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CHAPTER V

DANCE AND DISABILITY MEET ASSISTIVE TECHNOLOGY

Introduction

In the previous chapter, I explored the faciliatory effects of the dance and disability dyad, as each one prompts the other to challenge the status quo. In this chapter, I move towards understanding a third significant variable in relation to the dance and disability dyad: the assistive device. I probe into how the assistive device is re-imagined through the dance and disability dyad, ultimately suggesting new notions for assistive technology design theory/practice. Assistive technology, 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/needs. This means the pencil, the phone, the computer, the toothbrush, as well as cooking utensils, bicycles, cars, and planes; all fall into the category of "assistive technology." We all, in fact, utilize assistive aids to live our lives.

In the construct of disability, assistive technology may encompass a vast array of possibilities, including structural alterations (i.e., changes to the original structure of a physical environment such as ramps or roll-in showers), assistive devices (e.g., hearing aids, vision aids, and wheelchairs), material adjustment (i.e., large print reading material), and environmentally-based behavioral modification (i.e., supportive features such as noise reducing rooms or apparatus inhibiting the amount of stimuli from the environment for individuals with autism) (Fuhrer et al. 2003). For the purposes of this dissertation's discourse, I will specifically place

emphasis upon “assistive technology devices” (ADs) as 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” (Alper and Raharinirina 2006). Further, I will focus upon the wheelchair as a prevalent assistive device.

Assistive device design has evolved in tandem with constructions of disability. As ideas of disability were questioned, designs were concurrently questioned, prompting their evolution. Adding dance to the frame creates another powerful variable for thinking about design. As I will argue toward the end of this chapter, dance in tandem with disability is positioned as a radical catalyst for change in AD design, thus creating new ways of conceiving and working with devices. Furthermore, dance, probably more than any other area influencing assistive device design, has the power to destabilize the abled/disabled binary and untether the notion/practice of AD design from the habitually rooted domains of rehabilitation and medicine.

In order to pursue an assessment and understanding of AD design and its relationship to dance and disability, I will first explore a historical overview of the development of assistive devices, specifically wheelchairs, and their key influences in the United States and United Kingdom. Next, I will describe several contemporary, conceptual models and design paradigms relevant to AD design. Finally, I will articulate how dance and disability intersect distinctly and uniquely with these ideas to promulgate a new design lens.

Historical Snapshot: AT/AD Development

The use of rolling devices to transport individuals with disabilities is first known through the use of the wheelbarrow, invented and utilized in China (Kamenetz 1969). The earliest recording of the use of a rolling chair is traced to the depiction of a man in a chair with

three wheels from China in 525 A.D. from a stone sculpture (Kamenetz 1969). There is a notable gap in historical recordings depicting the use of wheeled chairs after the 6th century until the 16th century when references are found in drawings and literature in Europe. Some sources suggest that wheeled chairs probably entered Europe sometime in the 12th century with the wheelbarrow. In 1595, King Phillip II of Spain is depicted through an artist's drawing with his own wheeling chair with foot rests, called an "invalid's chair." In 1760, the "Bath chair" was invented in Bath, England which was a light carriage with a folding hood and three or four wheels. The first appearance of wheelchairs in the U.S. occurred during the American Civil War, and in 1869 the first U.S. wheelchair patent was issued. In 1916, the first motorized wheelchair was produced in London. In 1933, the first lightweight, steel, collapsible wheelchair was invented by Harry Jennings and his disabled friend Herbert Everest, who were both mechanical engineers (Kamenetz 1969). Wheelchair design has seen the greatest changes in the 20th century with the advances in power chair technology. However, the evolution of wheelchairs should not be viewed as simply "technological," since there are inevitable political and social forces which shaped these evolutions (Woods and Watson 2003). In the next sections, I describe explicit forces of influence for AD design, including medicine, war, sports, and disability activism.

Medical Model Influence

In medicine, disabled bodies in general were often treated as "specimens," a thing to be analyzed, scrutinized, categorized, and dissected in the laboratory. The "medical model," as it has come to be called in disability studies, situates disability predominantly in the person as an isolated, problematic, static condition to be fixed, or at the very least managed in predictable ways (Davis 2013). The "social model," on the other hand, situates disability predominantly in social/environmental factors (e.g., social attitudes and conditions as well as the built

environment) (Albrecht, Seelman, and Bury 2001). The social model perspective grew out of disability activism and disability studies discourse as a reaction against the medical model.[1]

Historically, connotations of disability aligned with the medical model and often assumed that a disability permanently defined a person's condition as not able, passive, and dependent, as well as economically burdensome. Things, services, systems, policies are designed for what designers expect people to do/be or expect people to want to do/be. Assumptions are made. Values are placed. Designers in positions of power (e.g., those in media, business, or government) in large part shape how human beings are imaged. Disabled people, historically, were viewed as *not capable* of attending school, being employed, or partaking in any real way in social and recreational activities; thus, there was no need to make provision for these individuals or to allocate resources in the form of assistive technology devices or anything else. They were categorized as sub-human in many cases, and only charitable organizations, some families with disabled children, and select health professionals seemed to recognize the need to both care for and promote equality and life opportunities for individuals with disabilities (Albrecht, Seelman, and Bury 2001). It was not until national governments took a more active and participatory role in assistive technology development that it developed on a larger scale. One reason governments became actively involved is the subject of the following section.

War-related Influences

War was one of the most significant socio-economic forces in shaping wheelchair design. In this context, the focus was mainly concentrated on rehabilitating injured male veterans. World War I brought the attention of disability to the fore. Suddenly, government had a moral and legal

[1] Reference Chapter III Disability Studies: Revealing Bodies, Confronting Space, Claiming Power for discussion and definitions of the social model and medical model.

obligation to care for injured veterans. Advances in medical science were also enabling people to live longer with disability. In the first developments of wheelchairs, the construction of disability began to subtly shift towards the idea that a person with a disability *could be* capable and independent with technological aids. However, it was clear that aspects of the technology posed limits for users as well. Standard manual wheelchairs possessed limits with regard to their ability to be used outdoors and with regard to the often cumbersome nature of the push-based propulsion systems. The Everest and Jennings chair (1933), through its lightweight and tubular frame, helped make the chair lighter and easier to transport; however, it was breakthroughs in power technology which helped individuals access outdoor environments with more ease (Woods and Watson 2003). The first version of this power technology was a motorized attachment, which would fit a standard, folding manual wheelchair (Woods and Watson 2003). By the end of World War II, electrically powered wheelchairs were on the market for indoor/outdoor use.

Beyond pressures from disability rights advocates, governments saw the economic value in rehabilitating veterans back into the work force. They also saw the advantage of asserting nationalistic pride and hope by restoring veterans' disabled bodies. The images of these restored disabled-abled bodies could potentially mollify and/or justify the effects of war (Fritsch 2013). The technology facilitated the new emerging construction of disability prompting autonomy, independence, and social access for disabled individuals. But, while the technology produced benefit, it simultaneously revealed and created other conflicting issues of concern. For instance, the governmental provision of wheelchairs to male disabled veterans meant that ability in this respect was problematically tied to one population only. Other disabled bodies were less visible and, thus, less important. Disabled male veteran bodies warranted AD provision; others did not.

