CHAPTER VI A Prototype Intervention- Towards an Embodied Socio-Spatial Design Paradigm.docx

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CHAPTER VI

A PROTOTYPE INTERVENTION: TOWARDS AN EMBODIED SOCIO-SPATIAL DESIGN PARADIGM

In the 21st century designers will produce many things besides chairs, many of which will not be objects. Some will be services and experiences, such as healthcare and wellness. Some will be ideas. Is an idea a thing, a product, a service? Whatever they are called, they need to be designed not as isolated things but as complex, interrelated systems, as total experiences. As relationships. (Norman 2015)

Introduction

The former chapter concluded with a research-based analysis of how the dance and disability dyad re-imagines assistive technology design. This analysis highlighted the creative transformation of the device and its intercorporeal, spatially dynamic, and disruptive possibilities emerging out of the embodied nature of dance. In this chapter, I consolidate the ideas generated in Chapters III-V to propose and explore the notion of a dance-based Embodied Socio-Spatial Design paradigm (ESD). I will extend the concepts of embodiment and socio-spatiality, which emerged as major themes in disability and dance contexts, and apply these concepts to the assistive device design. The embodiment aspect highlights the central role of bodily interaction in meaning-making, acknowledging the emotional, felt nature of experience. The socio-spatial aspect highlights the organization and design of space as imbued with meaning due to social conditions.
Dance, as a body-based art form, communicates through embodied kinesthesia. In surveying current design paradigms which were introduced in the previous chapter, there seems to be a growing interest in the body’s role, with designers attempting to establish frameworks for integrating the body more fully into products and systems (Fogtmann, Fritsch, and Kortbek 2008; Klemmer and Hartmann 2006). In particular, these paradigms have emerged in the field of Human Computer Interaction (HCI). Theoretical frameworks such as Kinesthetic Interaction design (KI) and Kinesthetic Movement Interaction design (KMI), which are subsets of interaction design, reflect concerns for body and movement in design (Fogtmann Fritsh and Kortbek 2008; Loke and Robertson 2013).

Additionally, the philosophical perspective of approaching disability as a positive invitation for creative invention has generated interest in the design community at large. Graham Pullin’s popular book, Design Meets Disability, signaled this emerging perspective (2009). In his text, Pullin suggests that disability is a key to design innovation with designers learning from the uniqueness and perceived limitation of disability. He rallies and invites designers (e.g., fashion, product, furniture, and digital designers) to take a deeper look at the various technologies and products for disability and the choices surrounding those products. He encourages designers to see the expressive aspects of the users, to engage more directly with the user, and in general to seek more qualitative (versus clinical/functional) approaches in designing for disability (Pullin 2009). By citing the evolution of eyeglasses as a successful example of a disability product which has in fact become “fashionable” and seamlessly incorporated into the culture at this point, Pullin challenges designers to engage with disability as an enhancement, not a binding limitation to their creativity.
In thinking further about dance and design intersections, a known hallmark of design thinking is “human-centered design,” meaning the design is centered around the needs of people and it is cultivated through studying and observing people, to include how they navigate the world and what they find meaningful within that navigation. Design thinking\(^1\) emphasizes highly creative modes of thought in order to generate many ideas. It also encompasses collaboration, integrative thinking, and a sense of empathy. Similarly, in the dance field, professional choreographers often engage in collaborative modes of art-making, seek nuanced and complex understandings of human experience (integrative thinking), and seek to understand deeply the positions, contexts, and psycho-emotional experiences of other people through physical embodiment (empathy). Therefore, there is the possibility of commonalities between how design thinkers approach their work and how choreographers and dancers approach their work.

As I discussed in Chapter IV, disability offers dance an entirely new means for viewing, teaching, and creating movement repertoire, thus re-defining traditional norms. However, these explorations and redefinitions also require an acknowledgement of the technologies which can mediate disability experience. For dancers with assistive devices (i.e., wheelchairs, crutches, canes), the device has also been creatively incorporated into some, although not all, of this push for artistic rigor. What has not been fully called into critique and effectively analyzed more thoroughly is the device itself. The device design is the subject of critical analysis for this chapter.

Through informal discussions with several dancers and choreographers, I have noted that, at times, the dancer’s device, whatever \(it\) happens to be and however \(it\) works, can be unquestioningly accepted as an inherent part of the body. I agree that the device is an extension

\(^1\) For more information on design thinking see Brown 2009, and Dorst 2011.
of the body, and it, by itself, may also be considered a body in its own right; however, it should not be completely conflated as THE dancer’s body. When conflated as the dancer’s body, one loses the finer detail that the device is also its own entity. It has the capacity to separate from the dancer’s body. It has the capacity to be altered. It has the capacity to connect with other bodies. It has the capacity to be re-designed to better enable the dancer’s goals. It is a distinct entity. Thus, acknowledging the device as a distinct entity, designed by human beings, brings me to a discussion of how I began the process of re-imagining a chair designed with dance and dancers in mind.

My research aligns with the existing momentum in the design field by outlining a dance-based design paradigm attentive to the meaningful nature of movement experience as bodies with and without disabilities dwell and interact in space. In the sections which follow, I employ an explicit design intervention, a currently developed patented prototype wheelchair for dance as the means for theorizing a dance-based Embodied Socio-Spatial Design (ESD) paradigm. Further, I compare the embodiment capacities and spatial implications of traditional wheelchairs with the prototype omnidirectional dance chair using a dance-based Laban Movement Analysis (LMA) framework.

Concepts from LMA serve as a tethering foundation for the dance-based analytical theorization. LMA is a movement observation and analysis framework used in both dance and theatre domains as a valid and useful lens (Barteneiff and Lewis 1980; Newlove 1993; Hackney 2003). Included in this analysis are research participant responses and researcher observations. Participant responses from the research are threaded throughout the following sections and are also incorporated in earlier chapters where relevant to the discussion. The experience of working
with participants in the chair, therefore, led me to the development of this proposed design paradigm.

**Description of the Prototype Chair’s Design**

In 2011, I led a team in designing a dance-specific, wireless controlled, omni-directional powered wheelchair over a two and half year period informed by a dance lens and methodology (Morris, Lodato, and Chou 2011; Morris and Rumsey 2014; Morris et al. 2015). The current chair prototype addresses spatial accessibility in the vertical dimension through a manual hydraulic lift and adds sideways and diagonal traveling directions to the existing forward, backward, and turning abilities of the chair through custom-made omni-wheels. Additional movement and design features include: rotation of the seat independent from the base, four footholds or handholds for other dancers, and the ability to easily remove and exchange seats. In terms of control, the freely mobile wireless control can be placed virtually anywhere on the body (e.g., head, torso, back) or held by hand. The wireless control platform utilized is a smartphone. The simple tilting action of the smartphone propels the device through Bluetooth connectivity (AUTM 2013). When worn on the body, the dancers are hands-free and lean their body to direct the chair’s motion. The speed of the chair gradually increases with further tilt of the mobile phone. The phone may be programmatically customized per user with regard to responsiveness.

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2 It is important to note that the most recent research with participants presented here builds on a ten-eleven-year history, to include prior participant feedback, chair testing, practitioner experience in the field, and formal and informal conversations with those in the dance, disability, and design fields, as well as collaborations with engineers, physical therapists, and other designers. I began the Rolling Dance Chair Project™ in 2005. Multiple phases have occurred in the project over time with several prototype iterations.

3 Multiple phases have occurred in the project over time with several prototype iterations. This prototype, however, was the first one which integrated the majority of features I had conceived. The prototype on which this research is based came to full fruition in 2013, during the course of my doctoral work.

4 Another chair prototype design iteration is in progress, which expands and improves upon the current chair prototype.
and speed. The base of the unit is particularly compact so as to allow close interaction with other dancers (and easy passage through doorways). It is also very stable (non-tipping) with wheels situated securely on four sides to handle the uneven weight distributions and rigor which dance often demands. For instance, several bodies might move together on and off the device, or a dancer might lean back in the chair without concern of tipping. Two safety switches on the device allow the user to quickly cut the power if needed, and the chair may be stopped by the phone controller as well.

**Concept of Embodiment Applied to Assistive Devices**

The wheelchair serves as a bodily extension one navigates with and through in connection to environmental structures including buildings, stairways, and people. The device, the body, and the environment/space are all aspects of embodiment in the entire socio-cultural relationship when discussing the practices associated with wheelchair users (Gleeson 2012; Pazzaglia and Molinari 2016). Disability scholar Miho Iwakuma further describes the embodiment of assistive devices: “As a process of embodiment, an object becomes part of the identity of the person to whom it belongs” (2002, 79). The key point of relevance here is the recognition of embodiment as a *process* requiring time with the object (or device) and relating to *personal identity*. Researcher Ovid Standal describes the wheelchair embodiment process in this manner:

…the process of learning the skills necessary to control the wheelchair is not merely a matter of object manipulation, because in the process of learning these skills, the wheelchair as an experiential object is transformed. In the beginning of the learning process, the learners must attend to their wheelchairs and the movements of their bodies, for instance by controlling the position of the arms on the wheels or the posture of their upper bodies. This makes their efforts somewhat clumsy. But, through sustained practice they are gradually able to attend less and less to the details of the skill, so that the wheelchair becomes a familiar instrument. (Standal 2011, 181-82)
Personal identity signifiers on the wheelchair also reveal and enforce the embodiment process as users gradually adorn their chairs in specific ways, make unique adjustments, and add other visual or comfort-related features to the chair (e.g., lights, stickers, colors, cushions) (Smith 2005).

