of digital experiences and environments, while Kinesthetic Interaction (KI) design is defined broadly as "when the body in motion experiences the world through interactive technologies" (15). Practitioners and researchers in KI design have come to realize that stilling the body's motion potential during interaction with a device or the environment is not ideal for physical health or fulfilling engagement in the world (15). Instead, these practitioners are looking more broadly at what the whole body is doing, and how it is doing it, when interacting with computer-based technologies, for instance. I submit that these body- and movement-centered design approaches, such as KI, strongly direct attention to the experiential landscape of dance, in which the body in motion is the primary agent of meaning-making. Dance, in its qualitative and embodied movement artistry, suggests a design approach more intimately linked to the desires, intentions, and expressions of the human soul — the deep inner landscape of a person's identity. Because of this emphasis, this analysis focuses on how the performance of dance might help shape the future transformation of wheelchair design (and object/device design in general).

A PLACE FOR DANCE IN THE DESIGN WORLD

In a personal email communication on April 24, 2014, with power chair dancer Frank Hull (also a research participant), in which we were discussing the nature of disability, he queries:

> What would the world be like without disability or illness? It would be tragic because I would not be the person or the dancer that I am today. For me a world without physicalities, sexualities, spiritualties and different points of view would be

rather boring. Let's take the simple example of my mobility device. Why invent such a device if people like me did not exist?

Frank's comment reminds us that innovation is driven by the existence of human differences, and disability, in particular, causes us to think in new, productive ways about innovation. Additionally, as a dancer, Frank strives towards finding ways to truly integrate his body with his device. His expressive and athletic goals in dance further challenge the device design and the possibilities for invention. The dance context is uniquely positioned to help reveal and challenge issues of embodiment with the AD, enlivening the intersections between bodies and devices.

Intriguingly, the areas of concern for AD effectiveness, such as "individualized meanings," "psycho-social" factors, and "personal needs and preferences" identified in conceptual models for AT (39-42), materially manifest in the embodiment of dance. Dance is a landscape in which unique bodies, including bodies of disability, explore their experiences of embodiment with and without devices (assistive or otherwise). Embodiment is the notion that the body, in all of its tactile-kinesthetic sensory qualities, generates meaning-making and is a central and primary source of knowledge (6,43). Dancers are engaged in a constant act of embodying, generating, and expressing ideas first and foremost through nuanced qualities of the body in motion. In this act of moving and bodily interaction, an individual comes to know self and environment (6). The embodiment experience in dance has been referred to as "indwelling awareness" as well as a "style of knowledge" (43,44). Embodiment is an inroad to identity, to desire, to value formation, to body image, to competence, and to a sense of agency, many of the variables discussed with regard to AD use and design (11,45). This is where the dance lens intersects with some of the contemporary ideas in the AD literature. More importantly, dance physically epitomizes these ideas, modeling an active representation of human-device integration through embodiment.

Additionally, in surveying an array of select design paradigms, including universal design, inclusive design, ability-based design, emotional design, human-centered, and user-centered design, the common philosophical aspect they share is a focus on the personal attributes and needs of the individual, recognizing human diversity first and foremost (13-23). Further, ID and KI design place emphasis upon full bodily movement as a fundamental point of departure for computer-based design. These contemporary design paradigms reside in contrast to traditional engineering design approaches, which have often focused their priorities on utility, safety, reliability, cost, and efficiency and have tended to be driven by ableist perspectives (14). Also, with regard to AD design, the user-centered design paradigms are situated in contrast to a strict medical model approach, in which the body's perceived functionality is evaluated through able-bodied norms, while other issues of quality of life and the unique, expressive life of a person are largely ignored in the prescription or design of the AD.

Dance pushes these user-centered design paradigms exponentially further. As a moving art form comprised of human bodies, dance activates the theoretical, crystallizing design possibilities in a material way. It gives form to a concept, making it visible and palpable. Dance forces us to grapple with the inevitable bodily assemblages it produces and their meanings to the mover and the viewer. Because AD design (and, in fact, all types of device design) involves human bodies in motion, dance can play a significant role in the world of AT/AD design. Dance paired with disabled bodies radically ignites the possibilities of design.