However, resource allocation began to change with the effects of the polio epidemics of the late 1940s and early 1950s, and thalidomide in the 1960s (Fritsch 2013; Woods and Watson 2003). Additionally, developments in antibiotics, such as penicillin, extended the life of many with severe impairments, increasing the concern for disability beyond disabled veterans. Rehabilitation engineering and rehabilitation services grew significantly during this time as a result, also facilitating technological development and AD provision.

Another way in which wheelchair developments through government provision played a liberating yet conflicted role in the disability rights landscape was when serving as a "one size fits all" solution. "One size fits all" assumes a solution for *all* types of disabled people and *any* and *all* other access issues. As K. Fritsch describes, "The wheelchair was a tool of aggressive normalization, even as it simultaneously marked the individual as different." Fritsch asserts that disability appeared only to disappear in these contexts (2013, 138). In other words, the rehabilitative process and the AD as wheelchair "solved" the problem of disability so that it could become a non-concern again. The comprehensive needs of those with disability could be veiled with the wheelchair staged as THE socio-political agent of change. Issues of employment, transportation systems, and architecture were still problematic however, as were issues of access related to other types of disabilities (i.e., intellectual or sensory). Therefore, wheelchair/AD developments had and continue to have complex and contradictory effects, enabling while simultaneously un-enabling the disability community.

Disability Activism Influences

As civil rights movements for blacks and women emerged after WWII and gathered momentum to combat negative connotations of difference, notions of disability were also altered. The notion of difference being equal to and not less than within the civil rights movement

implicitly supported the disability rights platform. When the disability rights movement pushed forward in the late 1960s and early 1970s, explicit notions of disability in its varied forms were directly challenged (Albrecht, Seelman, and Bury 2001). Advocacy organizations such as the Paralyzed Veterans of America (PVA) in the U.S. and the Invalid Tricycle Association (ITA) in Great Britain helped to further re-craft the construction of disability thus prompting more consideration of environmental factors aligned with the social model and redefining independence for individuals with disabilities. This shift from viewing disability as a medical phenomenon to viewing it more as a social concern also impacted wheelchair innovation (Woods and Watson 2003). The view of the disabled as more abled/independent through AD use became furthered through activism, which reciprocally pushed the technology forward.

The 1970 Physically Disabled Students Program (PDSP) in Berkeley, California was an organization run for and by disabled people. PDSP provided personal assistants, repaired wheelchairs, and assisted in funding resources for disabled individuals (Woods and Watson 2003). The PDSP was a precursor to the Independent Living Movement and played a significant role in the disability activism landscape (Albrecht, Seelman, and Bury 2001). In these efforts, as well as the efforts of veterans' associations, disability constructions moved further from the medical model causing the wheelchair to become a political tool for disability rights advocates.

Wheelchair users enacted demonstrations in which they used the wheelchair's presence to physically combat accessibility issues (e.g., inaccessibility on buses). (This type of activism was discussed in detail in Chapter III.) In fact, wheelchair technology revealed the ableist privileging in society even more. From housing to workforce norms, it became clear that designs/designers did not have disabled people in mind. Life was designed upon able-bodied premises, a prejudicial concept known as "ableism," in the disability studies field (Lalvani and Broderick

2013). These premises were built on mythical notions of a society which never aged and whose bodies never or rarely deviated from a particular normative construction (Davis 2013; Fritsch 2013). The validity of these premises was more explicitly called into question when suddenly disabled bodies became more mobile with technology. Their bodily presence literally confronted the false design paradigm of privileging normalcy, critically challenging the intention behind these designed life spaces. From the physical environment (e.g., stairs, doors, sidewalks, bathrooms, work stations) to the social environment (i.e., access to recreation and social engagement activities), wheelchairs illuminated other barriers to access for all those sharing the environment together.

Wheelchair companies saw the advantage of this growing atmosphere of activism and profited from it. Quickie, a wheelchair manufacturing company, for instance, was a $40 million per year business by 1994 (Fritsch 2013, 139). Initially, much of the resistance to AT and AD development was due to capitalist perspectives assuming that there was not a large enough market; however, what has been revealed through AD development and production is that the market, and the disabled population defining and claiming that market, is much larger than anticipated.

Influence of Sports

A further contribution to AD development is in the realm of sports. As mentioned in Chapter III, the roots of the Paralympics can be traced to 1948, when a doctor by the name of Sir Ludwig Guttman launched a Stoke Mandeville Games in Aylesbury, England as an outgrowth of his rehabilitative work with spinal cord injured World War II veterans (Howe 2008). Initially, these sporting developments were simply tools to be used to help injured veterans return to "normal" social lives and return to the workforce; however, the games began to develop

competitive aims, heightening attention to the skillful prowess of these athletes with disabilities. The Paralympics accentuated the focus on ability and, in fact, promoted the notion of a "super-abled" body, sometimes connoted and critiqued as a "supercrip"[2] image, which overly emphasizes disabled people as heroic and inspirational for "overcoming" their disability/impairment (Schalk 2016). Despite a possible negative "supercrip" image, the Paralympic emphasis fueled beneficial skill development and professionalism for disabled athletes and, consequently, it spurred new technological developments. With sport, AD development became more specialized (Howe 2008). Wheelchairs needed to be adapted to help individuals with disabilities race, play tennis, and fence, etc. (Howe 2008; Pallis 2003). In this context, new technological solutions (e.g., lighter weight metals, new wheel frame designs) emerged to increase speed demands, turning needs, comfortability, etc. More importantly, the broader visibility of people with disability in competitive sports turned these individuals into legitimate athletes.

Further Technological Evolution

According to Woods and Watson, the BEC powered wheelchair, developed by Raymond Biddle, was one of the most successful due to its maneuverability and reliability (2003). In the late 1970s and early 1980s, it "set the tone for powered wheelchair technology" (Woods and Watson 2003, 170). It was noted for its "fold-ability" and lightness, as well as its turning ability. A confluence of factors stimulated its success, including media promotion, responses of users and, in consequence, its profitability. Still, there were difficulties with BEC's use, which prompted newer innovations with the advent of microprocessor technology enabling

[2] For a more thorough understanding of the super-crip narrative and critique in disability studies scholarship see: Schalk 2016.

programmable and remote controllers. These advances created new possibilities for increased further reliability, profit gains, and ease of control (Woods and Watson 2003, 172).

Powered mobility not only brought about changing societal perceptions, impacting policy and resource allocation, it also helped transform disabled people's views of themselves. The newfound freedom and independence created a sense of empowerment for the disabled body. The AD helped embody and physically actualize ability. For some individuals, manual wheelchairs relegated them to being pushed by others, whereas the power chair reformulated independence by supporting the user's sense of themselves as fully actualized, able human beings (Woods and Watson 2003, 172).