Another important aspect of the process of embodiment is that it is not only limited to the user, but also occurs in some manner for the spouses, friends, family members, or other dancers who engage with the device as an extension of the individual and an extension of themselves. When the wheelchair is touched, several research participants’ discuss it feeling as if they are also being touched. Similarly, a friend, or partner/caregiver often feels the chair as a part of their intimate connection to the person (Iwakuma 2002). Thus, the wheelchair is much more than simply a dissociated, neutral “object” of spatial transport from point A to point B; instead, it frequently exists as an embodied, dynamic socio-cultural shaping force linked to the user’s identity, informing his/her psycho-emotional landscape and those with whom he/she interacts.

What interests me in relation to my research into assistive device design is the level of embodiment, or the level of bodily\(^5\) congruency which some devices might enable more than others. Perhaps this issue is both a condition of the individual’s capacity for embodiment and a condition of the assistive device’s capacity for organic interaction with the individual. For instance, it is a common human experience to have felt moments of disjunctive or incomplete embodiment, such as working with a broken or faulty device or using an awkwardly shaped utensil whose contours simply do not conform naturally to the body. Another example might be attempting to wear clothing or shoes that are too small or too large. When the device limitations outweigh its possibilities, the level of embodiment seems limited. However, perhaps some bodies

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\(^5\) In using the term “bodily” I intend for self-hood and identity to be understood as part of bodily experience, not as a dualistic term separating body from being.
are better able to adjust or adapt to the device, even when it malfunctions or possesses a non-ideal congruency with the body. These are points of intrigue to continue exploring in the body-device-environment embodiment ensemble.

Researchers in the field of embodied cognition and assistive technology have shown that some types of devices become more embodied than others based on their materiality and sensory input, as well as the person’s type of impairment and psycho-emotional stance to the device (Pazzaglia and Molinari 2016). Other researchers have similarly noted that the degree to which the assistive device is simply a tool for mobility, versus a part of one’s experiential body, varies amongst individuals and may be attributed to the level of importance and relevance the person associates with the device (Standal 2011). The dance context is uniquely positioned to help reveal and challenge issues of embodiment with the assistive device, enlivening the intersections between bodies and devices. Thus, I ask, how can dance facilitate or train embodiment with the assistive device, as well as serve as a lens for understanding and “reading” levels or types of embodiment?

Concept of Embodiment as Evidenced in Participant Research

In my research with the dance participants working with differing assistive devices, the theme of embodiment surfaced in several ways. First, the way that each participant referred to the device implied that it was more than just an emotionally neutral aid for mobility. It was referred to as, “a helper,” “a part of me,” “a partnership growing over time,” a “good, reliable friend,” “an extension of my body,” and “support for my expression of artistry.” One participant, power chair user Frank Hull,⁶ referred to the desire to put his “soul into the chair.” Participants also described that the relationship with the device developed over time and involved a process

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⁶ Participant gave permission for his name to be disclosed, and preferred that his name was disclosed in this research rather than remaining anonymous.
of discovering “possibilities,” “opportunities,” or “different ways.” Luca “LazyLegz” Patuelli referred to the fact that with maturity he “learned to accept” his crutches as a part of him.

Another participant similarly expressed that while his device possesses “limits,” it also has created “possibilities.” He described that after his injury, he had to discover his “new bodily limitations” and “new capabilities” as well as his device’s limitations and capabilities. He discussed the various changes he made in his devices to try to maximize agility, while also retaining the support he needs (i.e., seating angle, and type of cushions). He also described that of the various types of chairs he has tried, no chair has (or will) ever quite meet all his desires and expectations for mobility. He expressed: “There is always an issue of sacrificing one thing for another. It is my experience that no one chair will ever provide me with every movement option that is available to the typical person.” These statements suggest there is a tension that individuals negotiate as they try to embody a bodily extension, such as an assistive device, and that the embodiment process takes time. It also suggests that some devices might promote more embodiment possibilities than others, and some may be more conducive to a fuller embodiment.

Within the participant research, similar, yet slightly different, views pointed to a more nuanced spectrum of embodiment experience. For instance, in terms of level of embodiment, Hull described the desire for a deeply felt soul connection to his device, whereas another participant described that he did not see the device as a part of him; instead, he positioned the device as “a good friend.” Here, there is still an aspect of emotional connection, but with clear boundaries between self and device. Another participant described being “proud” of his device, which indicates a deeper emotional relationship involving self-investment. Conversely, another participant seemed to create a more distant relationship between the dancer and the device, using

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7 Participant preferred to be named.
non-emotional language and stating: “It is my tool and form of mobility that extends my movement possibilities…. I consider the artist the dancer and the chair an extension of that artistry.” In this statement, the participant seems to direct attention to the artistry or expressive abilities coming from the person foremost, with the device positioned more passively as a consequence of the person’s intentions. In the following, I discuss the prototype chair explored by the research participants which was conceived and designed with notions of embodiment and socio-spatiality in mind.

In my observations of the research participants using the prototype chair, I saw differences in levels of embodiment. I noticed that all participants worked towards a kind of congruency between their bodily inclinations and the chair’s movement. However, this congruency took time and participants had varied approaches. Often, in the beginning, the participants held onto the sides of the seat with their bodies more rigidly held and their torsos often sinking back and down to assume a more protective, bracing posture. For some, there was a more obvious struggling period in trying to negotiate bodily control with the chair’s movement. This was also due to variations in types of disability with some individuals needing more supportive features (i.e., back support) to help them gain mobility.

As they began to learn the feel of the device and the control system, I observed a sense of continuity and connectedness developing between person and device. This was manifested in the gradual smoothness of their transitions, their facial and verbal expressions, their bodily postures, and their levels of risk taking. After becoming more familiar with the motion and speed of the chair, the participants would release their hands—often one hand at first, then the other. They seemed to be gradually “trusting” the device and settling into its capacities, even its agency. At
times, smiles or laughs would begin to appear as participants eased into the motion of the chair.

One participant remarked:

There was insecurity in the beginning. It took a few minutes to feel the way I could sit on the chair, the way my body could be positioned. It took a while for me to breathe and let go. It always takes times with a different chair. After a short time, it felt safe. Wrapping my legs and having the cushion also helped.

Further, on the questionnaire the participants were asked to mark the following elements concerning the difficulty level of control for the chair: (1) not difficult at all, (2) moderately difficult, or (3) very difficult. Most of them marked moderately difficult. This was congruent with what I observed in watching them learn to use the chair.

In the sessions in which the participants explored the chair with me in attendance, we always began slowly, working with the chair at a low speed and using simple movements to acclimate the participant to the device. Participants were shown the stop buttons so that they knew they also had control of the device and could stop at any moment. One participant was concerned about safety and listed it as a top design priority on the questionnaire. Given this participant’s history, which involved malfunctioning equipment causing severe spinal cord injury, her heightened attention to safety throughout the process made sense. For her, part of the embodiment process was linked to how safe she felt in the device.

As the participants became more familiar and comfortable with the device, I could see a gradual sense of confidence emerge as movement became more expressive and spatially expansive: they began to let their movement instincts manifest through the device. New body orientations in the chair were explored, such as placing the legs over the back of the seat and hanging upside down or leaning back in a nearly horizontal position. There was a concentrated, almost internal focus I noticed during the process as body and device formed a relationship. I realized I was watching the embodiment process in action.
While many of the participants were initially quiet as they worked with the device, power chair user Frank Hull was more verbal. His verbalizations throughout the process helped me understand what he was doing and how he was feeling. He also had the opportunity to work in the device longer than any other participant, so we had more time to experiment. Consistent exclamations of “oh, wow” and “okay, so if I try...” illustrated his bi-directional relationship with the device in which he essentially carried on a dialogue with the device as he figured it out. He was not directing the dialogue to me; rather, he was spontaneously reacting and responding to the motion and feel of the device.

One fascinating aspect of Hull’s exploration was how he engaged with the control system. He seemed to be enjoying the complexity of the control rather than becoming frustrated or fatigued by all the potential options the controller might enable. (My hope, as designer, has been to simplify the control to enable it to be as organic and intuitive as possible for the individual.) Currently, the chair controller can be challenging to navigate in some ways and it requires sensitivity and an attentive focus. Thus, Hull’s willingness and interest in indulging the complications and the nuances of the chair as it currently exists were surprising. This observation was supported through his written questionnaire feedback, in which he stated:

The complexity of the controller for this dance chair is wonderful. I love that I have to practice to control this chair. The beautiful fact is that depending on where the controller is placed on your body you need to relearn how to move and dance in the chair. This creates a world of infinite shape within your own body and changes the relationship with the chair. So a dance with the controller on my head will be a totally different kind of dance than if it is in my hand or on a different part of my body and so on. Or, even if my partner is controlling the chair. This creates infinite choice.

