

# Sociotechnical Synthesis

## *Technical Project*

The technical and sociotechnical sections of this paper are separate. The technical project addresses the problem of healthcare accessibility. According to the American Stroke Association, 25% to 43% of stroke patients experience spasticity, an abnormal increase in muscle tone or stiffness, in the first year after their stroke (2019). Regular physical therapy helps the patients regain their mind-muscle connection and mobility (Onishi, 2018), but it is costly and time-consuming. The goal of the project is to develop a cheap product that stroke patients could use comfortably at home to help with stroke recovery if they cannot or do not want to travel to physical therapy offices.

A solution was developed that would help stroke patients' recovery while minimizing the hindrance on the patient's daily life. A successful technical aspect of physical therapy, repetitive passive movements, was translated into a product that would enable an improved standard of living for stroke patients. The goal of the project was to produce a 2-degree of freedom (DOF) soft exoskeleton robotic arm that guides the patient through elbow and wrist flexion and extension, achieving a total range of motion (ROM) of 90 degrees for both the elbow and the wrist. Importantly, the robot had to be portable, lightweight, easy to take on or off, and programmable. These were the factors used to evaluate the product throughout its development. Through various prototypes, it became clear that although soft components were preferred for comfort, hard components were required to achieve significant ROM and constrain DOF. It was also found that a servomotor was well-suited for wrist flexion/extension, and a pneumatic muscle was well-suited for arm flexion/extension, since it had a great power-to-weight ratio. 3D printing was good for producing hard, lightweight components of the design.

The loud noise produced by the air pump was a significant drawback to the design. While the final product did not fully meet its ROM goals, it met the goals of 2-DOF, portability, programmability, and ease of use. Future researchers could improve upon this design by reducing noise production, increasing ROM, or introducing another DOF. Such work is necessary so that the product can better measure up to the level of care provided by an in-person physical therapist. This project is a step in the right direction and can be built upon for improved capability.

Thank you to Professor Sun for being an awesome technical advisor, inspiring the technical project idea, and for guiding and encouraging us throughout the design and build process.

## *Sociotechnical Paper*

The sociotechnical paper aims to address the problem of responsible innovation in U.S. defense. A 2021 paper by the Union of Concerned Scientists (UCS) titled *Slowing the Hypersonic Arms Race* claimed that the U.S.'s development of hypersonic missiles was devoid of rationality and was rather fueled by “hype”. Meanwhile, the U.S. Department of Defense has spent “\$8 billion since 2019 on programs to develop hypersonic missiles” and requested another “\$13 billion over the 2023-2027 period” (Congressional Budget Office, 2023). Consequences to irrational defense spending include a destabilized global arms balance, degraded international relations, and ineffective technologies. The U.S. government must critically evaluate defense technology before moving forward with investment, and the sociotechnical paper uses hypersonic missiles as a case study.

The reasons for and against hypersonic missiles development were discussed in order to determine if the U.S.'s investment in hypersonic missiles is justifiable under the responsible innovation framework. The paper explored the factors of the war on terrorism, competition with Russian and China, nuclear ambiguity, and intelligence deficiency, and determined that the risks associated with hypersonic missiles development vastly outweighed the benefits. The reasoning for hypersonic missiles development was often misguided, based on assumptions that were either uncertain or entirely false. In addition, the introduction of a new type of weapon drew Russia and China's attention and threatened their security. It was irresponsible for the U.S. to have such prolonged investment into hypersonic missiles when other solutions might be more effective and less expensive, all without instigating another arms race.

The sociotechnical paper contributed to the solution to irresponsible innovation by exposing the ways in which information has been manipulated or simplified to justify hypersonic missile development, so that this can be avoided in the future. It serves as a warning to the U.S. government not to jump to conclusions, and to instead perform an in-depth analysis of global conflicts in order to properly identify problems and come up with direct defense solutions.

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