In summary, 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. In the process of this evolution, disabled bodies moved from social positions of passivity, dependency, and inequality to positions of improved independence and empowerment. However, while disability was being reformulated to deconstruct abled/disabled binaries, there were simultaneous limitations with this reconstruction. ADs conceived of as "wheelchairs" post-World War I increased the visibility of disabled-abled bodies; however, they also had the problematic effect of marginalizing and excluding other bodies of disability (e.g., vision impaired, hearing, intellectual disability, etc.). AD design became largely focused on wheelchairs to the exclusion of other possibilities.

New issues of access came to the fore as well, such as access to education, work, and recreational activities. Further, difference was simultaneously accepted and reified with wheelchair development. For instance, the provisions of "accessible spaces" for wheelchair users

further boxed in and emphasized the split between "normative" and "non-normative," or "abled" and "disabled" people within shared spaces. The problems and limitations of addressing the full spectrum of disability with effective egalitarian solutions continue to persist in the contemporary milieu of disability and device design. Each technological evolution, while solving some issues, simultaneously creates other challenges, making traversing the technological design terrain a complex venture. One major question then becomes: How is difference effectively acknowledged and fully embraced without reinforcing separation? In the next section, I turn attention to contemporary conceptual models and design paradigms in which this question remains an impetus for further shifts in thinking about disability and the design of ADs moving towards integration.

Contemporary Approaches to Assistive Technology: Conceptual Models and Design Paradigms

In the late 20th century and continuing into the 21st century, AT design/development was influenced by the disabling effects of war, disease, and the on-going socio-political activism in the disability/disability studies field. However, more nuanced concerns arose in the literature calling for more device options in general and options which further increase quality of life (Alper and Raharinirina 2006). Legislation such as The Assistive Technology Act of 1998 (amended in 2004) is one indicator of this direction in more nuanced design thinking due to its reconceptualization of disability. The Act states:

> Disability is a natural part of the human experience and in no way diminishes the rights of individuals to live independently, enjoy self-determination and make choices, benefit from an education, pursue meaningful careers, and enjoy full inclusion and integration in the economic, political, social, cultural and educational mainstream of society in the United States. (Alper and Raharinirina 2006, 47)

The Assistive Technology Act of 1998 also indicates recognition of technological progress as an economic engine with benefits to individuals *with and without disabilities*.

In former modes of thought, disability needs were often thought of as economically burdensome and without benefit or gain to society at large. The reconceptualization of disability as "a natural part of the human experience" suggests a relatively new paradigm of thinking about AT, recognizing it as a global issue for not just select individuals but for everyone. Also, in this paradigm, independence is highly valued, along with education and work-related pursuits as "rights." This later 20th century reconstruction of the meaning of disability is important for framing how assistive technology can ideally serve and enhance the life of a person with a disability.

The voices of people with disabilities are increasingly present in qualitative studies of disability and AT design. Chin and head control systems, tongue control, voice control, eye tracking, and thought control systems all indicate a move toward greater diversity in wheelchair and other AD design (Barea et al. 2002; Huo and Ghovanloo 2010; Megalingam et al. 2013; Simpson and Levine 2002). Smart wheelchair technologies, including Android capabilities, have added additional possibilities for chair operation and, thus, scope of users (Kim et al 2012; Zafar et al. 2014; Milenkovic, Milosevic, and Jovanov 2013; Santhanam and Viswanathan 2013). However, AT/AD design and development still have further to go with regard to effective use, broader reach, and attention to quality of life.

The International Organization for Standardization (ISO) and the American National Standards Institute (ANSI) in conjunction with RESNA, The Rehabilitation Engineering and Assistive Technology Society of North America, have worked to develop standards for assistive device design and evaluation. These organizations are non-governmental, independent organizations made up of voluntary members. The organizations focus strongly on safety

concerns as the ISO website[3] states in their intention: "They [the standards] give world-class specifications for products, services and systems, to ensure quality, safety and efficiency" (2014). One might ask here who is defining quality and how is that "quality" defined? As well, how do safety, quality, and efficiency concerns interact? Or, are they taken as separate, isolated elements? In terms of wheelchair standards the ISO list is extensive and includes dynamic stability tests, braking effectiveness, energy consumption, overall maximum dimensions, weight, turning radius, seating and wheel dimensions, flammability, and an entire host of other measures of concern for the device. The focus seems to be connected to logistical material conditions of the physical environment, but how does this focus interface with the social environment and/or the desires of individuals?

Despite the existence of such organizations of standardization, there appears to be a lack of consistency in how assistive devices are evaluated and, hence, how designs progress or are developed. It is also unclear what the relationship of these practical standards is in connection to various assistive technology conceptual models discussed in the literature. While conceptual models discussed in the literature seem to create a more comprehensive view of disability and assistive device aspects, the regulatory organizations seem to adhere to a more unidimensional, functionalistic view. Perhaps this indicates a chasm between theory and practice. Researchers in the field of assistive technology, who are usually rehabilitation specialists, health professionals, assistive technology professionals (ATPs), and engineers, have called attention to the problem of inconsistency and inadequacy and have focused upon the need to find an adequate "predictive model" for the use and assessment of assistive technology (Lenker and Paquet 2003).

[3] See http://www.iso.org, search "wheelchairs".

Towards this need for developing predictive models, a series of various conceptual models have developed; yet none have fully realized the predictive theory needs for the field. It is not my intent here to perform a comprehensive review of the full variety of conceptual models existing with regard to assistive technology; rather, I am interested in finding basic themes or commonalities in the models which are discussed frequently and then examining how and in which ways design priorities surface in the approaches of these models. Furthermore, I am interested in exploring how a dance lens interacts with these conceptualizations.

Conceptual Models

According to Lenker and Paquet, who conducted and published "A Review of Conceptual Models for Assistive Technologies Outcomes and Practice," a fundamental commonality amongst the models' approaches is the foundational basis of each in social psychology (2003). The person-environment-behavior model proposed by German-American psychologist Kurt Lewin in 1936 asserts that behavior is the function of the person in his or her environment. Assistive technology outcomes and practice models use this idea to address the "fit" of devices in relation to an individual's goals, abilities, and environment. In the assistive technology theory arena, the goal is to enable "congruence of AT devices with individuals and their contexts of use" (Lenker and Paquet 2003, 3). For instance, in the Human-Activity-Assistance Model (HAAT model), four dimensions are considered: human, activity, assistive technology, and context (Lenker and Paquet 2003, 4). The human component consists of sensory, cognitive, motor capabilities, and acquired skills. The activity component consists of self-care, work and school, and play and leisure activities. The assistive technology component consists of a "human-technology interface; a processor; and an activity output" (4). The context

component consists of both social and physical contexts (including temperature, light, and sound). Here, at least theoretically, the importance of physical **and** social space is indicated through concern for environmental factors and the individual's surroundings and contexts in correspondence with the device design. The environmental component also aligns well with the social model of disability. And, for the specific purposes of this dissertation research, it can be noted that the goal for "congruence of AT devices" with body and environment has a parallel in the dance context, where dancers work towards a thoroughly qualitative embodiment of the device in ways that merge all 4 dimensions of the HAAT model: human, activity, assistive technology, and context.