It is worth noting that Hull is a lover of dance/contact improvisation and the act of yielding control and responding to the moment, as well as investing in a perpetual process of discovery, is embedded in the practice of dance improvisation. It is perhaps important to consider how
training in a particular dance form may predispose a person’s ability and comfort when embodying a device, prop, or object. I noted Hull’s willingness to adapt and to continue investing in the art of exploring creative movement possibilities throughout the process.

Embodiment experience was further evidenced in how participants described or physicalized their relationships with the device and other partners. I have noticed through past experiences working with dancers in mobility devices that when multiple dancers interact together with a mobility device, such as a wheelchair, the texture of the relationship develops concurrently through the chair’s motion and form. If the chair interrupts the sense of connective flow and contact through its incongruous materiality or movement incapacity, the dancers may innately feel this sense of disconnect as an interruption in embodied experience with the partner.

In this dissertation chair research, one of the participants referred to the interruption in embodiment he sensed when manually pushing his chair. He described the movement of rolling the wheels as a functional movement which was “not dancing” and “not in place.” He expressed frustration in wanting to move to another place in space, but not wanting to interrupt the movement flow by the necessity of pushing the wheels to get there. He spoke of artificially finding ways to “cover up” that basic functional movement to make it work in the dance. He also described removing the arm rests of his chair because of their barrier-like nature which prevented connective flow with a partner. This participant then noted appreciating moving in the prototype chair specifically because of the way he could maintain a connective flow with his partner and his own movement, without an “interruption,” as he called it. It is important to note here that this participant’s primary genre is, like Hull’s, contact improvisation, where maintaining and evolving contact with other dancers is a priority. The wheelchair, as a formative, interactive, intermediary “body” affects the quality of the dancers’ relationships; it affects how they know
each other on a sensory level. As a participant-observer in the chair experience, I interacted physically with the participants as they moved on the chair. These improvisational interactions engendered more of a flow when the chair followed the intuitive choices our bodies were co-initiating. However, there were several times in which the chair suddenly stopped and this created a disjunctive feeling—a halt in the embodiment process. It sometimes felt as if there were three distinct bodies: my body, the chair’s body, and the other dancer’s body, with the boundaries between each more pronounced. However, when the motion became more seamless and transitions smooth, the bodily boundaries began to blur again and the embodiment level intensified. The highest level of embodiment I experienced was working with one of the participants while being seated in the chair as well. I wore the controller on my torso, and sat in the chair with the other dancer. The participant also described the heightened sense of flow and movement connectivity in this experience. It truly felt as if we were moving as one entity through space, and the notion that we were even in a device disappeared from my own cognition. It simply began to feel as if we were revolving, gliding, drifting, and coasting through space in a constantly shifting fusion of form. Gravity was less apparent in this experience, evoking the feeling of weightlessness.

Another specific moment I recall as a higher intensity level of embodiment involved my interaction with a participant on the chair and one other standing dancer. The chair controller in this case was held by a person who did not physically make contact with us, but who controlled the chair remotely. Thus, there were a total of four people involved in the improvisation: me, the chair dancer, another standing dancer, and the person holding the wireless control while controlling the chair at a distance. The interactions between the three of us making direct physical contact (me, the dancer in the chair, and the standing dancer) was very fulfilling in the
way one moment threaded to the next and the way we all explored and talked about new ways of interfacing through touch and shared weight. We were continually surprised by how seamlessly the outside controller directed the chair influencing, yet not dictating our movement evolutions. The chair controller also described the way he attempted to react or respond to what we were doing and how he refrained from abrupt jarring motions. Thus, the experience amongst the bodies and the device were in conversation, listening and responding to one another. We did not encounter the type of awkwardness or discontinuity associated with interrupted embodiment. The chair in this instance served as a motion initiator, facilitator, and responder, enabling a full embodiment experience.

This experience also introduced an entirely new sensation for how contact improvisation might be experienced. Contact improvisation, as the name suggests, implies that bodies are in direct contact with one another. However, in this case, one of the bodies (remote control operator) was not in direct contact with the other bodies, however, he was still involved in relating and connecting with the dancers through the chair’s movement. Thus, his contact was experienced indirectly. His presence was felt intuitively by me through the motions of the chair but, since he was not directly interacting with us, he also receded from my consciousness in exchange for the more palpable, immediate presence of the other bodies. The person with the remote, wireless controller (the Android smartphone) discussed experiencing a kind of distant or virtual “contact” improvisation as he responded and reacted to our movement activity together while directing the chair carefully and smoothly. He verbally expressed this distant, yet intimately involved sensation. Interestingly, we as dancers also felt this distant, yet intimate, contact improvisation as well.
In another experience in which I was directing the chair remotely while two other dancers worked together in and with the chair, a similar sensation was described by the research participant in the chair. The chair participant described that, “although you [the researcher] were controlling the chair at a distance, the chair motions and the partner interactions felt organic and did not feel prescribed.” This remote-controlled action described as a contact improvisation experience potentially opens an entirely new area for dance both theoretically and practically. How does this form of virtual/cyborg dance reflect the technological culture at large? What can be explored in these relationships? Could this notion be useful when considering those for whom direct, live dance interaction is impossible or unlikely? For instance, telepresence robots are a wireless technology which have successfully been used in museums by individuals with significant paralysis. Similar to a Skype interaction, the person’s image is displayed live (real time) on a screen which is attached to a rolling robot. The person then can control the movements of the robot from their remote location (could be in another state or even country) to make the robot move and interact in the museum space. They are also able to talk to or relate to a person near them in the museum. Thus, like the telepresence robots which enable a real-time remote interaction of people in distant physical places, perhaps the prototype dance chair, in its wireless, remote-controlled, programmable capacity, pushes this idea further. Individuals from diverse parts of the world, with significant paralysis or other mobility obstacles, could dance together on a shared stage with other dancers. They would be able to control their assistive devices or a “dancing robot” in real-time with their live image projected on the device so as to glean a similar movement sensation. It would be as if they were moving together in a shared

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8 Telepresence robots are a commercially available product and I witnessed the successful use of one at a conference for which I was a guest speaker. The conference was the ADA Silver Anniversary Summit September 24, 25, 2015 held in Miami, Florida at the Adrienne Arsht Center for the Performing Arts.
space. These types of re-imaginations of dance and technology artistry surfaced for me during the course of the research and, more importantly, surfaced because of direct movement experimentation with the prototype chair.

In sum, the wheelchair, in its contours, its hardware, its responsiveness, its directionality, its control system, its size, 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. I now ask, in which ways can the materiality, the form, and the motion of the chair more significantly facilitate the sense of embodied movement connectivity for dancers? However, before continuing an in-depth analysis of the prototype chair and its imaginative future, I next briefly describe the general concept and significance of socio-spatiality in relation to the assistive device.

**Concept of Socio-Spatiality Applied to Assistive Devices**

The unique spatial stories of wheelchair users and different bodies often color outside of the lines of a planned geography: these stories inscribe new geographies and, in so doing, reveal the socio-cultural nature of a place. Access to things, people, places, services becomes an issue for how social space or socio-space is constructed and negotiated. Sociologist Peter Freund asserts from a “universal design” perspective that, “In a fully accessible society, the main feature would be the ‘universal recognition,’ that all structures have to be built and all activities have to be organized for the widest range of human abilities” (Freund 2001, 705).

The crucial role of spatiality in the interrelated embodiment complex of person, device, and environment, may be more specifically illuminated through the notion of “spatial disablement,” a condition in which the production and development of space can create disabling situations for people with disabilities (Gleeson 2012; Hansen and Philo 2007). For instance,
narrowly designed public spaces can be disabling spaces for wheelchair users as they privilege thin, agile walkers over those who are differently bodied or who have bodily extensions which move differently through space. In narrow spaces, wheelchair users may feel awkward and unwelcome in trying to maneuver into a tight space. The aspect of disability in this situation becomes the central focus, because the space design is preventing any kind of natural social flow. The wheelchair user literally “doesn’t fit” the parameters of the space design causing one type of culture to have privilege to spatial access over another.

Stairs present a similar signifier of cultural expectation when one assumes that all people at all times in their lives can climb stairs. For wheelchair users, stairs can signify no access, no engagement, no passage, and ultimately non-acceptance. The addition of a nearby ramp or elevator in the stair climbing condition is more inclusive, recognizing different types of bodies and promoting a sense of belonging rather than alienation. Therefore, from a universal design perspective, the ramp or elevator further permits many other types of “rollers” (e.g., people with baby strollers, rolling carts, rolling suitcases) and is thus a more inclusive design choice in general, embracing multiple possibilities.

