Thesis Project Portfolio

SURE: Soft Upper-limb Rehabilitation Exoskeleton

(Technical Project)

Navigating Responsibility:

Examining the Shortcomings of Ghana's Stroke Care Infrastructure

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

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My technical project and STS research both address stroke rehabilitation and focus on the issues created by accessibility. Several factors limit stroke victims from obtaining proper rehabilitation therapies, many of which stem from the nature of stroke rehabilitation itself: high intensity and frequent sessions at hospitals or clinics. My technical project addresses the accessibility of upper-limb stroke rehabilitation physiotherapy by producing a soft, wearable exoskeleton that rehabilitation motions for the upper limb, and my STS research aims to unpack stroke care in Ghana and how it is being hindered by both the publics and stakeholder's lack of understanding of stroke.

My technical project is a soft upper-limb rehabilitation exoskeleton (S.U.R.E) designed for people who have lost mobility in their upper limb in an effort to improve and, ideally, restore their lack of mobility. The current design was inspired by other research designs and improved upon in hopes of resolving the shortcomings that had not been accounted for previously. The main goal we sought to accomplish is to make this rehabilitation therapy usable at home, and without the help of a healthcare worker or engineer. Prioritizing it's at-home use comes with accessibility features including low cost, lightweight design, portability, and ease of operation. The exo repeats one motion: flexion of the elbow while the hand clamps into a fist, and extension of the elbow as the hand stretches back out. This combination of fine and large motor skills is an important component of the at-home rehabilitation exo that is missing in current practice. Combining these two motions saves time, as well as expands the applications of the machine itself. Only four components will come into contact with the wearer: a small runners backpack, a

wrist cuff, a compression glove, and a small push button. By using textiles, traditional use of hard plastics and metals to provide structural support is not necessary; instead, Bowden cables controlled by small motors in the backpack and glove will direct the movements. User-set maximum and minimum elbow angles help ensure that the biomechanics of the design is safe and usable for a wide range of populations. The elbow and hand motors are controlled by a microcontroller in the backpack, that utilizes PID motor control. Using small DC motors and microcontrollers allows the design to run independently of any computer and light enough to carry in a backpack, making it fully portable. The user progresses through the physical therapy session by pressing a small push button, that is accessible when wearing the backpack. The design's adaptability to patient circumstance counteracts the main issues facing the standard robotics used for rehabilitation. By eliminating the need for outpatient visits, the cost of rehabilitation and the physical barrier to accessing therapy is reduced.

My paper examines the challenges within Ghana's stroke care infrastructure, focusing on the high stroke rates combined with low rehabilitation success rates that afflict Sub-Saharan Africa. Using Star's Ethnography of Infrastructure as an STS framework, I establish areas of the system that result in low outcomes such as unsuccessful rehabilitation, socioeconomic disparities in recovery, and high caregiver burden. Research was conducted by treating the Ghanaian stroke crisis as a case study, so that I could gain a holistic understanding of the systems already in place. I gathered information from various sources including statistical data, surveys, medical papers, and interviews. Local insurance policies were also investigated for their compliance with stroke rehabilitation needs. In my analysis of this literature, accessibility problems relating to socioeconomic status, public awareness, caregiver burden, and policy constraints were analyzed, highlighting the need for accountability among stakeholders. Recommendations include

improving caregiver support from the healthcare systems, enhancing public awareness of stroke, incorporating cultural beliefs into care practices, and revising insurance policies to reflect the requirements of stroke rehabilitation. My paper advocates for a collaborative effort to optimize Ghana's stroke care infrastructure and alleviate the burden on individuals.

By working on these two projects simultaneously, I was able to take what I learned for one and apply it to the other project; the projects informed one other. My technical project is applicable to more populations and addresses more accessibility issues as an upper-limb wearable exoskeleton. After conducting research on typical barriers facing stroke victims, I could develop my design to overcome some of these, including costs, frequency, and distance of hospital visits. Through my design project, I was able to do more productive and informed research for my socio-technical report. Experiencing the nuances of developing a rehabilitation device helped me to understand important aspects of stroke rehabilitation. Combining these two unique projects, I will bring more perspective to the stroke community on how to accommodate diverse obstacles facing stroke care.