I assert that when the duet between dance and disability is placed in relationship to AT design, at least three important aspects surface: 1) The device as "medical aid" is transformed and re-defined as a creative, embodied instrument of expression and art-making; 2) the social and intercorporeal facet of AT is foregrounded; and 3) the importance of the moving body is magnified, with attention to the spatial illuminated. All three aspects confront negative stereotypes of disability and socio-political barriers while re-orienting design priorities. Therefore, I argue that dance is perhaps the most radical and the most radically positioned for inciting productive, helpful change in how design is conceptualized and how individuals with disabilities are frequently viewed.

Assistive Device as Medical Aid Transformed in the Act of Dancing

ATs and ADs, in the broad conception asserted earlier, have been present in dance since its beginnings. Choreographers and dancers frequently sought out bodily extensions in the form of unique costumes, fabrics, headwear, footwear, and transport devices, such as flying wired extensions, to expand their movements and artistic potential (46). Chairs (including rolling chairs) are regularly used in the modern/contemporary dance genre as choreographic devices. Therefore, in dance, the incorporation of objects or devices into the body is nothing new. One has only to look at the extensive use of devices and apparatus utilized in Cirque du Soleil to see a heightened representation of the way dancers can engage with objects and devices as artistic motion facilitators. In this regard, dance enacts the notion of a creative, embodied design on a regular basis. Given the consistent use of bodily extensions in dance, it would not seem unnatural to include an AD, such as a wheelchair, in a dance context.

The way in which the device is used in dance suggests a very different conception of an AT/AD as a "medical aid." Medical aids are traditionally understood as utility-oriented devices meant to fulfill basic activities of daily living: simply moving from point A to point B. They often are associated with a negative stigma and symbolize a person's lack of capacity or otherwise non-normative status (39,40). In the dance context, medical aids may be reimagined as aesthetic elements serving creative purposes, such as flipping the device over or upside down to enable new formations and interactions or using the device as a rhythmic element. What the AT/AD is and how it is supposed to function may be completely altered in the dance context. The wheelchair, crutch, or cane is transformed as a creative, embodied instrument completely outside the realm of traditional rehabilitation. To exemplify the preceding points, I discuss some of the feedback from several participants who took part in the research. For the purposes of the discussion in this article, I excerpted relevant quotes about AD relationships, which my research participants described through their written questionnaires and verbal discussions. For a more extensive discussion, including information about the prototype chair innovation which participants also tested, see Morris' dissertation (4).

The participants described the positive ways in which dance influenced their approaches to their mobility devices. One participant, a manual wheelchair dancer with AXIS Dance Company, described the device as a "partnership growing over time," in which limits are constantly being explored and expanded. He stated that "dance has immensely increased my ability to control and maneuver my wheelchair." Another research participant, a power chair dancer, described the desire to inject his "soul" or "spirit" into the chair. He seeks this embodied integration and this ideal in how he explores the device through movement as a bodily "extension." He also described the ways in which dance incites him to explore new moving possibilities with his chair in each new piece of choreography, such as extending his body horizontally across the chair and removing the back rest. His chair has further been mechanically and programmatically adjusted to better address his creative goals in dance. A third participant, a crutch user, described that, over time, he has "accepted" the device as "a part of me." He now associates the device with pride and sees it like a "pair of shoes." In addition to instilling confidence, dance has also supplied him with new balancing options in using the device in his daily life. A fourth participant, a classical Chinese dancer and manual wheelchair user, described her device as a "helper" and referred to the fact that working with it in dance has helped facilitate her ease of use in daily life due to the smooth transitions and challenging movement sequences required in dance. For these dancers with disabilities, the dance context enabled a new way of seeing and exploring their mobility devices, thus obliterating their medicalized association and revealing the embodiment aspect of the device experience in dance.