One indication that designs for assistive technology (devices) still have more room for development is the amount of research indicating the rate at which devices are abandoned or underutilized (Phillips and Zhao 1993; Roelands et al. 2002; Wessels et al. 2003). This research is shedding light on the complications of human interfaces with devices and, in some cases, heightening attention to the dynamics of both physical and social space and embodiment concerns. In "Predictors of Assistive Technology Use: The Importance of Personal and Psychosocial Factors," Scherer et al. state that "approximately 30% of obtained ATs are discarded within a year" (2005, 1323). In their study, they attribute this largely to inadequate assessment of the user's needs and preferences and the need to account for personal and psychosocial variables. They recommend (and validate) the use of the Matching Person and Technology (MPT) model as the most ideal way of predicting a match between person and technology.

The MPT model addresses three major prongs: milieu/environment, consumer personal and psychosocial characteristics, needs and preferences, and functions/features of the most

desirable and appropriate technology (Scherer et al. 2005, 1322). The model was developed through grounded theory research with ten adults with physical disabilities (spinal cord injury and cerebral palsy) (Lenker and Paquet 2003). The user, in conjunction with the professional provider, work together over a series of two or more meetings to address these three main areas. The Assistive Technology Device Predisposition Assessment (ATD PA) is one of the assessment forms used and is comprised of 54 items (three sections) encompassing quality of life and well-being questions and personal and psychosocial characteristics questions. The researchers in this study sought to statistically correlate two areas of the ATD PA (and thereby further validate the MPT model). The two areas correlated the quality of life and well-being questions specifically (12 items) with the personal and psychosocial characteristics (33 items) to determine how well these two areas predicted a person-device match. Personal and psychosocial question items ask yes/no questions about mood, self-esteem, self-determination, autonomy, family support, friend support, therapist and program reliance, and motivation to use support (e.g., "I am often frustrated or overwhelmed"), while the quality of life items ask questions about *how satisfied a person is* in such things as social relationships, recreational involvement, freedom to go wherever desired, emotional attainment, autonomy and independence, and fitting in and belonging on a 5-point Likert scale (Scherer et al. 2005). The researchers conclude by suggesting that their research indicates statistical validation of the instrument and thus MPT as a useful model.

Similarly, researchers, such as Pape, Kim, and Weiner, bring attention to how "individual meanings" are assigned to AT, shaping the person's choices in using it (2002). Individual meanings and, thus, AT use may reflect social stigma and symbolize abnormality or may also symbolize a reminder of skills lost or death – "nearing the end" (2002, 15). The authors point to

the importance of reformulating one's self-concept in the process of utilizing an AT. This process encompasses body image, competence, values, and goals. While AT use may enhance independence, it may not match the user's identity. Identity, of course, is also shaped by socio-cultural norms and develops through relational processes with others. Therefore, social expectations and perceived roles, as well as cultural conditions, affect the use of AT/ADs. One study reported that in Anglo-Canadian families rehabilitative "normalization" was privileged over "the happiness and contentment" of the child, with the latter being emphasized in Chinese-Canadian families (Pape, Kim, and Weiner 2002, 17). These cultural preferences then shaped the attitudes toward AT/AD use.

Relatedly, but with exclusive emphasis on the psycho-social impact, researchers in the area of psychology draw attention to the need to examine psycho-social aspects of the design of assistive technology, recognizing the social space in which users engage as significant to how users feel about their assistive technology. Researchers Jutai and Day developed an instrument specifically to measure these psycho-social aspects (2002). Termed the PIADS, Psychosocial Impact of Assistive Devices Scale, the instrument has been validated and utilized by multiple researchers examining device effectiveness and utilization (Jutai and Day 2002). Psychosocial is defined as, "factors within the person and factors attributable to the environment that affect the psychological adjustment of individuals who have a disability" (107). The 26-item self-report scale was developed out of qualitative focused research groups with AT users, literature on personality research, and empirical explorations with the Pleasure-Arousal- Dominance scale.

Also of note in how the PIADS was constructed, is that the researchers attempted congruency with quality of life perspectives based on current frameworks in disability and rehabilitation research (Jutai and Day 2002, 108). Quality of life is defined as "the degree to

which the person enjoys the important possibilities of his/her life," a definition borrowed from Renwick et al. (Jutai and Day 2002, 108). Items on the scale include such concepts as competence, happiness, independence, adequacy, quality of life, frustration, sense of power, and sense of control. The researchers conclude that potentially personal control and self-efficacy are the most promising "psychological conceptualizations for developing a user-focused, environmentally sensitive understanding of AT adoption and retention" (Jutai and Day 2002, 110).

Collectively, these conceptual models for AT practice illuminate a needed, yet complex, path for the evolution of AD/AT design. The researchers point to an entire system of variables which need to be synchronized in order to achieve a successful person-device relationship. For the purposes of this research, I am also proposing that the use of AD/AT within a dance performance context may add relevant, complementary, and effective lenses, 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 AD/AT devices.

Design Paradigms

As can be seen in the preceding sections, researchers are calling attention to the issues of disability construction and device use and challenging design in doing so. In addition to the conceptual models introduced earlier, there are a number of design paradigms which surfaced in the late 20th century and then continued to evolve with specialized delineations. These paradigms often share similarities to the conceptual ideas described in the preceding section, with many having overlapping aspects and terms that are used interchangeably. In general, the paradigms emerged out of the fields of architecture and industrial design with influence from the field of psychology. Universal design, inclusive design, ability-based design, emotional design,

interaction design, and human-centered and user-centered design are all often used terms within these design paradigms and further suggest useful ways of thinking with regard to both the construction of disability and assistive technology design. The terms focus on the personal attributes and needs of the individual, recognizing human diversity foremost.

Researchers Newell et al. (2011) make three distinctions regarding current approaches to design, to include mainstream design (focusing on abled-bodied individuals in general), disabled-only design (focusing on people with disabilities only), and universal design or design for all (an inclusive approach to capture the widest range and diversity of individuals). Traced to Selwyn Goldsmith's architectural descriptions in the 1960s, universal design or inclusive design, is a paradigm which seeks to include the elderly and other disabled populations in design approaches with "abled-bodied individuals." Philosophically, it seeks the inclusion of "all" abilities in the design approach. Additionally, it seeks the involvement of people with disabilities in the design process. The critique of this approach has been the difficulty of practically implementing it to attend to such a widespread notion of diversity. Instead, variants have emerged, such as "User-Sensitive Inclusive Design," which attempts to address user specifics in disabled populations and narrow the broad, grandiose brushstroke of "universal design" (Newell et al. 2011). In the user-sensitive inclusive design paradigm, Newell et al. describe certain concerns of disability for the designer to address at the outset, such as: (1) the need to engage with medical personnel in designing for disability, (2) that users may not be able to communicate their thoughts, (3) that it may be difficult to obtain informed consent, and (4) that payments may conflict with benefit rules. To address these concerns, the authors replaced "user-centered," a traditional design approach practice, with the term "user sensitive" to refer to the fact that "it is rarely possible to design a product that is truly accessible by all potential users" (Newell et al.

