

**UPPER-LIMB EXOSKELETON FOR SHOULDER JOINT CONTROL**

**HOW ROBOTS CHANGE THE PATIENT-CAREGIVER RELATIONSHIP**

An Undergraduate Thesis Portfolio  
Presented to the Faculty of the  
School of Engineering and Applied Science  
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Bachelor of Science in Mechanical Engineering

By

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## **SOCIOTECHNICAL SYNTHESIS**

The rise of robots in the health care industry has provided tremendous growth for both patients and their caregivers. Creating an upper-limb exoskeleton using soft materials can provide relief from the stress and workload in this patient-caregiver relationship, but it is equally important to understand the social implications that go along with introducing robots into sensitive populations, like the elderly and persons with disabilities. The STS research paper aims at identifying ways that robots can change and improve the patient-caregiver relationship. The technical report and STS research paper are tightly coupled, in that the exoskeleton developed in the technical report is one example of a robot that can affect the patient-caregiver relationship. By understanding the various ways that this exoskeleton could change the dynamic between these two individuals and improve or worsen both of their lives, engineers will be able to make informed decisions when designing their technologies.

The technical research report describes the design and development of an upper-limb exoskeleton for motor control and rehabilitation. With the addition of this exoskeleton into the patient-caregiver relationship, patients that have motor impairments will gain some of their independence back. At the same time, caregivers will have more time to focus on making meaningful relationships with their patients, instead of having to perform everyday tasks for them.

The exoskeleton designed in the technical project focuses on actuating the shoulder joint using inflatable artificial muscles and 3D printed support structures. Several iterations of various types of artificial muscles were tested to decide which model produced the most force and was therefore able to lift the human arm in the most efficient way. Overall, the exoskeleton provides moderate range of motion to the shoulder joint, but solely in the abduction/adduction degree of

freedom. While the exoskeleton was tested on team members, because of the time and resources allocated, it did not end up being tested in a clinical setting.

The STS research discussing the patient-caregiver relationship was inspired by the rise of robots in the health care industry combined with the increasing elderly population. This research seeks to discover if robots change the patient-caregiver relationship for the better. First, the existing patient-caregiver relationship was defined. Next, the problems in this relationship were identified through scholarly essays and first-hand accounts in newspaper articles. Finally, the addition of robots into this relationship was analyzed using Law and Callon's Actor-Network Theory.

It was proven that both patients and their caregivers have a severe amount of stress put on them, and this has serious effects on their physical and mental health. The use of both social and physical robots can provide relief to both parties. Patients receive aid with everyday tasks or companionship, while caregivers get extra time to focus on specific aspects of their jobs rather than having to do everything for their patients. Although these benefits prove that robots will improve the patient-caregiver relationship, it was found that it is also important to introduce them slowly, and only if both individuals are in favor of it.

It is clear that the caregiving industry needs to be improved for both the caregiver and their patients. Robots offer promising improvements that can lessen the burden put on these individuals. At the same time, they can also cause misunderstandings and be used inappropriately. With the correct trainings and introductions, robots have the ability to change the patient-caregiver relationship in order to benefit everyone involved.

## **TABLE OF CONTENTS**

### **SOCIOTECHNICAL SYNTHESIS**

#### **UPPER-LIMB EXOSKELETON FOR SHOULDER JOINT CONTROL**

with Colton Applegate, Joseph Carley, Nazirah Farach Rojo, and Marvin Lee

Technical advisor: Sarah Sun, Department of Mechanical and Aerospace Engineering

#### **HOW ROBOTS CHANGE THE PATIENT-CAREGIVER RELATIONSHIP**

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### **PROSPECTUS**

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