As a point of fact, it is important to note that all the participants in this research made technological adjustments to their devices because of their creative explorations in dance and the desired embodiment they seek. Moreover, in their verbal comments and written responses, they described how future design possibilities could enhance their expressive and performative potential. The crutch dancer seeks a tip with less slippage and a chrome finish to reflect the

movement of light; the power chair dancer seeks a refinement of oneness with his device, including greater speed regulation and a desire for a hands-free control; and the manual chair user seeks a balance between stability and close interactive motion with other dancers, an issue related to wheel design structure. Similarly, dance performer Bill Shannon, the "Crutchmaster," uses shock-absorbing fuel hoses at the bottom of each crutch to provide an improved grip while mobilizing through space (47), and Kitty Lunn, artistic director of Infinity Dance Theatre, describes the specialized nature of her manual wheelchair (i.e., very low back support, no brakes) to enable as much upper body mobility, ease of motion, and bodily control as possible (verbal exchange with Kitty Lunn, during a rehearsal of Infinity Dance Theatre in New York, July 8, 2016). She is interested in an aesthetic that emphasizes the dancer and not the apparatus, so she has made changes to the chair that de-emphasize the materiality of the chair and heighten the way her body can create motion with it. Through these adjustments, Lunn has found ways to maximize her arms and upper body movement while keeping the chair in motion and reducing constant hand to wheel propulsion. The 90° angle of the seat and the very low back-rest both contribute to making her more visible than the chair Additionally, her choice of five-inch caster wheels and non-cambered large wheels are specific to her goals for accuracy in directing the chair straight forward and back and for turning in a tight circle (phone interview with Kitty Lunn, August 2, 2016).

Explorations in dance with ADs have taken some time to evolve to the current point, in which the device is used more innovatively and expressively and abled/disabled binaries have been aggressively broken. In some earlier dance works and in some continuing practices, the device is used conservatively, enforcing normative expectations and nothing more, aligning with traditional assumptions about what mobility devices and disabled bodies do and do not do.

Disability scholar Telory Davies expresses that dancers with disabilities who use aids create "new versions of the dancing body" as technology-assisted bodies (47). The "new version" and "new aesthetic sensibility" Davies discusses could also be seen as not only challenging disability and dance perceptions but also equally challenging AD design. Dancers with disabilities who use aids not only create "new versions of the dancing body" but also create new versions and models for AD design (47). There is a reciprocal effect occurring when dancers who have disabilities engage with their ADs. Multiple transformations are being enacted, both bodily and in device possibilities, prompting questions, such as the following: How can the crutch or cane design better enable falling/leaning, bodily suspension, and weight shift? How can the wheelchair support a wider palette of speed and force dynamics (e.g., percussive and adagio movements) as well as control options for maximum mobility? How might the wheelchair fly or jump/elevate and provide new spatial options? How can the form of the device spontaneously morph and respond dynamically to the individual's bodily movements? How can these new designs promote new ways for the human body to move in diverse future environments?

Intercorporeal Facet of AD Design Highlighted

In viewing the contemporary work of professional physically integrated dance companies, such as AXIS Dance Company, Dancing Wheels, and CANDOCO, another important aspect emerges with regard to dance and AD use beyond the creative embodiment and transformation of the device out of its medical aid association. This is the interplay between disabled and non-disabled bodies and their related use of the AT/AD, or what I call the intercorporeal aspect. Intercorporeality, a notion traced to the work of Merleau-Ponty, pertains to the way in which body boundaries blend into a shared space of exchange and meaning-making between people (12). It suggests that bodies reciprocally affect one another in organically interconnected and palpable ways. Philosopher Lisa Käll uses the concept of intercorporeality to explain shared pain responses between people. She summarizes:

> An intercorporeal understanding of bodies shifts focus from individual bodies to the constitutive relations between them. The notion challenges ideas of the body as a self-enclosed discrete entity with distinct boundaries and instead brings out a corporeal interconnectedness as the very ground for the individuation of bodies. (48)

