

**Modular Walker Handles for a Motorized Posterior Walker**  
**How Inequity Was Introduced into The Organ Transplant List**

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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## **Introduction**

In 2022, 42,887 organ transplants were performed in the United States (Young, 2023). Despite this, there are still currently 104,234 people on this list and a new name is added every ten minutes. Seventeen of those people will die every single day waiting for an organ (Health Resources and Services Administration, 2023). In a system with stakes this high, inequity and discrimination lead to deadly consequences. Due to this, inequities throughout the creation and evolution of the organ transplant list are well documented (Kjellstrand, 1988; Simmerling, 2007). However, efforts to combat this inequity have had mixed results (Park et al., 2022). In this portfolio, I will analyze the history of discrimination and inequity in the organ transplant list using the Social Construction of Technology framework to gain a better understanding of who influenced the policies and organizational structures of the list and how discriminatory practices became rooted in it.

A field of healthcare that is picking up major traction in the US is gait biomechanics. Original methods that analyzed how a patient walks using techniques like kinematic analysis and electromyography were how researchers initially looked for biomechanical indicators of disease and how the mechanisms for gait related disorders were characterized (Whittle, 1996). New advancements in sensor and video tracking technologies are allowing for groundbreaking research into improved therapeutics for musculoskeletal and other gait related disorders. Recent studies have shown results in characterizing the forces involved in gait biomechanics for children with cerebral palsy (Chakraborty et al., 2020; Park, 2017), but developing therapeutics for the disease is challenging. Cerebral palsy causes considerable pain, which hampers researchers' ability to develop therapeutic strategies because they're painful for the child to complete (Swiggum et al., 2010).

The Motion Analysis and Motor Performance Laboratory at UVA is working with Barron Associates to redesign the walkers used in day-to-day life by children with cerebral palsy to improve its therapeutic function. In a clinical trial investigating gait biomechanics involving these walkers, our technical team is redesigning the walker handles used in these trials to optimize data collection and minimize time spent waiting by the child participants between trials.

These parallel healthcare systems, one well-developed and the other still in its embryotic stage, both exhibit inequity that needs to be extinguished. Many attempts have been made to address inequity in the organ transplant list, and by studying the history of the field and these efforts, strategies can be implemented to prevent inequity from taking root in developing fields of healthcare such as gait biomechanics.

### **Technical Topic**

Cerebral palsy (CP) is a congenital disease that affects the development of motor and balance skills. It is the single most common motor disability affecting children in the United States, diagnosed in roughly 1 in 345 children (Centers for Disease Control and Prevention, n.d.). The Motion Analysis and Motor Performance Laboratory at UVA, in collaboration with researchers from Barron Associates, is in phase two testing of a clinical trial to develop a motorized posterior walker to be used by children afflicted with CP to optimize energy consumption while walking. This walker will offer an improved therapeutic approach to current walkers, better addressing the pathological gait associated with CP that results in wasted energy when moving in forward motion such as walking (Russell et al., 2011).

In the clinical trial, child participants are attached to various instruments including electromyographs (EMGs) which measure electrical activity in response to nervous stimulation

of muscle tissue, a VO<sub>2</sub> mask, and reflective markers which are used to measure energy consumption and gait cycle during trials. Currently, a standard posterior walker, used as a control, and a motorized posterior walker, developed by Barron Associates, are being tested during data collection.

The handles of these walkers are attached to powerful but expensive force transducers that help measure the forces involved in the gait biomechanics of children with cerebral palsy, which means they must be interchanged between the two walkers during the trials. However, transferring between the two walkers takes a team of three people and several minutes. This downtime can lead to calibration errors of the other equipment being worn by the participant or a skewing of the data from the unaccounted variations in motion while they are waiting for the walker to be set up and calibrated. Given that each force transducer starts out at a cost of almost \$6,700 (ATI, n.d.), buying an additional set of transducers and having another set of handles is not a viable solution on the trials' limited budget.

To address this problem, utilizing computer assisted design, 3D modeling, and conventional manufacturing techniques, our capstone team will redesign the walker handles used in the clinical trial with three objectives in mind: First, our handles must fit securely to the force transducers and on both walkers used in the trials, and they need to be manufactured with budget-friendly materials. Despite this, the handles must also be strong enough that they do not flex under load and mess up the data collection process. Finite element analysis techniques (Ganeshkumar et al., 2022) will be used to identify weak points and the minimum required tensile strength.

Second, we will design the handle to be mountable or dismountable by a single person. This will require redesigning the body of the handle and the locking mechanism so that one person

can both stabilize the walker and dismount or mount the handle. Minimizing the amount of people needed for the mounting and dismounting process minimizes both the chance for unintentional errors and cost of labor for the trials.

Third, we will design these handles to be mounted and dismounted significantly faster than the current model. The current design is not user-friendly and requires the precise use of a large, specialized Allen Key to operate the locking mechanism of the handle. This drastically increases the time required to set up these walkers and can increase the amount of people necessary for the process. By utilizing an easy-to-access and easy-to-operate locking mechanism, our handles will be able to be mounted and dismounted not only by one person but faster than the current handles. While reducing the amount of people needed to mount the handles is an added benefit, the main goal of this objective is to reduce the time spent waiting in between trials by the participants, who are usually children.