2011, 237). The term is also meant to signal an empathetic, responsive relationship with the user, rather than a more sterile approach of user as "test subject." Further, the authors suggest that a "meaningful relationship" should be developed with users in the design process. This notion of user-sensitive inclusive design aligns with other approaches, which intentionally involve people with disabilities into the design process throughout, including participatory design and empathetic design (Newell et al. 2011; Norman 2013).

Ability-based design is another variant, which intentionally moves "ability" to the foreground. Two principals, amongst a list of seven, are required in this approach:

(1) Ability – Designers will focus on ability, not dis-ability, striving to leverage all the users can do.

(2) Accountability – Designers will respond to poor performance by changing systems, not users, leaving users as they are. (Wobbrock et al. 2011, 11)

Therefore, in ability-based design, binary distinctions of disability and ability are again blurred in favor of a more all-encompassing view placing the focus on ability and supporting a social model approach to environmental barriers. The researchers working in this paradigm critique some AD design approaches for the ways in which they create inefficient "add-ons" to the person, rather than examining and changing the design as a whole. The researchers suggest that often AD interfaces, such as a mouth stick to type on a keyboard, may negatively affect a person's dignity and require the person to accommodate to the device. Instead, the researchers posit that the design should accommodate to the user's needs as opposed to the user accommodating to the device design (Wobbrock et al. 2011). For instance, reconfiguring the computer system to not necessitate a keyboard at all might be a more effective solution enabling the user to engage with another type of sensory input (e.g., voice input or eye tracking input).

Although this approach is applied to ADs in the form of computer systems, it is a useful paradigm in thinking about all forms of ADs, such as mobility aids.

Several researchers also suggest that emotional and aesthetic responses are often left out of design processes, especially designs for people with disabilities (Alper and Raharinirina 2006; Desmet and Dijkhuis 2000; Newell et al. 2011). Newell et al. state: "Many products designed for older and disabled people show evidence that the design team do not engage emotionally with the user groups: assuming that older and disabled people lack aesthetic sense and unlike other user groups are motivated entirely by the functionality of the products" (2011, 237). The "function-only" priority is seen, therefore, as problematic in fully serving the user. Through these types of observations, designers both in and outside of disability have urged "emotion-driven design," and "human-centered design," which reprioritize focus from simple "function" to the unique experiences and needs of human beings, acknowledging the linkage between cognition and emotion (Norman 2004, 2013). The link between cognition and emotion is often tied by differing theorists in the field of emotional design to how humans moving in their environments relate to and feel about the objects they use in order to function within those environments. Despite the unceremonious attitude we, as humans, might have towards the "stuff" we use, we simultaneously treat things and objects in very potent embodied and emotional ways. From cell phones, to cars, to paper clips, to pictures, jewelry, and personal grooming products, objects play consistent, compelling, and powerful roles in our lives. Sherry Turkle, author of *Evocative Objects: Things We Think With,* summarizes this notion**:**

> We find it familiar to consider objects as useful or aesthetic, as necessities or vain indulgences. We are on less familiar ground when we consider objects as companions to our emotional lives or as provocations to thought. We think with the objects we love; we love the objects we think with" (Turkle 2007, 5).

The emphasis in Turkle's book is that the "object brings together intellect and emotion" (2007, 5). However, the relationship of person to object is not solely based on good, logical functionality; instead, the object is treated as "a companion in life experience" (2007, 5). For example, in Turkle's book, a diabetic discusses his intimate relationship with his glucometer and a woman discusses the meaning of her ballet shoes to her dancing life. Objects may indicate major transitional moments in a person's life, important connections to experiences and people of the past, or they may concretize the present.

In thinking further about object/device relationships, Bruno Latour's actor-network theory is a faciliatory perspective from which to analyze the role of objects. Latour criticizes traditional sociological approaches for the ways in which objects are dismissed or forgotten as less relevant than people in a network of relationships. Instead, Latour gives equal consideration and weight to objects as the often hidden structures influencing social dynamics and assemblages. Latour states, "as soon as you believe social aggregates can hold their own being propped up by 'social forces', then objects vanish from view and the magical and tautological force of society is enough to hold *every thing* with, literally, no thing" (Latour 2005, 70). He even suggests that objects have agency. Latour designates actor-network theory (ANT) as an approach to the social, which is "an association between entities" rather than an extracted linkage explaining social behavior and emphasizing human action primarily (Latour 2005, 65). The definition of "actor" is not isolated to a human being. In fact, the actor/agent/entity, as Latour refers to it, may be anything as long as it is the source of an action and in order to define it one must excavate its attributes — its network (Latour 1996, 373; Latour 2011, 800).

Latour asserts that the definition of the "social" ascribed by sociologists is flawed in that it privileges humans exclusively with acts of agency and the ability to have meaningful intention.

For Latour, agency (the ability to act) is also revealed through objects. For example, a knife *cuts*, a fork *stabs*, a cleaning agent *removes* dirt, a railing *prevents* falling (Latour 2005, 71). Latour stipulates, however, that the attribution of agency should not be conflated with causality. In other words, the object may not be the cause of the action, but nevertheless it acts. While humans may be involved in the causation string, objects are not to be erased or de-valued in the network of relations. "ANT is not an empty claim that objects do things 'instead' of human actors: it simply says that no science of the social can even begin if the question of who and what participates in the action is not first of all thoroughly explored" (Latour 2005, 72).

Latour claims that "in addition to 'determining' and 'serving as a backdrop for human action', things might authorize, allow, afford, encourage, permit, suggest, influence, block, render possible, forbid and so on" (Latour 2005, 72). In the case of an assistive device, this concept becomes useful for recognizing how the device authorizes or permits a human being to move and occupy space.