Conditions of control and power also produce spatial disablement. The crafting of spaces often involves separation and isolation, so as to exert a particular form of societal control by institutional, governmental, or socio-political powers. In *Discipline and Punish*, Michel Foucault illuminates this idea:

> In organizing ‘cells,’ ‘places,’ and ‘ranks,’ the disciplines create complex spaces that are at once architectural, functional and hierarchical. It is spaces that provide fixed positions and permit circulation; they carve out individual segments and establish operational links; they mark places and indicate values; they guarantee the obedience of individuals, but also a better economy of time and gesture. (Foucault 1977, 148)
The social model of disability shares a relevant relationship with Foucault’s examination of spatial configuration as a condition of power/control in that the social model attends to disability as a social construction and addresses how design enacts or produces disablement. This includes the design of spaces, places, objects, and systems, everything from cities to homes, to appliances, to cell phones, to educational curricula, to wheelchairs.

With the previous concepts in mind, I further question how and in which ways do AD/wheelchair designs create or enforce “hierarchical” space, “carve out individual segments,” “mark places” and “indicate values.” How is the assistive device addressing spatial access and what does that spatial access imply socially and politically? Issues of both movement and form of the device suggest aspects of isolation and power in what the wheelchair itself might evoke. Movement features include such considerations as height change, directionality, and control system; form features include structural shaping of the whole chair and the materiality of the wheelchair. While spatially containing an individual for safety, how might the enclosed form or restricted motion of the chair also produce more isolation? How does one hug a person in a wheelchair? By having limited vertical motion, and existing in a rather fixed position in space, how are power relations enacted? What are the issues of agency? These types of socio-spatial questions will be addressed in the forthcoming sections by applying an analytical movement framework to the assistive device analysis. This analysis, like the examination of embodiment, will be informed by participant responses.

**Method of Analysis for Assistive Device**

As was discussed in Chapter II, the methodology section of this dissertation, Laban Movement Analysis is a comprehensive, multi-layered approach to the observation, interpretation, performance, and experience of human movement (Bradley 2008; Hackney 2003).
It has been regularly utilized in dance and theatre contexts, as well as in business, industry, and robotics. As such, it is a useful system from which to analyze not only human movement, but also the movement of the assistive device.

The system was developed by Rudolf Laban, dance theorist, choreographer, and dancer, in the early 20th century (Bradley 2008). Laban posited that the exploration of movement in its full spectrum was central to human experience and human development. The system was premised on the belief that expanding one’s access to a wider array of movement qualities is a healthful means of internal development, an inroad to self-awareness and self-expression (Bradley 2008). Although the system has been largely utilized in dance and theatre domains, Laban viewed it as applicable and beneficial to anyone. He believed movement literacy was as important to human development as any other form of literacy, to include math, science, language, etc. (Bradley 2008). There are four main areas of analysis in the Laban framework in its contemporary form: Body, Effort, Shape, and Space (Hackney 2003). Effort is defined as the “dynamic quality of the movement, the feeling-tone, the texture” (Hackney 2003). It relates strongly to the nuance of precisely how the movement is occurring. It is manifested through four Effort Factors: Time, Weight, Space, and Flow. Each Effort Factor exists on a continuum and is delineated by two polar extremes termed Effort Qualities or Effort Elements. When analyzing human movement, the Effort Factors are related to an inner attitude. The movement quality is felt as a direct linkage to an attitudinal approach/motivation.

The Body category of the LMA framework looks at how the moving entity organizes its parts and how the parts are linked together. The Body category analyzes how parts are initiated,

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9 Terms will be capitalized throughout the discussion due to applying their specific meaning in the LMA framework. However, it is important to keep in mind that these movement concepts are generally applied and referred to in dance practice.
aligned, and sequenced as well as which parts are still and which are mobile. Shape relates to the body’s form and how it changes in relation to self and environment. The emphasis is upon the process of shape change (Hackney 2003). Lastly, the area of Space is concerned with all aspects of where the movement is going. This includes considerations of low, middle, or high space, the spatial facing of the mover, the spatial pulls, the way the mover reaches out to space (near/mid/far-reach space), and the tensions and relationships developed spatially through the placement of the body and its limbs in space (Bartenieff and Lewis 1980; Hackney 2003). Space also attends to the differences between one, two, and three dimensional spatial experiences. Shape and Space have overlapping connections due to the fact that as soon as the body/entity changes form, there is also a spatial change. Space will be a predominant focus of the analysis used in this dissertation, as this area has formed a core interest in the research and in the development of the prototype chair design. I will illustrate how spatial concepts in the LMA framework apply to the assistive device design thus impacting socio-spatial conditions. Additionally, space and socio-space are areas of focal importance in the disability and design literature. I will also address concepts from the Effort and Body areas as further considerations for theorizing the design evolution and re-imagining of assistive technology.

Connecting Laban Movement Analysis Theory to Practice in the Prototype Chair: A Space Analysis

In the LMA framework, the category of Space relates to all aspects of where the movement is occurring, with this category having high relevancy for the spatial implications of assistive devices. 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. (Laban 1966, 93-94)
From an LMA perspective, therefore, traditional chairs\textsuperscript{10} 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 only provide the user with a one-dimensional experience of movement, rather than a two or three dimensional, planar experience of movement. For example, the wheelchair user can travel straight forward in the traditional chair but the chair does not 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; however, this traveling action usually requires the users to turn their bodily facings as well. 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. This may be compared to a standing individual who, rather than being able to rotate his or her torso in a particular direction while their lower body moves another, must move the entire unit, torso, pelvis, legs, all in one particular direction.

One problem engendered by these spatial restrictions is that it may produce an embodiment experience which 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,

\textsuperscript{10} First and foremost, I want to recognize the value of wheelchairs to begin with; their initial introduction as an assistive technology 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 again, and I am in great appreciation to the designers who have worked to enable accessibility in this manner. It is not my intent to disparage these efforts in the least; but, rather to encourage a more expansive examination and more intense, higher priority focus towards improving existing technologies by attending to embodiment 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 believe, some dancers and choreographers have sought to turn the chair upside down, tilt it on its side, or use wheelie techniques (lifting the bottom part of the chair up): they are seeking new spatial orientations and greater spatial dimensionality.

The prototype, omnidirectional dance chair discussed in this dissertation was built to enable spatial movement in all directions: forward, backward, sideward, diagonal, and rotation left/right. The purpose of omnidirectionality was to foster the potential for full spatial coverage/access or the ability to go everywhere in a fluid, organic manner. An enlarged capacity for spatiality produces the potential for expanding one’s possible embodiments and possibilities for expression as a three-dimensional moving being. According to the underlying philosophy of the LMA system, the more a human body can employ its many bending, extending, rotating, rising, sinking, advancing, retreating, spreading, and enclosing possibilities, the more capacity it has for expansive, all-encompassing spatial involvement (Bartenieff and Lewis 1980).

During my research with participants exploring the prototype chair, there were three features discussed and/or commented upon by the participants which dealt with the use of space: the hands-free capacity induced by the mobile wireless control, the omnidirectional aspect of the chair, and the height feature. In one of the written questions which asked for the participant to prioritize certain chair features, the omnidirectional aspect, height aspect, and the hands-free/mobile control aspect were all marked as high priority features. These features all effect spatial access. Participants commented that the hands-free aspect would be useful in both dance and daily life situations, such as the need to carry things. One of the participants even stated that the chair would offer her a sense of freedom which her current chair does not provide.

The narrow base of the chair was also noted favorably due to it allowing close proximity with other dancers. Relatedly, a participant who described his history of using different devices
mentioned having switched from wide-angle cambered wheelchairs to those with much less of a camber angle in order to better partner with other dancers. For me, this was important to hear as it reiterated the importance of socio-spatial concerns focused on the relationship between people. Logistically, with too wide of a base, intimate interactions with other dancers or other individuals in daily life are more challenging. Navigating narrow spaces is also made more difficult with a wider base. Thus, the prototype was specifically designed with a narrow base to more easily navigate space and enable closer interactions with others.

Power chair user Frank Hull, who worked in the chair the longest, was the most detailed in expressing precisely what he found the most liberating. His comments linked to issues of agency and creative liberation. He stated that the chair’s spatial possibilities enabled, “A new and more powerful way to feel the dance not just do the movements.” He described that his current chair lacks the ability to move in all directions and he further expressed, “the joystick control forces me to lose my one hand and side.” He also stated that the chair opens a new world of movement choices and ways of connecting and partnering with both “sit down” and “stand up” dance partners. In my own experiences improvising with Frank, I also found more points of contact were possible spatially due to his not needing one hand or body part affixed to the joystick.

Therefore, the new possibilities engendered by the omnidirectional movement capacity in the prototype chair may prove to be extremely liberating for dancers. Consider the many movements in dance which travel side, or require a diagonal rather than strictly forward/backward mode of travel11 (i.e., chassé, tombé pas de bourrée, side roll, cartwheel, etc.).