Likewise, scholar Kelly Fritsch urges a "relational ethics of inter-corporeality," foregrounding the importance of relational realities between bodies for all but especially in the lives of those with disabilities (49). She critiques independent living models, which "assert a normative encounter between autonomous and sovereign selves" (49). She counters negative perceptions of caregiving and care receiving and explores the "intimate assemblages" involved in attendant care, in which bodily boundaries blend and extend. She suggests that the emphasis in these relations should be "not on what you can do for me, but on what we can create together" (49). I extend these intercorporeal notions to dance by thinking about how the AD is corporeally involved with not only the user but how the device is shared amongst multiple bodies, once again ultimately affecting design conceptions for the AD.

One example of the intercorporeal use of the device is in a choreographic work by Bill T. Jones, created for AXIS Dance Company, in which both disabled and non-disabled bodies move in and out of wheelchairs while performing various movement sequences (47). Instead of wheelchair dancers remaining in their chairs, they slide out of their chairs to the floor and exchange places with non-disabled dancers. Whether this exchange is meant to signal the fluctuating nature of disability and ability or not, I am not sure, but it certainly prompts the audience to question whether the device is strictly for one person's body, stretching traditional binary assumptions. Another example may be seen in a different AXIS dance, in which non-disabled dancer Sonsheree Giles extends her body in space and spins horizontally atop the wheel of Rodney Bell's chair in Alex Ketley's Vessel (*Portland Press Herald*, August 2, 2010, "Physically Integrated AXIS Delivers Moving Performance").

Wheelchair dancer Bell flips the chair over and places himself in a side-lying position while Giles adeptly suspends her body across the wheel as if flying. The chair becomes a shared mobility partner in this context. Similarly, in another duet between Bell and Giles, (performed on *So You Think You Can Dance* in 2011), Giles leaps across and onto Bell's back while he is moving his chair across the space. He quickly spins the chair in place while Giles continues to balance and suspend her body on his back in a prone position. The momentum of the chair spin helps Giles' movement evolve until she eventually rotates off Bell and onto her feet. Additionally, in a dance by Ihar Kisialou and Hanna Harchakova, European and World champions in wheelchair ballroom dance, Ihar picks the entire wheelchair up with Hanna in it, spinning her in the air with the chair against his body while he turns. This act emphasizes the embodied nature of the chair with both bodies. All three bodies (Hanna, Ihar, and chair) become part of that intimate, emotional moment (live performance for "A New Definition of Dance," October 16, 2015, University of South Florida).

Similarly, when Hanna and Ihar perform ballroom dance movements with arms linked, the chair motion also becomes a consequence of the pressure and force directed through their embrace – highlighting the device as a shared, intercorporeal element. In *Divide*, a dance work by Marc Brew and commissioned by AXIS Dance Company, intricate trio and duet sequences depict the way multiple bodies weave through and merge with the device as they all glide fluidly through space together. At one point, two standing dancers intertwine their limbs with a wheelchair dancer so that they circle as one unified whole, and then one dancer launches the front of her body across the back of the wheelchair dancer to ripple onto the other side as another dancer follows with a supple back walkover. All three bodies sustain a point of contact throughout, creating a moving amalgam activating and influencing the motion and momentum of the wheelchair. The chair's motions become subsumed into the activity of these bodily assemblages, thus attuning the viewer to the connections between people (live performance at the Florida Dance Festival, June 24, 2016).

Further images from the dance repertory of CANDOCO Dance Company depict a wheelchair dancer lying on the floor with wheels upended while a presumed non-disabled dancer holds the lower frame of the chair to tilt off axis with leg extended to the side. His standing foot is anchored by the hand of the wheelchair dancer; the effect is that the boundaries of both bodies blend (image from Alexander Whitley's *Beheld*). Whether dancers are pulling, pushing, lifting, suspending, flying, inverting, and/or balancing with each other, they both negotiate the use of the

AD together. It becomes an integral, shared partner in the entire bodily assemblage.