In a parallel manner to Turkle and Latour, design theorist Don Norman draws out the impactful role of objects and things through his explicit theories of *emotional design*. Norman states: "A product is more than a product, it is a relationship that drives multiple relationships." (Norman 2015). In his work, Norman explains the ways in which cognition and emotion are inextricably linked. He asserts three aspects of design: visceral, behavioral, and reflective. Norman further asserts that all good design should be attentive to all three. The visceral level refers to visual appearance, behavioral relates to the pleasure and effectiveness of use, and reflective refers to the intellectualization and rationalization of the product or device (i.e., how it tells a story or what it represents) (Norman 2004, 5). Norman predicts of chair designs:

> Modern chairs will be intelligent, anthropomorphic, sensing, dynamic, capable of altering their shape, form, and function. Some chairs might come when called, others might lift

> people to reach high-up objects, and yet others might socialize with like-minded chairs, forming moving patterns across the room as they travel to wherever they might be most useful. These 21st century chairs are social, aiming to please. They will be active servants, relationship builders, and enablers of social interactions. (2015)

When thinking of the assistive device in this manner, the true partnership between person and device rises to prominence. Intriguingly, Norman was not referring to wheelchairs or assistive devices for disability in his description above; however, I find his futuristic description resonant with the creative, embodied kinesthetic design I propose for AD design from a dance perspective to be discussed in Chapter VI.

Industrial designers Desmet and Dijkhuis also foreground the importance of "emotional design" in their article, "A Wheelchair Can Be Fun: A Case of Emotion-Driven Design" (2000). The designers in the article posit that wheelchairs in general have an unpleasant emotional impact; thus, they pursue a new design of a wheelchair for children which is emotion-driven and which assumes as its design starting point the children's and parents' emotional reactions to the design. While Desmet and Dijkhuis acknowledge the myriad differences of emotional responses individuals have to products in general, they suggest that it is still possible to develop a method for assessing users' emotions and then attend to those emotions. They employ the Product Emotion Measurement Instrument (PrEmo, a tool formerly used in assessing automotive designs and chairs) as their tool for compiling emotional responses and interview both parents and children on their opinions of various designs.

What is particularly unique and unusual in this study, compared to the majority of assessment and design measures for assistive technologies, is how the researchers chose to privilege emotion, rather than basic usability and ergonomics as the design priority and lens. The authors assert that a wheelchair for children should help children explore and play. Implicit in this statement is that the researchers recognize the spatial ways in which children interact with

their bodies in connection to their environment. Different from the broader psycho-social measures, which include the use of some emotional language, this approach more directly attends to emotional words such as disgust, boredom, amusement, fascination, and surprise. With an accent on exploration and play/creativity, the nature of "assistance" and the nature of "disability" is re-defined. In this context, the design goal is to facilitate interactive creative exploration; thus, cultural codings and neat distinctions of disability and assistive device tend to be subsumed. Also, the emphasis becomes more on the significance of social space and intercorporeality — bodies interacting and sharing spaces interdependently.

Researchers in the field of embodied cognition have similarly contributed to these current trends in design and product thinking. Embodied cognition promotes that "human thought and knowledge are inherently and fundamentally perceptual and that the meaning of objects and situations is based on how a person's body can interact with them" (Kreuzbauer and Malter 2005, 169). Thus, embodied sensory experience such as sight, smell, touch, and sound become more central to design in this view. In traditional knowledge-process views, knowledge is understood to be represented by non-sensory symbols and the world is translated cognitively as an abstract mental language of associated symbols or "associative semantic networks" (Kreuzbauer and Malter 2005). In an embodied and emotionally-based view of design, shape, touch, and bodily engagement aspects of the device become a priority.

In *The Meaning of the Body* (2007), philosopher and scholar Mark Johnson also makes the case for embodied meaning-making. He grounds his assertions in phenomenology, linguistics, and the cognitive sciences. Johnson asserts:

> An embodied view of meaning looks for the origins and structures of meaning in the organic activities of embodied creatures in interactions with their changing environments. It sees meaning and all our higher functioning as growing out of and shaped by our

> abilities to perceive things, manipulate objects, move our bodies in space, and evaluate our situation. (2007, 11)

Therefore, Johnson suggests that all thought and concept development is body-based. In this view, body and mind exist as an integrated, interdependent unit, not separate entities, and the body is in perpetual interaction with the environment, both material and social, in order to make sense of the world. When Johnson refers to environment, he is attending to spatialized experience and knowledge. He emphasizes:

> There is no movement without the space we move in, the things we move, and qualities of movement, which are at the same time both the qualities of the world we experience and the qualities of ourselves as doers and experiencers…We put things into and take things out of containers, and so we learn about containment. We experience linear versus nonlinear paths of motion, whereby we develop our understanding of trajectories. We feel various degrees of exertion and force, and we thus learn what level of exertion is appropriate for moving ourselves from one place to another and for moving objects of various weights. Feeling what it takes to cause an object to move from one place to another is a core part of our basic understanding of physical causation. (Johnson 2007, 20-21)

In the recent developments in interaction design,[4] the body in motion has become a central topic of discussion (Fogtmann, Fritsch, and Kortbek 2008; Klemmer, Hartmann, and Takayama 2006; Loke and Robertson 2013). Practitioners and researchers in what has been termed Kinesthetic Interaction Design,[5] or KI, have come to realize that stilling the body's motion potential during interaction with a device or environment is not ideal for physical health or fulfilling engagement in the world (Fogtmann, Fritsch, and Kortbek 2008). 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. However, it seems the emphasis is still somewhat mechanical in nature, focusing upon the science and physiology of the body: motor

[4] Interaction Design 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.
[5] Kinesthetic Interaction (KI) is defined broadly as: "when the body in motion experiences the world through interactive technologies." See Fogtmann, Fritsch, and Kortbek 2008.

skills, abilities, and sensory apparatus. The emphasis on creating a *relationship* with and through the technology seems a bit sterilized in this context. Dance, in its embodied movement artistry, suggests a design approach more intensely linked to the desires, intentions, and expressions of the human soul — the deep inner landscape of a person's identity. 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. Because of this emphasis, this dissertation research focuses on how the performance of dance might help shape the future transformation of wheelchair design (and object/device design in general). On the dance stage, assistive devices, such as wheelchairs, are being re-fashioned through performance rigor and creativity, signaling new potentialities for design. These ideas and practices will be discussed in the following section and in further detail in Chapter VI.

A Place for Dance in the Design World

Intriguingly, the areas of concern for assistive device effectiveness such as "individualized meanings," "psycho-social" factors, and "personal needs and preferences" identified in the preceding sections, materially manifest in the embodiment of dance (Jutai and Day 2002; Pape, Kim, and Weiner 2002, 15; Scherer et al. 2005). Dance is a landscape in which unique bodies, including bodies of disability, explore their experience 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 (Johnson 2007; Parviainen 2002). 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 (Johnson 2007). The embodiment experience in dance has been referred to as

"indwelling awareness" as well as a "style of knowledge" (Parviainen 2002; Sheets-Johnstone 1999). Embodiment is an inroad to identity, to desire, to value formation, to body image, to competence and a sense of agency, many of the variables discussed with regard to assistive device use and design (Iwakuma 2002; Standal 2011). This is where the dance lens intersects with some of the contemporary ideas in the assistive device literature, and, more importantly, dance *physically* epitomizes their meanings, modeling an active representation of human-device integration through embodiment.