11 To be clear: I not suggesting that integrated dance needs to adhere to traditional dance styles or forms, or follow an ableist rubric. I am suggesting that from a spatial access perspective, limiting the device design to minimal spatial options is a type of discrimination (intended or not). In traditional chairs, movement in the vertical plane is
By increasing the spatial range of the device, the wheelchair dancer can engage with and embody new possibilities of spatiality. For instance, the wheelchair dancer is able to maintain a front facing torso in connection with the audience if they would like, or in connection with another dancer, while traversing the space in a sideways manner. This feature could be particularly useful in ballroom dance. New relational facings (as referred to in dance) and thus, new interactive relationships are supported for the wheelchair dancer. The wheelchair user may also cut through the space on diagonal paths, with or without moving the torso facing. In reference to the omnidirectional feature, one of the research participants stated:

The chair can move in all directions and depending upon where the controller device is put on the body you get to re-experience a whole new way of moving the chair. Very exciting for creating dances with lots of movement vocabularies and shapes. My every day power chair does not move in all directions, such as diagonals front and side to side.

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 social and functional aspects.\textsuperscript{12} However, funding sources, such as Medicare, do not view height change as an essential element. 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 (Butera 2008; minimally available. Notably, dancers (and basketball players) radically challenge manual chair designs by attempting to tilt up and onto their wheels sideways.  

\textsuperscript{12} I was an invited guest speaker at National Seating and Mobility’s Annual Wheelchair Symposium in July 2015 (Nashville, TN) where I saw a live demonstration of Quantum Mobility’s latest powered wheelchairs specifically their “iLevel” wheelchair.
Feldman 1975; Gilmore 1996). If wheelchairs were built to raise the user above most standing individuals, how might the perceived power relationship shift?

The prototype dance mobility chair also possesses height change, adding another key dimension of socio-spatial access. Research participants who tested the chair commented that they enjoyed being at eye level with other dancers. Additionally, with the dynamic change of height, two and three-dimensional movement is possible. For instance, as the wheelchair user propels forward in the space he/she can rise as well, or while propelling on the diagonal, he/she can rise and/or lower to experience two dimensions of movement experience (planar experience of movement) simultaneously. Height change enables level change in vertical space, so the wheelchair user can engage at eye level, and can experience shifting out of mid-level space. This embodiment experience potentially produces more spatial access to the environment and others, more opportunity for emotional connection through eye contact, and more autonomy. The flexion/extension capacity of spine, hip, knee, and ankle joints for a typically-bodied individual similarly enables this possibility of vertical spatial change and embodiment potential, and many of the dynamics created in dance are due to moving fluctuations between low, mid, and high levels in space. In manual wheelchairs, I have seen individuals tilt the manual wheelchair off its axis, and I have choreographed pieces where the wheelchair is tilted 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 re-imagine the device design. Thus, what if the device were better designed to enable these capacities from the outset?
Many spatial combinations are possible in simply combining the omnidirectionality with the height changing dynamic. Adding other individual bodily capabilities to the design capacities of the device would further open even more spatial access opportunities for engagement with other dancers and other forms of expression. Explorations in prone or side-lying positions in combination with the chair’s movement capacities may produce other spatial embodiment permutations as well, lending a versatile experience of movement and bodily orientation.

As another aspect of spatial disablement, consider the way the user is expected to control the device: either hand grasp on the wheels or hand grasp on a fixed joystick is the common mode of control. Several difficulties are presented in this system of control. Firstly, with hands fixed in space and attending to the control of the device, the ability for physical engagement on a social level is limited. For example, individuals might want to move together side by side and hold hands or engage with arms otherwise connected in some manner (around waist or shoulders). The wheelchair user is unable to fluidly engage in this type of embodied movement interaction which serves psycho-emotional needs, due to the need to appropriately navigate the device. Additionally, a caregiver, friend, or spouse must frequently position themselves spatially behind the wheelchair user if pushing the user’s chair (in the case of manual chairs); yet, one must ask how this re-positioning then ascribes a differing embodied connection and may create a sense of disengagement between the two people. In most situations of social engagement people stand next to each other or in front of one another in order to interact and elicit eye contact, not behind one another. This type of control system also presupposes only one type of disability—a disability in which the user has the full use of hands and arms for control. It also does not take into account long-term effects on the user in this system of control (i.e., shoulder wear and tear in the case of manual chairs, postural considerations, etc.).
In a dance context, the exclusive type of hand/arm control is particularly relevant, because the dancer’s upper body movement becomes limited to operating the device predominantly, restricting interactive engagement with other dancers and expressive freedom. There have been tactics adopted to deal with this issue, such as gaining enough momentum for the wheelchair so that the dancer can briefly sustain their arms in the air or having a standing dancer push or propel the wheelchair in some manner to enable the wheelchair dancer’s upper body to engage in other ways. However, again, this does not enable the wheelchair user/dancer to be autonomous in their approach to controlling their mobility and engaging with others. In either case, the wheelchair dancer is not situated to fully manage their movement choices or become leaders/initiators versus perpetual followers.

Several research participants in my study mentioned the value and desire for hands-free movement. It was also a feature that was rated as highest priority on the questionnaire for the majority of participants. One participant remarked:

Finally, a power chair designed for dance. I was not tied to a joystick and my whole upper body was free for expression. The chair being designed for dance takes dance for a power chair user to the next level because of how the chair is controlled through a smartphone.

Yet another participant described that the feeling of not employing his hands to move his manual chair felt liberating. He stated that he was happy to be free from rolling the wheels and that it was the most significant characteristic of the chair that he noticed in comparison to his current chair. He described the sensation of being in the prototype chair and not using his hands to propel the device as “a bit like floating, like being in space without gravity.”

In contrast to a control where hands and arms are affixed in space, the prototype chair enables hands-free movement, spatially unfixing the control. The prototype chair control is a mobile wireless remote in the form of a smartphone. It may be hand-held by the user, it may be
held by a caregiver or friend or fellow dancer a distance away from the user or it may be placed on the body as a wearable device (i.e., torso) for hands-free operation. It also may be programmed differently for different users in terms of sensitivity and speed. When the controller/the phone is tilted forward the chair moves forward, when it is tilted back the chair moves backward, when it is tilted side the chair moves sideways, and so on and so forth. Thus, like the omnidirectional feature, this control feature is meant to spatially unfix the control, offering a greater capacity for socio-spatial mobility, and increasing the capacity for interactivity. The control is also designed to be user-friendly without complicated buttons to push, etc., which might require fine hand motor skills. It is this control feature which enables a wheelchair user and their spouse, friend, partner, etc., to embody a closer relationship side by side (i.e., hand-holding, etc.). The spouse, friend, partner may simply tilt the remote control/phone forward while moving, or the wheelchair user may wear the control and utilize their torso to direct the chair, forward, etc., freeing the upper body.

This feature also produces additional creative possibilities in the dance context, as the control becomes as mobile as one’s imagination, producing a number of movement possibilities and configurations. In the research, when participants mentioned “freedom” it was often related to the fact that their arms and hands could be free to do other things due to the mobile control which could be worn on the body or held by another person as described above.\(^\text{13}\) For instance, while traveling in space, the chair user can place both arms above the head. Wearing the controller on torso or head also created a different, perhaps more dynamic, connection for the users to the device. Thus, one user described this hands-free experience as “natural,” another as “amazing,” and another as “something I have always wanted to do.”

\(^\text{13}\) I further discuss this notion of “freedom” in the research participants’ responses in the concluding chapter (Chapter VII).
Due to the spatial mobility of the smartphone control (it is not fixed in space like a joystick or wheels), the non-prototype chair dancer or the chair dancer may direct the chair’s motion either in close proximity with one another or at a distance. Unlike manual and powered chairs, the non-chair dancer need not be in physical contact with the chair in order to cause it to move. This produces a kind of remote-controlled contact improvisation (refer to former embodiment section for thorough discussion of this experience in the participant research). For instance, chair dancer and non-chair dancer may be located across the room from one another and through a simple tilt of torso, tilt of head, or motion of hand, the chair can be activated by either dancer as they move towards each other in a mirroring activity or any other type of lead/follow movement. If the non-chair dancer is wearing the control on torso or head and circles his/her torso or head around, he/she simultaneously effects the movement of the chair which would circle as well. Or, if the dancer wearing or holding the control tilts the phone sideways, the chair partner would move sideways as well. The degree to which one dancer leans (or tilts the phone) produces a simultaneous and comparable movement of the chair partner. The degree/magnitude of one dancer’s leaning action is proportional to the speed of their partner’s “body” (referring to chair and person combined) so the two are sharing in a danced relationship of time and direction. They are sharing an embodied relationship in which the partner wearing the control is responsible and innately connected to where and how fast his/her partner moves. However, the chair partner is also able to take control by stopping the chair motion through the stop buttons on the chair at any time.