In addition to these three objectives, our capstone team aims to ensure that our handle designs do not introduce new sources of inequity. The grip of our handles will be designed so all the participants can easily wrap their hands around it and to prevent discomfort or injury (Grant et al., 1992). The shape, material, and pattern we decide on for the grips will come from research into literature and industry standard grip designs for devices similar to our walkers, to prevent any chafing or discomfort for participants during the trials.

## **STS Topic**

Organ transplant is a technique that has allowed doctors to perform lifesaving treatments on patients with otherwise fatal conditions. However, there is an extremely limited number of available organs for transplantation at any given time, so the concept of an organ transplant

waitlist needed to be created. In 1984, Congress passed the National Organ Transplant Act, establishing the Organ Procurement and Transplantation Network, known as OPTN (*History and NOTA – OPTN*, n.d.). This is the registry where organ matching between donors and patients is done. However, while the government created the network for organ transplant, they don't manage the list itself. The organ transplant waitlist is managed by a private company contracted to the federal government, the United Network for Organ Sharing (UNOS, 2023). This is not the only link in the chain that could be subject to personal interests or discriminatory practices, though, and from for-profit organ procurement organizations to entrepreneurial transplant hospitals, there are a multitude of ways and methods that people can and are being discriminated against.

This discrimination is not unknown however, and in the case of the organ transplant list, has been well documented over the past few decades. A review on kidney transplantations found that doctors were less likely to put Black patients on the list, and that Black patients who did make it onto the list had longer waiting times than White or Asian patients (Malek et al., 2010). A study in 2008 that found while 16.9% of organ donors are uninsured, only 0.8% of organ recipients are uninsured, showing a clear inequity in the number of organs being donated vs. received by uninsured patients (Herring et al., 2008). Despite it being well-known phenomena, recent research suggests that these inequities are still extremely prevalent in today's list (Park et al., 2022). This indicates that the roots of inequity run deep into the foundations of the organ transplant list and warrants attention towards how those roots grew in the first place. For the sociotechnical aspect of this portfolio, I will be examining the history of the Organ Transplant List. How did the discriminatory practices and regulations inherent to the system we see today come to be?

I want to examine how these practices that discriminate against different groups across the United States became integrated into the regulatory and organizational foundations of the organ transplant list. Specifically, I will be analyzing it through the lens of the Social Construction of Technology (SCOT) (Pinch & Bijker, 1984). This framework introduces four key ideas that I will apply to the history and evolution of the organ transplant list.

The first key idea from SCOT is interpretive flexibility, which is that different people have alternative interpretations of the technology which result in different problems to be solved. The second key idea is the concept of relevant social groups. In relation to a specific technology, there are many groups (users, producers, politicians, etc.) who must be identified, as each group has interpretive flexibility towards how they view the technology. I will be identifying the relevant social groups such as patients, doctors, researchers, and policy makers and their interpretive flexibilities in the history of the organ transplant list to see who, how, and why these practices became ingrained in the transplant list. The third key idea from SCOT is closure. It is the idea that, as development goes on, the interpretive flexibility will decrease and the problem will be considered solved, either through rhetorical closure or redefinition of the problem. This could be exemplified in the design choices that were made in the development of the list's structure and the organizations that were given power over it. The final key idea from SCOT that I will be using in my analysis is the concept of stabilization. Like closure, stabilization is the idea that the relevant social groups eventually decide that the problem has been solved, and the technology takes on a form that becomes the norm, and no more attempts at innovation occur, such as restructuring the organizations or hierarchies of the list. I will be identifying the closure and stabilization mechanisms that allowed discriminatory practices to become ingrained in the organ transplant list.

To apply these four key concepts to my research, I will dive deep into the history and regulations surrounding the creation and evolution of the transplant list. Investigating the history of organ transplantation will involve historical studies from US based journals such as the *American Journal of Transplantation* or *Current Opinion in Organ Transplantation* and transcripts and recordings from conferences related to transplantation such as the American Transplant Congress or the National Conference on Donation and Transplantation. To learn about the regulatory history, I will analyze documents from government sources like Congressional Research Service Reports, the Code of Federal Regulations, and legislative reports from the U.S. Department of Health and Human Services relating to organ transplant.

The culmination of this project and the ultimate goal of this research is to gain a better understanding of how the influence of relevant social groups involved in the creation and evolution of the organ transplant list ingrained discriminatory practices into its' organizational and regulatory foundations through interpretive flexibility, closure mechanisms, and stabilization. These insights can then be utilized in other developing areas of healthcare to avoid falling into the same pitfalls of inequity that plague the organ transplant list.

## **Conclusion**

Through the STS portion of this portfolio, I will be investigating the history of discrimination in the organ transplant list and how inequity became baked into the essence of the system. This will provide a deeper understanding of how discriminatory practices were entrenched into the organ transplant list in the first place and how they've been allowed to linger since. In the technical aspect, our team will redesign walker handles used in a gait biomechanics trial to optimize data collection, aiding in the creation of an improved therapeutic approach for



children with cerebral palsy. This approach revolves around making physical therapy a part of their day-to-day activity by making the walker itself a therapeutic device. The lessons learned from investigating the organ transplant list can be applied to gait therapeutics and our clinical trial to reduce current sources of inequity and prevent new sources of inequity from occurring during the development of this field.

**WORD COUNT: 2186**

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