Interdependence between bodies is portrayed in these interactions, opposing the dependent-only view of disability OR the independent-only notions of disability. As symbol, this staged interaction of abled and disabled bodies flowing together in, with, and through various devices counters the separation systems produced in society, such as the disabled-only bathroom stalls and parking spaces, which, while well-intentioned, continue to produce ideas of isolation and separation between normative bodies and others (50). Instead, in dance, audiences witness the AD being equally used by typical and atypical bodies, those appearing with and without disability. In AD design, there is a tendency to place focus mainly on the individual user, forgetting the other bodies with whom that user will contact through and with their device. For instance, while a design might enclose or restrain the user for safety, how does the design also attend to the parent, friend, child, and/or spouse who wishes to have access to the person for something as simple as a hug, physical affection, physical play, or collaborative task sharing? How are both people's mobility enabled by the design of the AD? For example, in the design of most manual chairs, handles for pushing are located at the back of the chair. While logically functional, this position provides the caregiver or friend with limited interactive capacities if they are behind the chair pushing. If interaction between bodies was considered foremost, the design might enable side by side engagement, supporting eye contact connection and easier verbal exchange.

Additionally, if enclosures for the chair (i.e., side and back support structures) and appendages of the chair's "body" (i.e., arm and footrests) were made more porous or more easily removable and mutable, thus creating morphability, interactive options might be easier. There is also the issue of materiality: What types of materials would most encourage touch interactions? Metal and hard plastic are usually not the most affection-eliciting materials. I have seen a child attempt to sit in their parent's lap in the wheelchair or a friend or spouse attempt to ride on the back of the chair as a natural tendency for human play and affection, but the chair's structure does not facilitate those efforts very well. How could the AD better enable those natural inclinations if it were designed from an interactive/intercorporeal perspective at the outset? For integrated dance purposes, perhaps the device design might also better facilitate the intercorporeal goals by providing more malleable contours or surface areas for physical points of contact and weight sharing as well as new types of motion (i.e., vertical, lateral, aerial). Ultimately, integrated dance suggests that the device be seen as part of a relational matrix.

Spatially Versatile Body in Motion as Impetus for Design Thinking

In this section, the third aspect of the dance and disability duet, the importance of the moving body and its spatial implications for design thinking, is discussed. The art of dance is dependent upon change, specifically changing movement dynamics and changing configurations of forms in space. Dance lives within the space of change. This ability to create change is one aspect that ADs, such as wheelchairs, frequently lack. Dancers and choreographers frequently seek more complex and nuanced motion options in terms of space and time in order to effectively communicate ideas. Simple motions with minimal variation are often limiting for the expressive purposes of dance. Professional dancers with disabilities attempt to use their devices in dynamic, integrated, and alive ways, suggesting new design transformations for the device, both in and outside of dance. For instance, in a high-intensity athletic work with four male dancers, performed for "A New Definition of Dance" at the University of South Florida (2016) (choreographed by Leymis Bolanos Wilmott), wheelchair dancer Dwayne Scheuneman performs multiple types of handstands and off-centered movements in his wheelchair. At any moment in the piece, the device, as well as Scheuneman's body, is reoriented in space. He pitches himself laterally, touching the floor while the wheels lift off the floor. There are times when he is nearly upside down and his wheels are upended, and he is lifted at times. Wheels are also removed from the chair, heightening some of the spatial choreographic opportunities for the quartet and lending new motion opportunities. The kinds of movement invention risks professional dancers with disabilities are experimenting with in dance point to the possibilities of new technological

innovations to better facilitate these movement aspirations. Research participants in this study often relayed the desire for a greater degree of spatial access, including height change, and expressed the need for more variation in speed in using their devices. On a practical level, the need for the device to support bodily movement and spatial reorientation is highly important to address issues of circulation and general health.