Interestingly for some of the research participants, having another person control the chair evoked a sense of ultimate freedom; whereas, for others, there was a feeling of restriction evoked by not being fully in control of the chair’s motions. Research participants also
commented upon the trust needed to relinquish chair control. These different perspectives surfacing in the research were interesting, pointing to the differences in how individuals perceive freedom. In thinking about the chair’s design development, these different perceptions signaled a reminder that a flexible, versatile control system would be most ideal to accommodate differing approaches to agency and notions of freedom.

In sum, examining the spatial aspect of wheelchairs as rooted in a dance/movement-based LMA Space perspective provides a new way for envisioning and analyzing the assistive device design. The prototype chair design grew from intentional focus on the Space aspect, both as a means of broadening choreographic possibilities and empowering the wheelchair user. The types of new embodiment possibilities presented with an omnidirectional, mobile controlled, height adjustable device are significant in contrast with traditional chairs. The new ways in which wheelchair dancers may discover and re-create their socio-spatial embodied selves through a different type of mobility device could lend significant change in perceptions of able-bodied and disabled dancers as well as impact the identity of wheelchair users.

However, there can be no “one size fits all” solution, and there are multiple concerns to attend to in future designs. Yet, by paying close attention to how bodies relate with one another in space through their daily lived experiences, and how these insights might be further enacted on the dance stage, new possibilities for this prototype device and/or any device may become realized. It is here at this pivotal threshold of interaction, of spatial junctures, of unexpected dynamics and change, that the real notion of disablement is tested. In the next section, I examine another dimension in the LMA framework as a method for further re-imagination of the device design: Effort.

Connecting Laban Movement Analysis Theory to Practice in the Prototype Chair: An Effort Analysis
This chair took my physicality to a whole new level. It enabled a different kind of movement vocabulary to play with. The chair gave me a lot more options. I could actually begin creating a dynamic; I could actually feel the dynamic of the movement in terms of speed. I was able to feel that connection between body and device. In essence, I felt that I could put my soul or spirit into the chair, a lot more easily than the current chair I use.  

**Time Effort**

The above quote from one of the research participants who tested the prototype chair illustrates the subject of the next analysis: the use of LMA Effort. The participant specifically is referring to how the dynamic quality of the movement was experienced through Time Effort. Effort is defined within the LMA system as the dynamic quality of the movement, feeling-tone, texture (Hackney 2003). Regarding human movement, it reflects an inner attitude towards investing energy. It is manifested through four Effort Factors: Time, Weight, Space, and Flow. Each Effort Factor is delineated by two polar extremes termed Effort Qualities or Effort Elements. In order to analyze the assistive device in terms of Effort, I will look at how the assistive device might embody a full palette of dynamic qualities, attending to both of the polar extremes. Each Effort Factor will be explored separately. I now discuss the ways in which the assistive device design may support a wider spectrum of Effort dynamics, both for creating positive perceptions of disability and for enabling a greater canvas of movement choices for the user.

Time Effort refers to how the movement changes in speed and, more specifically, how the mover or object experiences time changes. On one end of the continuum, Sustained Time indicates movement which is experienced as more leisurely, gradual, lingering, or prolonging. While, on the other end of the continuum, Sudden/Quick Time indicates movement which is
experienced as more urgent, quick, instantaneous, or staccato. How does the assistive device change in Time Effort? How might the wheelchair embody and manifest a sense of urgency and, conversely, how might the wheelchair embody and manifest a sense of lingering or prolonging?

The majority of research participants all referred to speed changes as being a very high priority for them either through the written questionnaire or verbally. One participant remarked that he would like to see the prototype chair possess “more rigor for its attack and execution.” Another participant’s first question upon seeing the chair for the first time was: “how fast can it go?” Yet another participant remarked that he would like to use the chair to “go fast across the stage.” Clearly, this was an important aspect for the dancers who participated in my study and thus led me to imagine how I might in the future refine the control system to address Time Effort in its fullest range.

Wheelchairs, both manual and powered, generally do have some capacity to embody both Quick and Sustained Time. However, not all bodies are able to regulate these differing time ranges and the more sophisticated regulation of time in wheelchairs is difficult for most wheelchair users. Additionally, more nuanced rhythmic possibilities are often not accessible. For instance, a dancer may begin with a quick initiation of the chair or stop the chair abruptly, but the ability for the chair itself to be continually percussive or diversely rhythmic is minimal. This lack of range in timing becomes an issue within dance performance since the finessing of time is important in the dance context as it contributes to the expressive, communicative whole.

The perception of time in the chair, I believe, is related to the chair’s static shape; the momentum in the rolling action of the wheels; and the degree to which the control system enables acceleration, deceleration, and stopping. It is difficult to produce a sharp attack with the continued rolling momentum in the chair’s wheels. Further, the static shape of the chair does not
allow for how bodies/chairs might change when moving with different Time Efforts. The dynamic quality of wheelchairs is frequently gliding and spinning; this is what they do well. Gliding is one of eight basic effort actions identified in the LMA framework and it is composed of Sustained Time Effort, Direct Space Effort, and Light Weight Effort. However, most wheelchairs do not have the capacity to enact the other seven LMA basic Effort actions: Float, Thrust, Slash, Dab, Wring, Flick, Press, or produce aerial-related actions like hopping, jumping, leaping, or rising. I have seen performers attempt small hopping actions with the chair in an effort to employ a differing dynamic, but the chair, unfortunately, was not designed to assist this movement option. Changes in Time are often produced best by the chair when a long gliding series is halted with a sudden stopping motion, or a turning series is halted abruptly. Or, the wheelchair user might employ noticeable contrasts in bodily movement for a more diverse time dynamic.

Eliciting Quick Time with more complex movement phrasings is also challenging in wheelchairs due to the fact that the chair is a compact unit, moving generally as one undifferentiated whole. If components of the chair could be differentiated in their movement timing, the potential for other layers of time dynamics could emerge. For instance, a possibility might be the movement of the seat moving at a different timing than the base of the chair, or a leg or arm support being activated sharply, or wheels possessing actions apart from moving the chair through space (i.e., pivoting back and forth, without moving the actual chair). Notions of parts of the chair bending/folding or extending might also lend towards more complex time dynamics. Lighting effects (e.g., LEDs) on the chair could additionally support a broader rhythmic spectrum. Flashing or pulsing of light, or color shifts could become accent points in the choreography, enhancing the phrasing of time. These lighting effects could be embedded in the
wheels, under the seat, under the base of the chair, or in the back of the chair. Further, devices could be included to allow the chair user to control these lighting effects.

In the prototype chair, due to its programmable capabilities, speed may be increased to a very high rate and it also may be decreased significantly. Thus, accessing the extreme points of Quick Time and Sustained Time is potentially more possible in the prototype chair than in traditional power chairs or manual chairs. However, finding rhythmic precision such as a quick-slow-quick phrase, or a quick initiation which then drifts into Sustained Time, is more challenging due to the reaction time between the mobile controller and the chair. The responsiveness of the chair to the controller also needs to be regulated for safety. In other words, it is jarring for an individual to be immediately jerked into motion when the controller activates the chair. Instead, it feels better for the acceleration to gradually climb. Thus, the chair often gives the effect of Sustained Time more often than a sense of percussive or staccato Time Effort.

Additionally, there is another time dynamic in the prototype chair created through the differentiation of movement between the seat and the base of the chair. The seat may rotate independently of the movement of the base. Thus, each can move at different timings. For instance, the seat may rotate slowly while the base is rotating or moving through space quickly. This is an example of the differentiation of parts I suggest may be one method of creating more complex timing capacities in the device.

One of the research participants worked extensively to attempt to regulate the time dynamic with artistic prowess. He chose to hold the mobile control with one hand while spending a large part of his time in the prototype chair working directly with the time dynamic through the mobile control. He tilted the wireless control back and forth repetitively with small motions and then larger motions in order to discover differing response possibilities. Then, once
he learned how precise the response from controller to chair could be, he began taking more risks in stopping and starting, sometimes in very short bursts, sometimes in longer phrases. As researcher, I observed this activity with intrigue, realizing how the dancer was attempting to learn the time dynamic of the chair and then finely regulate it to his desired goal for precision.

**Weight Effort**

The *Weight Effort Factor* is associated with the assertion of pressure/force. Light Weight movement is more of a floating quality while Strong Weight is more of a punching, thrusting Effort quality. Additionally, Passive Weight is how the body succumbs to gravity, appearing limp or heavy in nature. Weight-Sensing is related to a softening of weight, readying the body to exert lightness or strength similar to the motions of a tap dancer sensing rhythm or yielding weight to the rhythm felt in the body (Hackney 2003). By reflecting on these ideas within the LMA system, I asked the following questions: How does the wheelchair device express Weight Effort? How might a changing sense of Weight Effort be created? In answering these questions, I speculated that there are two primary aspects influencing the perception of Weight Effort: the form/shape of the device\(^\text{15}\) and the motion of the device.