Additionally, in surveying the aforementioned selected 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 foremost. Further, interaction design and kinesthetic interaction 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 focused on utility, safety, reliability, cost and efficiency, and tended to be driven by ableist perspectives (Norman 2013, 218). Also, with regard to assistive device design, the user-centered design paradigms are situated in contrast to a purely medical model approach, in which the body's perceived functionality is the focus, and other issues of quality of life and the expressive life of a person are largely ignored in the prescription or design of the assistive device.

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 assistive device design (and, in fact, all types of device design) involves human bodies in motion, dance can play a significant role in the world of AD/AT design. Dance paired with disabled bodies radically ignites the possibilities of design. This idea is poignantly captured in a personal email communication on April 24, 2014 with power chair dancer Frank Hull,[6] in which we were discussing the nature of disability. He queries and then discusses his insights to his query:

> 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, spirituality's 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?

For the purposes of this research, I assert that when the duet between dance and disability is placed in relationship to assistive technology 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 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 in this chapter, have been present in dance since its beginnings. Choreographers and dancers frequently sought out bodily extensions in the form of unique costumes, headwear, footwear, and transport devices, such as flying wired

[6] Frank Hull has also been a research participant in my Rolling Dance Chair Project research over several years and he took part in the research for this dissertation. This research will be further discussed in Chapter VI.

extensions and aerial silks to expand their movement and artistic potential. Chairs (including rolling chairs) have been 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, therefore, suggests a very different conception of an AT/AD as a "medical aid." Since when have medical aids been tilted on their sides or flipped over in inventive ways to support another dancer climbing on, spinning on, or falling atop the device? *What* the AT/AD is and *how* it is *supposed to* function may be completely altered in the dance context. The wheelchair, crutch, or brace 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 this dissertation.[7] The participants described the positive way 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 (Frank Hull), a power chair dancer, described the desire to inject his "soul" or "spirit"

[7] Further participant research will be discussed in Chapter VI, when I explain the development of The Rolling Dance Chair Project, a research-based assistive device design project, culminating in the prototype chair's development. For the purposes of the discussion in this chapter, I excerpted relevant quotes about assistive device relationships, which my research participants described through their written questionnaires and verbal discussions.

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. 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. For these dancers with disabilities, the dance context enabled a new way of seeing and exploring their mobility devices thus obliterating the "medical aid" 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 my research made technological adjustments to their devices because of their explorations in dance and the desired embodiment they seek. And, in their verbal comments and written responses, they described how future design possibilities could be made to 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 and a desire for a hands-free control; and the manual chair user seeks a balance between stability and interactive motion with other dancers, an issue related to wheel design structure. Similarly, Bill Shannon, the "Crutchmaster," uses shock-absorbing fuel hoses at the bottom of each crutch to provide an

improved grip while mobilizing through space (Davies 2008), 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.[8] She is interested in an aesthetic which emphasizes the dancer and not the apparatus, so she has made changes to the chair which de-emphasize the materiality of the chair and heighten the way her body can create motion with it. The 90-degree angle of the seat and the very low back rest both contribute to making her more visible than the chair.[9] Additionally, her choice of five inch caster wheel 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.

Explorations in dance with assistive devices have taken some time to evolve to the current point in which the device is used more innovatively and expressively, with abled/disabled binaries 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. And, the person using the device is often led, rather than leading, and supported, rather than supporting. In many earlier dance performance practices, one would see the able-bodied dancer performing stunning leaps off the device, while the wheelchair dancer sat rather passively, enforcing ableist assumptions (Albright 2010). Rather than drawing attention to possibilities between bodies, the intent seemed to be to distract the eye away from the person in the wheelchair in favor of the technical prowess of the "able" dancer.

Disability scholar Telory Davies expresses that dancers with disabilities who use aids create "new versions of the dancing body" as technology assisted bodies (Davies 2008, 48).

[8] Verbal exchange with Kitty Lunn, during a rehearsal of Infinity Dance Theatre in New York, July 8, 2016.
[9] Phone interview with Kitty Lunn, Artistic Director of Infinity Dance Theatre/NY. August 2, 2016.

Davies describes a piece performed by Nadia Adame (AXIS Dance Company) and choreographed by noted postmodern dance artist Stephen Petronio, in which she utilized her cane as an embodied partner to play with the quality and the reality of instability and imbalance in her body. Apparently, this was the first time Adame used her cane while dancing since other choreographers with whom Adame worked viewed the cane as a limitation and chose to have her supported by another dancer's body or be seated (Davies 2008, 53, 55). By combining disabled imagery, breakdancing isolations, and partnering techniques, Davies asserts that a new aesthetic sensibility in dance was created in Petronio's choreography (2008, 53). This new aesthetic sensibility embraces interdependency with the assistive technology as artistically generative. Adame's reliance on the technology is less about unidirectional dependency due to physical inability (medical aid conception) and more about a creative conversation of risk and discovery. The cane enables Adame's movement qualities, inasmuch as the cane's movement is enabled by Adame's use of it. The cane and Adame are both dependent on each other for the movement which ensues between them, and the cane emerges as another dancing entity in Adame's "solo." Petronio uses the contingent, changing nature of Adame's body with her cane as creative stimulus for conceiving the dance, and inventing the movement vocabulary (Davies 2008, 55).

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 (and perhaps product design in general). 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 (Davies 2008, 48). There is a reciprocal effect occurring when dancers who have disabilities engage with their assistive device. Multiple transformations are being enacted, both bodily and in device possibilities. Therefore, the questions for future designers become: How can the crutch

design better enable falling/leaning and weight shift? How can the wheelchair fly or jump? 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 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 AT use beyond the creative embodiment and transformation of the device out of its "medical aid" association. This is the interplay *between* both abled-bodies and 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 (Flynn, Froman, and Vallier 2009). 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. (2014, 2)

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 (2010). She critiques independent living models, which "assert a normative encounter between autonomous and sovereign selves" (Fritsch 2010, 1). 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" (Fritsch 2010, 12). I extend these intercorporeal notions to dance by thinking about how the assistive device is corporeally involved not only with the user, but how the device is shared amongst multiple bodies, once again ultimately affecting design conceptions for the assistive device.

One example of the intercorporeal use of the device is in the aforementioned Bill T. Jones choreography, in which both disabled and non-disabled bodies move in and out of the wheelchair performing various movement sequences (Davies 2008). 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. Another example may be seen in another AXIS dance in which non-disabled dancer Sonsheree Giles spins atop the wheel of Rodney Bell's chair in Alex Ketley's "Vessel."[10] The chair becomes a shared partner in this context. Additionally, in a dance by Ihar Kisialou and Hanna Harchakova, European and World champions in wheelchair ballroom dance,[11] 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. In "Divide,"[12] a dance work by Marc Brew and commissioned by AXIS Dance Company, intricate trio and duet sequences depict the way multiple bodies thread and merge with the device as they all move through space together. At one point, two standing dancers intertwine their limbs with a wheelchair dancer so that they circle as one unified whole, 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 seamless back

[10] *Portland Press Herald*, August 2, 2010. "Physically Integrated AXIS Delivers Moving Performance."
[11] Live performance for "A New Definition of Dance," October 16, 2015, University of South Florida.
[12] Live performance at the Florida Dance Festival, June 24, 2016.

