IMPROVING THE ERGONOMICS OF THE MODERN GI ENDOSCOPE

AN ACTOR-NETWORK ANALYSIS OF NEGLECTED STAKEHOLDERS IN THE DESIGN OF THE ENDOSCOPE

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SOCIOTECHNICAL SYNTHESIS

In a sociotechnical world, the future of a technology depends not only on the quality of its design, but also on the actors that comprise the network around it. The modern endoscope, first introduced in the 1950s, is a technology that has stood the test of time, but has also carried along a persistent ergonomic flaw that causes musculoskeletal overuse injuries in gastroenterologists. The technical team identified this problem in the clinic and developed an endoscope attachment to alleviate thumb strain during the operation of the endoscope. Although the concept of the team's novel device is practical, wide scale acceptance and adoption of this device requires the mobilization of a network of actors. Law and Callon's Actor-Network Theory (ANT) was used to examine different groups involved with the endoscope and to identify 'neglected' stakeholders that suffer from its design. Using ANT, the Science, Technology and Society (STS) research paper was able to both identify gastroenterologists as neglected stakeholders and propose a solution that uses engineers as the catalyst to mobilize systemic change. The STS research provides the technical project a conceptual framework to guide the engineering work in endoscopy toward a direction of sociotechnical transformation.

The need to provide gastroenterologists with a better ergonomic solution to the endoscope was motivated by the technical team's identification of the problem in the clinic and in a handful of past research. While looking into the research literature, the technical team found that in combination with a high volume of work, three main risk factors in endoscopy emerge as key contributors to musculoskeletal overuse injury of the thumb: prolonged strain on the thumb, repetitive action of the thumb, and high forces being exerted on the thumb. In response to this ergonomic downfall, the technical team decided to design a device that would address at least one of the identified risk factors. Furthermore, success would be measured not only by the design

of a viable, working prototype, but also by a measured decrease in thumb muscle exertion after the implementation of the device.

After months of iteration, the technical team is close to a minimally viable prototype that uses a ratchet mechanism to lock the position of the dials in place when turned. By designing a locking mechanism for the dials, the gastroenterologist's thumb would no longer need to hold positions for extended periods of time, decreasing their muscle exertion. Although there are currently no comparable results to report, the technical team has prepared a BioRadio electromyograph to measure muscle activation of the abductor pollicis longus muscle, as well as a SingleTact force sensor to measure the amount of force exerted by the thumb during endoscope operation. Measurements will be taken before and after the implementation of the device and a decrease in these parameters would indicate a successful design.

The ergonomic endoscope attachment serves as the technical foundation for the STS research portion which takes a step back from design to look at the actor network surrounding the endoscope. By doing so, the STS research contextualizes the engineering problem through a social lens. The goal of the STS research was to use ANT to examine the interactions between gastroenterologists, fellowship programs, and manufacturers. This analysis determined gastroenterologists as neglected stakeholders and was able to explain why the ergonomic problem of the endoscope had persisted for so many years. The STS research examined manufacturers like Olympus, evaluated the role of fellowship programs, and compiled past research and personal interviews to synthesize the point of view of gastroenterologists.

It became clear that the lack of an overwhelming response to the problem was not because the ergonomic flaw is not recognized; rather, the cycle of inaction is preserved by a lack of unified mobilization of actors for change. Manufacturers like Olympus have a history of

improving patient diagnosis and treatment rather than improving the ergonomics of the endoscope. Fellowship programs train cohorts of gastroenterologists to be competent with the conventional endoscope, solidifying physician dependence on the poorly designed device. Most importantly, many of the neglected actors themselves, the gastroenterologists, are seemingly unenthusiastic about drastic change to the endoscope because of the level of disruption involved. A novel device would require them to undergo extensive amounts of training to regain a comparable level of competency. In order to shift the actor network to favor an ergonomic solution, the STS research proposes that engineers must step in to push the system out of complacency and mobilize all the actors in the network to adopt a new technological paradigm.

Engineers are in a unique position to bridge the gap between people and technology and bring about sociotechnical change to a network of stakeholders. Although engineers can turn actor networks toward new technological directions, it is important to consider the consequences of their own inaction. It is not enough for a novel technology to work. If the engineer does not mobilize the stakeholders to integrate the device into their network, their technology will be unable to reach the people who need it the most, and the status quo will remain unchanged.

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