

**DEVELOPMENT OF A SHEATH TORQUING TOOL FOR MINIMALLY INVASIVE
PROCEDURES**

**INVESTIGATING THE EFFECTS OF HUMAN-AUTOMATION INTERACTION IN
MEDICINE**

An Undergraduate Thesis Portfolio
Presented to the Faculty of the
School of Engineering and Applied Science
In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science in Biomedical Engineering

By

Anna Lam

April 28, 2020

SOCIOTECHNICAL SYNTHESIS

The design of an innovative medical device and the investigation of automation in technology collectively explore the realm of automation and its impact in medicine. The technical research report addresses the instability in the movement of a guidance tool commonly used during medical procedures for the treatment of cardiovascular diseases through the development of a novel medical device. The device seeks to minimize frustration and distractions caused by the current technology and, by doing so, demonstrates the importance of balance in human-automation interaction. The science, technology, and society (STS) research paper investigates the impact of how current systems that value business profits more than patient care affect automation of technologies on medical professionals, patients, and associated institutions in medicine. Exploring the varying levels of automation and the effects of a lack of collaboration between humans and machines establish significance for a human-automation interaction continuum. The technical project and the tightly-coupled STS research study the current use and impact of automation in medicine and the implications it has on providing medical care.

Intracardiac ultrasound catheters are medical devices intended to provide convenient guidance during medical procedures by producing real-time images of the heart's interior. The innovative technology can be manipulated by physicians to achieve different views through four degrees of movement. There are no current designs nor methods that account for the instability of the catheter's movement within a patient's body, demonstrating a device flaw that the technical research aims to eliminate by providing users greater control of the catheter by using a novel sheath torquing device. Through collaboration with experienced users of intracardiac

ultrasound catheters, two models were developed to redistribute the weight and add stabilization to the catheter handle.

Potential users of the novel device are intrigued by the solutions that the design models present for the long-standing problem and indicate interest in performing in-person testing and potential application of the device. Future work and further testing will be necessary to demonstrate complete success of the intended goals of the technical project which have been impacted by unforeseen circumstances regarding the 2019 Coronavirus Disease.

With the amount of power that automated technology harvests in the medical field, how will the fundamentals of medical care be impacted by increased automation? More specifically, does increased automation in medicine foster physician complacency and create a lack of oversight in medical procedures other potential consequences of a human-automation interaction? These questions are explored through the STS report which searches for a root cause for the adverse effects of the well-intended innovation. With supporting research from experts in the field of automation, psychological concepts of human complacency and moral injury, and the human-automation intersection, the STS report examines current systems in place that prioritize business operations more than quality patient care. The status of the current system and a refined model that establishes critical relationships between involved social groups of the system are illustrated using conceptual STS frameworks such as Social Construction of Technology and System in Context.

Considering human experiences do not usually fit into binary categories but are rather described better as a continuum, human-automation interaction should also avoid falling into a binary system of needing to choose between machine and human. As the role of automation grows and increases productivity, consistent quality, and greater accuracy, different levels of

involvement for a human operator and machine have been introduced in literature. The interaction of automation and medical professionals can be adopted by a five-level taxonomy that compactly yet descriptively characterizes the human-automation interaction in medicine. Research studies show that the highest levels of efficiency and lowest levels of complacency do not stem from either extreme of levels of automation, but are rather found within the continuum of the five-level taxonomy. Taking the social contexts into account and establishing critical checks and balances between actors can establish an improved system that promote better patient outcomes, reduced burnout rates, and greater business operations.

Technological advancements and the direction society is taking toward automation do not have to be detrimental or cause more harm than good. As demonstrated by the technical project and explored by the STS research, automation in medicine can help transform a culture of wealth into a culture of health. Seeking balance by maintaining within the continuum of the levels of human-automation in a combined context of system goals and actor involvement can enhance not just medicine, but all fields impacted by automation.

TABLE OF CONTENTS

SOCIOTECHNICAL SYNTHESIS

DEVELOPMENT OF A SHEATH TORQUING TOOL FOR MINIMALLY INVASIVE PROCEDURES

with Avinaash Pavuloori

Technical advisor: Nishaki Mehta, MD, Department of Biomedical Engineering

ETHICAL IMPLICATIONS OF UNSECURED PUBLIC INFORMATION SYSTEMS

STS advisor: Catherine D. Baritaud, Department of Engineering and Society

PROSPECTUS

Technical advisor: Nishaki Mehta, MD, Department of Biomedical Engineering;

STS advisor: Catherine D. Baritaud, Department of Engineering and Society