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.

Further images from the dance repertory of CANDOCO[13] Dance Company depict a wheelchair dancer lying on the floor with wheels upended while a presumed able-bodied dancer holds the lower frame of the chair to tilt off axis with leg extended side. His standing foot is anchored by the hand of the wheelchair dancer; the effect is that the boundaries of both bodies blend. 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 (Fritsch 2013). Instead, in dance, audiences witness the assistive device 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

[13] See: http://www.candoco.co.uk/home, "Beheld"

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 foot rests) were made more porous or more easily removable and mutable, 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 is usually not the most affection eliciting material. I have seen children 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 affections, but the chair's structure does not facilitate those efforts very well. How could the assistive device better enable those natural inclinations if it was 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. These future ideas for the device design will be further discussed in Chapter VI.

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 dynamic change is one aspect assistive devices like wheelchairs frequently lack. The device is also not used in an inert, static way separate from the body, but rather in a dynamic, embedded way, suggesting, if not prompting, new design transformations for the device, both in and outside of dance. 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, the "affordances," and enliven otherwise static space with vitality.

Affordances pertain to the possible actions between object or environment and organism (Norman 2013). The term originated in psychology and has been applied in the domain of design. Possible actions are determined by the relationship opportunities *between* organism and object or environment. The features or qualities of an organism or object do not determine possible actions; rather, their interactive, reciprocal effects determine these actions. For example, a wheelchair is perceived to "afford" sitting and rolling. However, what dance does is radically expand the interactive possibilities of the relationship thus changing one's perception of what is possible. The wheelchair in a dance context also affords tilting, hopping, side-lying, spinning horizontally and so on —notions encompassing both what the seated dancer or the standing dancer might do. Thus, as a conceptual strategy for design, dance prompts a revision of what

disability is while revising traditional expectations for interaction between the individual and the device.

Luca "Lazy Legz" Patuelli is a dancer with 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 participated in a full-length performance of international professional dancers with disabilities in an event entitled "A New Definition of Dance."[14] 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 often appears freer than others who balance themselves on the ground with their hands and are not able to gain the kind of spatial height Patuelli can due to the height attribute the crutches enable. The crutches also enable a pendulum-like bodily swing of the whole lower body, a movement not usually seen by typically-bodied dancers. Acting as alternate points of stability and balance, the crutches enable 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, the crutches become quite obviously beneficial and desirable as a movement extension, supporting new forms of motion. Therefore, Patuelli's dance engages

[14] The New Definition of Dance Event occurred at the University of South Florida in Tampa, Florida on October 12-17, 2015 and the following year as well on October 14 - 26, 2016 covering three cities: Tampa, Jacksonville, and Miami.

rigorous risk-taking, which subsequently requires a certain robustness for the device through which he is working. Of import to the focus of this dissertation chapter, is how this need for robust assistive devices 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

This chapter involved a three-part inquiry process. The purpose was to first investigate the major shaping forces in the evolution of wheelchair design and technology, to second examine current assistive device (AD) conceptual models and relevant design paradigms, and, finally, to contemplate how integrated dance, through the use of assistive devices, interjects a complementary and generative force for conceptualizing AD design in relation to these knowledge domains and, therefore, more robust use in everyday life. In exploring wheelchair development, I surveyed various histories to identify that the major socio-political forces shaping wheelchair evolution included war/government, activism, capitalism, sports, and medicine. Tensions were evident in the discussion of wheelchair evolution, pointing to the device as both enabler and limiter. It enables some bodies and not others, and the device itself poses barriers for users in its incongruency with the environment as well as the desires of users, even as it makes mobility possible. This constant tension continues to propel the technology in new directions.

Dance, therefore, inserts a new socio-political shaping influence, sharing similarities with sports and activism influences, yet charting new terrain due to its emphasis on creativity, individual expression, intercorporeality, and sophisticated motion dynamics. In the integrated dance domain, disabled bodies and abled 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 assistive devices both in and outside of dance, while it simultaneously re-frames negative perceptions of disability.

In examining the conceptual models and design paradigms, I surveyed the main tenets and premises in these approaches to understand what priorities are considered foremost. There is a clear struggle for design to adequately meet the diversity of disability for a variety of reasons. My point of research inquiry sought to find linkages, parallels, and differences amongst the models and paradigms and explore how dance and disability practices interject new possibilities into how these models might be reimagined. Design paradigms of note which seemed to resonate with the body-based meaning- making emphasized in dance, due to the ways they address personal uniqueness, environment, and identity, were: emotional design, human-centered design, and interaction design. While my research illuminated intersecting and complementary points of resonance between dance and these paradigms, I continued investigating whether any distinctions could be found within the dance domain, which would make it relevant and radically generative to existing design paradigms. This pursuit led me to three main ideas as elicited through my research. First, I examined how dance and disability interact to transform the device from medical aid to creative, embodied instrument of expression, and what this implies for design. Second, I examined the intercorporeal focus of the dance and disability duet pointing to how the device design should attend to *all* the bodies who might interact with the user (e.g., spouse, partner, friend, child). And, third, I examined the way the *moving* body *in space* in dance transfigures how the assistive device should respond and interact with the human body. The centralizing idea is that the device enacts an *embodied relationship* between person and environment.

In order to consider dance as a propulsive design generator for devices/objects, the role of the device needed to be understood for its impact and influence in conditioning and shaping human relationships. I drew from the writings of Turkle, Latour, and Norman to ground and theorize what role the assistive device plays in the lives of individuals. By looking at what dancers with disabilities are doing with their assistive devices, and foregrounding the agency of the device, as another "body," new conceptions for what the device can enable rise to the surface. The words of "partnership," "bodily extension," and "helper," were all themes which surfaced in my research defining the device relationship. From a dance lens then, one might ask the following questions: How does the AD design enable creative embodied expression rather than just "function"? 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 body in motion?

In the next chapter, I describe a design intervention based on my research and work in the integrated dance field which critically probes these questions and raises concerns regarding the prioritization of AD/AT design development and application. I worked collaboratively with engineers to create a dance specific wheelchair incorporating new possibilities for materiality and motion based on kinesthetic and embodied practices. Important to me was a view that specifically embraced the notion of interaction with the wheelchair user. In Chapter VI, I discuss the advent of the *Rolling Dance Chair Project* and the research involved in its development and on-going design explorations of the prototype chair. In conjunction, I propose and articulate a dance-based Embodied Socio-Spatial Design paradigm (ESD) with connections to the design paradigms articulated in this chapter, specifically Emotional Design.