While the wheelchair does have a gliding motion to it, and gliding is generally understood in the LMA framework as encompassing Light (Weight), Direct (Space) and Sustained (Time), the form of the wheelchair can project a heavier or more passive sense of weight in its feel of physical groundedness. However, in contrast to power chairs, manual wheelchairs may create a more airy, less cumbersome perception due to the transparency enabled by the spokes of their wheels and their smaller sizes. Power chairs, specifically, can appear heavy due to their large sizes and the solidity of their builds. In addition, many wheelchairs often

\(\text{15} \) Note that this an example of overlap in the LMA framework, where aspects of form or Shape may effect the perception of the Weight Effort.
include features to stabilize a person, such as Velcro straps, cushions, postural supports, and foot rests. Some of these features might also contribute to heavier weight perceptions.

To combat this overall sense of heavy weight, one could imagine how transparent materials or light sensitive materials (i.e., clear acrylic, clear polycarbonate, luminescent fabric, color responsive, reflective surfaces) might provide a Light Effort effect when the chair is moving, especially if the materials are used strategically throughout the chair’s body. Additionally, when the orientation of the chair is changed (i.e., turned upside down or on its side) it begins to shift the chair out of its predictable groundedness, enlivening a lighter weight dynamic. Further, if the wheelchair user can make the wheels of the chair leave the floor, this aerial moment can provide a sense of lightness (similar to a standing dancer’s feet leaving the floor if only for a split-second).

On the other hand, wheelchairs, when in motion and when gaining higher speeds, can portray a sense of power associated with an active Strong Weight Effort. This is particularly in the case of power chairs. When one sees such a heavy-looking, solid machine bolt through space, it may feel and be perceived as possessing a strong power.

As designer, I have struggled with ways for endowing the device with a wider spectrum of weight dynamics in order to yield more nuanced expression. For example, I intentionally chose to mount a clear, translucent seat on the chair base to elicit a sense of lightness in appearance, which would, hopefully, also primarily place focus upon the dancer’s movements. I further intentionally kept the base of the chair small and had it painted black in an effort for it to blend with most stage floors and not appear as a cumbersome, overwhelming, and bulky machine. Research participants noted the compactness of the prototype device and one participant described it as “modest” and uncumbersome looking. But, what I have struggled with
most is broadening the movement repertoire so that gliding is not the only movement choice when trying to elicit a weight dynamic. My goal for the future then is to attend to different portrayals of Lightness and Strength. Questions guiding this goal include: Are there any suspension features or elements of the wheelchair by which it can float, fly, jump, soar, or hover? Can there be a sense of rebound in the device (perhaps springs/spring-loaded wheels, responsive spring-like seating, or translucent materiality which reflects light to change the notion of weight)?

The Weight Factor was not an element that research participants discussed in length concerning their prototype chair experience or their own devices. However, one participant did remark specifically about how he sensed the motion of the prototype chair as light. He described his experience in it as a floating sensation. I also have experienced this feeling when moving in the chair, and I believe it may be largely connected to the hands and arms being free in space, instead of being attached to the chair in some manner. Thus, by continuing to focus on how I might further free the dancer’s body for fuller expressiveness when using the prototype chair, I might develop new ways to elicit and portray a Light Weight sensation.

There is also a practical aspect of weight to consider in the chair design as well since ease of transportation is a top consideration for most wheelchair users. This is one advantage of manual wheelchairs. The lighter carbon fiber frames many now have enable a great ease of transport. Power chairs are typically large and heavy to transport (thus, the need for automatic van lifts). I designed the current chair prototype with the idea of transport needs in mind. Thus, because the seat disconnects easily from the base, its transportability is possible in a car. However, the chair base is heavy, like most power chairs, making it very stable, but also
challenging in its ability to travel with ease. In the next iteration, I am striving for a lighter overall weight and modular configuration of the base to assist transportability issues.

**Flow Effort**

A third dimension of Effort in the LMA framework is Flow. Flow is described as the “baseline goingness, the continuity of the movement out of which the other Effort elements emerge and return” (Hackney 2003). Flow refers to a sense of control and is defined on one end of the movement continuum as Bound or on the other end of the continuum as Free. To provide a point of reference, when I refer to Free Flow, I associate this to the releasing of energetic tension as seen in the frolicking play of puppies and children. The dance movements of a fall, leap, or drop-swing, which appear to be unstoppable once initiated, are also considered Free Flow actions. When I refer to Bound Flow, I associate this to the approach a surgeon might use in performing a surgery or the controlled regulation needed for carrying a full, hot cup of coffee. Movement which appears as if it could be easily halted or re-directed at any moment in its trajectory is more Bound than Free. A dance movement example might be a ballet fondu or a Martha Graham contraction.

I observed the most Bound Flow use of the traditional, manual chair by one of the participants whose practice is ballroom dance. In this participant’s ballroom dance movement, such as tango and swing, she mostly engages in tight regulated control of the chair in order to sharply change directions and align with specific timing expectations in the ballroom genre. Intriguingly, this participant also demonstrated what I perceived to be the most Bound Flow approach to using the prototype chair. The participant sought constant limb and postural control (upright). This approach contrasted with other participants who were more willing to let their limbs and/or bodies fall, release, swing, or drift in connection with the movement of the chair.
The research participant who was a power chair user commented that he envies manual chair users since, in traditional joystick controlled power chairs, the ability to release the control and simply drift or coast without continually regulating the joystick is not possible. When he lets go of the controller, the chair stops instead of having the capacity to stay in some form of motion. For this reason, he enjoyed moving in the prototype chair where the chair could stay in a constant perpetual motion without him using one hand to manipulate a joystick.

The word “free” was used by multiple participants to denote their experience in the prototype chair. It is interesting to analyze what about this experience seemed free to them. My interpretation is that the hands-free aspect of this chair may have developed more possibilities for creating a feeling of Free Flow. However, the term free may not be an indicator of the Flow Factor at all. Instead, it may have been more about the freedom to find different spatial possibilities. Additionally, one participant described how, even though his arms were free to move, controlling his core proved difficult in the chair given his injury level. This lack of core support then restricted his ability to attain further mobility. However, throughout my observations, I did notice a great deal of movement invention by the participant, including hanging upside down off the chair seat.

When creating the prototype design, I asked myself the following question: How could a sense of Free Flow be more enabled? Part of the way I accomplished this was to change the locus of control and to de-emphasize the appearance of constraint features that might create spatial hindrances or overshadow the dancer’s own presence (i.e., arm rests, tall back rests, large cushions). My focus was to place more emphasis visually on the dancer and less on the device. Hence, the circular,\textsuperscript{16} rather than square, shaping of the seat and the seat’s transparency were two

\textsuperscript{16} This is an example where other aspects of the LMA framework, such as Shape, overlap and inform notions of Effort.
ways for developing a greater sense of freedom of motion for the user and viewer. Also, rather than having distinctly separate arm rests jutting out in space, the seat is made to curve around the person allowing a place for resting the arms while also providing a sense of security for the user. The translucent/ invisible nature of the seat allows the viewer to see the chair dancer freely moving. However, most importantly to developing a sense of Free Flow, was how moving the locus of control from the arms and hands to the moving torso enabled a freer use of movement to the majority of the research participants. This sense of freedom was further enhanced when control of the wireless device was given to another dancer.

In observing participants, I noticed a sense of Bound Flow being demonstrated in the beginning of their prototype chair exploration as they employed more restrictive, cautious, careful effort at regulating motion. After this initial phase of exploration, I observed more Free Flow as participants allowed their bodies to release into space. Again, I observed the most Free Flow Effort when I operated the chair and there was no need for the participant to control the chair’s motion at all.

When the chair is in motion it also appears to have a kind of non-stop continuity as it glides and drifts through space. This gliding action is similar to what I noticed when observing the users in their manual and power chairs. However, the omnidirectional aspect of the prototype chair seemed to contribute to an enhanced sense of Free Flow. The more expansive spatial directions supported the notion that the chair is unbound in terms of space. This was an interesting self-reflective observation as it pointed to the way aspects of space use and Space Effort (to be discussed in the next section), inform the perception of Flow Effort.

Although my desire as designer was to create more access to Free Flow through the hands-free control system, I noticed a contrasting experience when I wore the controller rather
than the chair user. During one of the movement experiments in which I worked with a participant in the prototype chair, I wore the controller on my head. With the controller strapped to my head, a yes-no motion of the head would produce forward-backward movement of the chair partner, a side-side tilt of the head would produce sideways movement of the chair partner, a rotation right or left would produce corresponding right/left rotation of the chair partner, and a diagonal tilt of the head would produce diagonal chair motion. The slightest movement of my head produced movement. Thus, I felt the need to tightly regulate my movement, otherwise, my chair partner could easily move too abruptly or too far across the room with a mere incline or turn of my head. This realization made me restrict my improvisational range, which further restricted my freedom of limbs and torso. The chair user I was working with remarked at being intrigued by the scale of movement difference between him and me and suggested that this disparity of movement freedom and range might create the basis for a very interesting piece of choreography. With further practice and familiarity with the control, it is possible that a sense of Free Flow might also develop for the person not in the chair but wearing the remote. Further, it may be that enabling a dual ability to both manually control the chair at times (push/pull) and electronically control it by an outside user could provide greater access to the Flow dynamic. Therefore, a future multi-modal control system might offer the most versatility in terms of Flow.