In the LMA framework, the category of Space relates to all aspects of where the movement is occurring, with this category having high relevance for the spatial implications of ADs. Rudolf Laban clarifies:

> Dance is the transition into a world in which the illusory, static appearances of life are transformed into clear spatial dynamism. Awareness of this spatial world and its exploration open up a horizon of unexpected breadth. From the simplest motion to the artistic creation of dancing, the flowing stream of movement expresses dynamic space, the basis of all existence (34).

From an LMA perspective, therefore, traditional chairs possess limited spatial possibilities and, thus, limited capacities for embodiment. In general, the utilization of space is limited to three spatial directions (forward, backward, and rotation). These chairs frequently provide the user with a one-dimensional or two-dimensional experience of movement, rather than a three-dimensional, planar experience of movement. For example, the wheelchair user can travel straight forward in the traditional chair, but the chair does not inherently enable a forward and up motion or a forward and down motion (planar experience). Also, the wheelchair user can travel to some degree in the horizontal plane (i.e., circling or rotating in the space) due to the turning capability of the chair, but a three-dimensional spiral motion (rotating while moving upwards or downwards and condensing or expanding) is not a feature the chair inherently enables. Also, most actions of the chair usually require users to turn their bodily facings as well (some dancers are inventive in how they address this by twisting the upper body, but not all bodies have this capacity). Thus, the whole unit of the chair and body must turn due to the wheelchair structure and the users' torsos must face the direction they are going. If the seat rotated independently from the base of the chair, new spatial facings would be enabled (visualize a traditional office chair with a rotating seat), and a user could travel any direction and reorient their torso facing without redirecting the whole device.

One problem engendered by these spatial restrictions is that it may produce an embodiment experience that is more static and roboticized due to the predominantly one-dimensional orientation and engagement in space. The chair user is persistently in mid-level space and often moving strictly in a sagittal (forward-backward) manner. Other options are not easily available because other spatial options were not designed into the technology. This is why, I believe, some dancers and choreographers have sought to turn the chair upside down, tilt it on its side, or use wheelie techniques (lifting the front part of the chair up): They are seeking new spatial orientations and greater spatial dimensionality.

Bodies of disability prompt new uses for the device as dancers turn their wheelchairs upside down and on their sides, or spin them quickly and sharply in different directions, or tilt the chair off axis. Dancers move in and out of their wheelchairs to the floor, and components of the chair (such as wheels) may be dismantled and reassembled as part of the choreography. Dancers do not just sit vertically in their chairs; they upset the status quo expectations. They change the action possibilities and enliven otherwise static space with vitality.

Additionally, in consideration of the design aspect of height change, most wheelchairs, both powered and manual, usually do not incorporate height change. It is not considered an essential feature but, rather, an add-on or embellishment. More recently, top companies such as Quantum Mobility have begun to embrace the importance of height change in their wheelchairs, recognizing the combined social and functional aspects. I witnessed a live demonstration of Quantum Mobility's latest powered wheelchairs, specifically their 'iLevel' wheelchair, at National Seating and Mobility's Annual Wheelchair Symposium in July 2015 (Nashville, TN).

However, funding sources, such as Medicare, do not view height change as an essential element (unless deemed medically necessary). Because of the lack of

height change in most chairs, the wheelchair user frequently exists in a static, lowered position in space. Those engaging with the wheelchair user either tower above the seated person, in a panopticon-like position, or kneel down in order to meet at eye level to connect. The bodily positioning in space asserts particular meanings, reinforcing a system of hierarchical marginalization (51-54). Wheelchair users are "looked down upon" spatially. Individuals of shorter stature have often suffered prejudice in society, a form of discrimination called "heightism" (51-54). If wheelchairs were built to raise the user above most standing individuals, how might the perceived power relationship shift? In manual wheelchairs, I have seen individuals tilt the manual wheelchair off its axis, and I have choreographed pieces where the wheelchair is tilted to the side or back, causing the dancer to change level in space. I have also choreographed pieces in which the wheelchair (with dancer) is lifted high into the air. This is, in my interpretation, an effort to deal with the otherwise spatially restricted design of the wheelchair. It is evidence of how dancers and choreographers creatively reimagine the device design. Thus, what if the device were better designed to enable these capacities from the outset?