**Space Effort**

Space Effort relates to how the mover gives attention to space rather than where the user moves in space. The continuum for this Effort is defined by Direct Space Effort on one end and Indirect Space Effort on the other end. Directness in the LMA concept is about zeroing in, pinpointing a focus. Indirectness is linked to the notion of multi-focused or an all-encompassing spatial dynamic. Circularity, twisting, and curving is often understood as more of an indirect
spatial dynamic. My question then became: To what extent can the AD design enact spatial
directness and indirectness?

Generally, when one looks at the movements of traditional wheelchairs, the eye is not
drawn to multiple places in space. The contained, unchanging nature of the wheelchair “body”
draws the eye to mostly one directional pull in space. Directness is generally sensed in how the
sagittal movements of the chair (forward and backward) mobilize the whole chair/device as a
directed unit (i.e., wheels don’t move in one direction while the seat moves a different direction,
etc.). However, Indirect Effort can be found in the chair’s rounded, circular motions. Winding
and circular turning movements in space are possible, lending to a sense of Indirectness as the
user takes in many points of focus. This variation between Directness via straight
forward/backward tracking and Indirectness due to circular motions adds a useful dynamic to the
device, giving it more intrigue as a moving object. But, through deeper consideration of how to
expand the Space Effort, further technological innovation could occur.

In hand propulsion of manual wheelchairs, spatial Directness is limited by the fact that
the device itself has no ability for its form to morph, or for its parts to change in prominence (i.e.,
for one wheel to jut further into space). In either case, if the form could morph (i.e.,
narrow/widen/re-organize its parts) or if parts of the chair could become illuminated, spatial
Directness or Indirectness could be heightened. Spatial Directness is also limited by the fact that
if either wheel is pushed independently, the chair veers off and begins to turn. Two arms must
generally control both wheels with equal pressure in order to make sure the chair maintains a
direct focus.

In the prototype chair, other options for Directness have been added through side-side
and diagonal movement capacities. Also, one possibility explored to enact the effect of
Directness is through lighting, specifically the way lighting bounces off the seat and the way LEDs can be applied to create a distinction in focus may assist this issue. Additionally, another layer of Indirectness has been added to the prototype chair by creating a seat that rotates independently from the base. Thus, while the chair base circles or curves one way in space, the seat may be spinning or circling the opposite way and circling with different timings compared to the circling of the base. In this instance, the eye becomes drawn to multiple places and foci in space.

In the explorations with research participants, a new type of Indirectness was achieved in the chair when one dancer began spiraling in tandem with the circling of the chair base. This was largely possible because the dancer’s body could lean far back, almost horizontally in the seat. Thus, a tilting seat enabled a new body orientation, which led to another type of Space Effort possibility. Further self-reflection upon the Space Effort has caused me to consider how the vertical height motion could become more Indirect (i.e., floating or spiraling up or down) rather than following such a direct path up or down in space. The tilting action of the seat combined with the height change and the seat rotation collectively may produce this new type of Indirect Effort manifestation within a vertical spatial pull. These enhancements to the prototype chair are very much in the future, but may provide exciting possibilities for how dancers utilizing wheelchairs might expand their movement options.

**Thoughts and Future Possibilities for Incorporating Effort Analysis in Design**

In sum, examining the LMA concept of Effort adds yet another design dimension for thinking about the device as a moving, expressive entity interfacing with a human body. Analyzing the Effort dynamics of Time, Weight, Flow, and Space focuses attention upon the qualitative dynamism of the device, fostering new creative permutations in dance while
deconstructing stagnant, passive, and disempowering representations of disability. While current
devices do provide the opportunity for producing some contrasting dynamics, such as Direct and
Indirect Space Effort, these dynamics could be expanded to provide access to more sophisticated,
multi-layered movement qualities for device users. Expanding Time and Weight Effort qualities
is potentially the most compelling area of focus for future device iterations due to the limited
range of Weight and Time Effort current devices possess. This is an area I continue to work
towards expanding in the prototype chair development.

Connecting Laban Movement Analysis Theory to Practice
in the Prototype Chair: Body Analysis

The Body category of the LMA framework looks at how the moving body or entity
organizes its parts and how the parts are linked together. Several concepts may be useful to
consider here. Successive, Simultaneous, and Sequential movement distinguish three different
ways in which parts may move (Hackney 2003). In the LMA concepts, the term Simultaneous
movement denotes how movement of the body’s parts, or for the purposes of this research an
entity’s parts, move together at the same time. For instance, in a human body the head and tail of
the spine may move away from each other in an arch or towards one another in a curve at the
same time. On the other hand, Sequential movement denotes the movement of non-adjacent parts
moving in a sequence one after the other (i.e., head, hip, shoulder), while Successive movement
denotes the movement of adjacent parts moving one after the other (i.e., imagine a slinky’s
movement or the succession of elbow, wrist, then hand in the British queen’s wave).

In wheelchairs, motion is frequently Simultaneous. One sees a mostly compact single unit
moving through space. Parts are differentiated to some extent through their various materialities
(i.e., the look and feel of the chair’s wheels versus its seating construction). Footrests are further
differentiated visually, spatially, and tactiley from arm rests. However, from a movement
perspective parts of the chair are not differentiated when the chair is in motion; instead, all parts move together as a single unit. In the past, to challenge the mostly undifferentiated compactness of the manual chair’s movement, I have explored choreography where the dancer removes wheels from the manual wheelchair or where other dancers remove and replace wheels. I have also seen choreography where these actions occur. Here again, the explorations in dance are pointing new ways forward for design of the device. My questions for future design now become: How might the chair embody Sequential or Successive movement? Would it be possible to have the mid-portion of the chair or the seat move and then the base of the chair? Or, could different wheels move at different times enacting a kind of “sprawling” action like in the game of Twister where one limb then the opposite limb moves to reach another place in space?

To explore these questions, I conceived how the prototype chair seat rotation may occur independent of the movement of the chair base, thus enabling the action of non-adjacent parts moving (Sequential movement). Or, the seat could be made to rotate opposite to the direction of the base/wheels creating a different rotational organizational pattern. Additionally, due to the easily removable configuration of the seat, it could be potentially lifted out of the base by another dancer, separating base and seat. In the next iteration of the prototype chair, I can also imagine a removable, adjustable foot/leg rest which will also provide possibilities for Sequential movement and new bodily/object arrangements. This type of removable, adjustable foot/leg rest design is, in fact, already in progress.

Further, regarding Successive movement, might the chair’s wheels reach out in front with the back wheels following in a kind of lead-follow action? Could some parts linger in space or leave some type of imprint, while others move ahead or sideways? Could the bottom of the chair become the top or the sides become the front? One inventive example to point to here is the
IBOT (Cooper et al. 2003). The IBOT is a stair climbing wheelchair, in which this very notion of one part of the chair leading and another one following in succession occurs. There are also existing wheelchairs which transform from seated to lying or standing apparatuses. Additionally, with seat tilting mechanisms and seat raising (elevator systems) mechanisms, there is some differentiation of parts so that the entire chair form is not only doing one motion. Rather, part of it is rising (seat) or tilting while the other maintains forward motion (wheels and chair base). Thus, some aspects of different parts of the device moving in different ways is occurring in wheelchairs, but not in significantly varied or intriguing ways. By considering some of the concepts within the Body area of the LMA framework, the assistive device design may be re-conceived as a body with differentiated mobile parts initiating new patterns of organizations to be explored. Further, how differentiated mobile parts might be organized and assembled in the future to support the user’s complex movement could open new expressive possibilities in dance.

**Summation and Further Thoughts**

This chapter sought to bring more prominent attention to a socio-spatial, embodied movement perspective in the design of assistive technologies and to identify a specific need for attending to assistive device innovations in dance when acknowledging bodies of disability. I applied a dance-based lens to the assistive device design through utilizing key aspects of the Laban Movement Analysis framework. I self-reflectively evaluated the prototype chair design, while contrasting this with traditional wheelchair designs. Participant research responses helped to shape and inform the analysis. This process of theorization presented the potential for a dance-based Embodied, Socio-Spatial Design (ESD) paradigm as a useful and novel way for re-imagining device design.
I hope that this discourse prompts further ideas for wheelchair design as an embodied, meaningful, formative element in the life of users and their friends/caregivers/partners. Perhaps the wheelchair’s form can be a morphing form rather than a stilled/static/contained form. What other possibilities could be probed? It is up to those unique bodies who engage with and conceive of devices as dancers/performers, as caregivers, as therapists, as wheelchair users, as technologists, and as choreographers, to decode and re-code the possibilities, to invent new tactics, and to push into new places and spaces. These actions will continue to renew and challenge our lives as embodied, interdependent, and complex human beings.