Luca "Lazy Legz" Patuelli is a dancer with a disability whose use of crutches aptly illustrates the relationship between organism and object as an impetus for creative design. Patuelli was one of the research participants in my study, and he participated in a full-length performance of international professional dancers with disabilities in an event entitled "A New Definition of Dance" (October 12-17, 2015, and October 14-26, 2016, at the University of South Florida). In his breakdance performances, Patuelli uses his crutches like another pair of legs. In breakdancing, dancers change their body support surface quickly and in variable ways, transitioning smoothly from back, to head, to stomach, to leg, to arms, often creating a cyclical flow of weight transition from one body surface to the next. The crutches produce an entirely new repertoire of movement within this genre of dance. Patuelli adeptly balances on them and suspends his whole lower body up in the air. He also uses his crutches to enable a pendulum-like bodily swing of the whole lower body, a movement not usually seen by typically-bodied dancers. Patuelli masters the use of the crutches to finesse the stability and balance needed for his body to variably swing, wrap, hop back and forth between legs, and traverse space quickly. In one of his signature moves, he nimbly releases both crutches and hovers in mid-air, letting the crutches fly away. He sweeps down to the ground, catching himself with the weight of his arms. Rather than appearing at all limiting, Patuelli makes the crutches a creative instrument of expression, a bodily movement extension, supporting new forms of motion and highlighting a spatially versatile body. Patuelli's creative use of crutches transforms them from a rehabilitative/medical model, which pre-supposes one type of use, pointing towards new innovative potential. Furthermore, Patuelli's dance engages rigorous risk-taking, which subsequently requires a certain robustness for the device through which he is working. This need for robust ADs in dance could also support the robust goals in device design for daily living activities: Dance promotes possibilities for full-bodied action in everyday life.

CONCLUSION

First and foremost, I want to recognize the value of wheelchairs. Their initial introduction as an AT has been a significant advancement to assist and improve the isolated conditions many individuals with disabilities have experienced in trying to become mobile in society, and I am in great appreciation to the designers and AT specialists who have worked to enable accessibility in this manner. It is not my intent to disparage these efforts in the least; rather, I hope to encourage a more expansive examination and more intense, higher priority focus towards improving existing technologies by attending to embodiment and interpersonal aspects. Advancements in this area are necessary in order to continue moving towards inclusive practices and processes in an ever-growing world of notable diversity.

I look forward to seeing and being a part of the continued landscape of design innovation in the 21st century. Choreographers are designers of form and motion and, as such, contribute a useful perspective to the field of design. My research aligns with the existing human-centered/user-centered momentum in the design field by pointing to a dance-based design paradigm attentive to the meaningful nature

of human movement experience as bodies with and without disabilities dwell and interact in space. Dance performance, as illustrated in this paper, charts new terrain with regard to AT due to the emphasis on creativity, individual expression, intercorporeality, and sophisticated motion dynamics. In the integrated dance domain, disabled bodies and nondisabled bodies of many types negotiate their relationships in space, revising hierarchical divisions and expectations while pushing the devices to do more and be more. The union of dance and disability, through the genre of integrated dance, suggests new design conceptions for ADs both in and outside of dance while it simultaneously reframes negative perceptions of disability.

In sum, the wheelchair or AD, in its contours, its hardware and software, its responsiveness, its directionality, its control system interface, its size, and its overall form and parts, plays a significant role in conditioning the embodiment possibilities of the user and those interacting with the user. It conditions how movement qualities are negotiated and how space may be experienced. From a dance lens, then, one might ask the following questions: How does the AD design enable creative embodied expression rather than just functional utility? How does the AD design attend to and support dynamic and intimate relationships with others? How may the AD design be transformed aesthetically and tactilely to better match identity, interests, and desires of users? How is the AD a responsive entity, supporting the spatial versatility and health of a human body in motion?

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