Ergonomic Lead Garment

Gender Disparity in the Operating Room

A Thesis Prospectus
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By
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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Patient demand for minimally invasive surgery procedures has increased greatly in previous years (Hamad & Curet, 2010). This procedure has caused increased exposure to radiation for surgeons who now wear protective garments, specifically the lead garment, for many hours a day. Although this garment provides adequate protection against radiation exposure, the number of injuries and other ergonomic risks caused by this device has increased risk sustaining an impact on a surgeon's career span. Specifically, female surgeons are more affected than male surgeons. Surgery is a male dominated field (Almendrala, 2017) and many of the top leadership positions in the American Medical Association and hospital boards are held by men who create policies and regulations that support male surgeons more. This has created many ergonomic challenges for female surgeons as medical devices are not designed and rules are not set to their parameters.

The technical paper and the tightly coupled STS research paper look to provide a better understanding of ergonomic challenges in the operating room. The technical research looks to create an innovative and improved ergonomic lead garment that significantly reduces the amount of pain felt by surgeons and medical teams during operations. The STS research focuses on examining ergonomic challenges experienced by female surgeons as a result of top medical leadership consisting of men who create regulations and guidelines that accommodate male surgeons better. The technical research will be presented in a journal style paper and the STS research will be presented in a scholarly article.

LEAD GARMENTS AND ERGONOMIC PAIN

With the guidance of Dr. Nishaki Mehta, in the Cardiovascular Medicine Division at the UVA Health System and Biomedical Engineering Graduate Student Katerina Morgaenko, Biomedical Engineering Undergraduate Students Rohni Awasthi and Briana Fuller will be looking to create an improved ergonomic lead garment. A lead garment, presented in Figure 1, is protective clothing used by radiographers, surgeons, and medical teams to protect against the side effects of radiation.

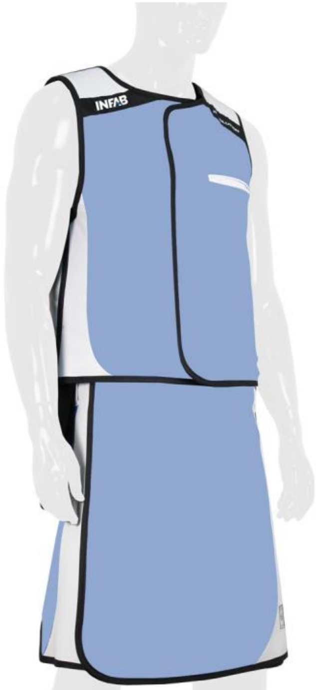

Figure 1. Lead Garment. Displays the lead garment and how it is worn explaining distribution of weight. (Infab, 2018)

As surgery is moving toward more minimally invasive procedures the use of x-rays and need for protective clothing has increased (Hamad & Curet, 2010) and the lead garment is the most commonly used protective measure (Hyun, Kim, Jahng, & Kim, 2016). The lead garment usually consists of one or two pieces which can weigh up to a total of 20 pounds leading to a significant amount of orthopedic stress on surgeons and medical teams. As seen in Figure 1, the two-piece device rests on a person's hips and lower back, causing low back pain, and the vest bears a significant weight down on the shoulders causing pain in that area. These health professionals wear these garments anywhere from 4 to 10 hours a day while performing operations.

Although alternatives have been made to the lead garment in the form of protective lead shields and zero-gravity machines, these do not allow for free movement as the surgeon is attached to the contraption, provide little to no protection around the neck area, and are not easy to maneuver in an operating room. Moreover, the current alternatives do not function well for people of different heights and weights. Therefore, the biggest problem of all current solutions is the inability to effectively reduce the impact of weight as well as allowing mobility and ability to function properly. Therefore, the primary objective of this project is to design and test a modified lead garment to reduce the orthopedic stress on surgeons and medical teams. Health staff experience greater low back pain than other occupations (Karahan, Kav, Abbasoglu, & Dogan, 2009) and a significant number miss work because of this pain (Pelz, 2000). In a study conducted of employees in the cardiology and radiology departments of various hospitals it was concluded that most work-related pain was experienced by technicians, nurses, and physicians (Orme et al., 2015). In another study employees were surveyed and it was shown that 30% sought medical care due to work-related pain from lead garments and 16% developed short- and long-term disabilities (Alexandre, Prieto, Beaumont, Taiar, & Polidori, 2017). This establishes that there is a significant need for a new and improved garment as the current design is causing injury and pain.

DESIGN PROCESS

There are three primary aims of this technical project: (1) conduct interviews of medical health professionals at the UVA Hospital to understand challenges of device and improvements needed, (2) design three lead garment prototypes to test on human sized mannequins to address needs of health professionals, (3) test the best prototype on medical team volunteers at the UVA Hospital and adjust prototype after testing. To better understand the limitations and challenges of the current design, input will be taken from health care teams, including physicians, surgeons, nurses and technicians at the UVA Hospital through interviews conducted via the iCoreQuestionnaire. This data will then be organized to create 3 models of a few designs that address the concerns of working professionals. These models will be tested on mannequins to measure distribution of weight as well as different sizes, stiffness, materials, and access to free movement and range of motion to select the best option to convert for human testing on medical team volunteers at the UVA Hospital. Materials and machinery will be provided by the Machine Lab through the Physics Department at UVA. The testing prototype should have redistributed weight in a proper manner to reduce orthopedic stress as well as allow proper functionality and movement. The prototype will be tested on medical team volunteers, who will wear the garment with added weights to stimulate the force felt after about 4-10 hours of surgery. It will also be tested in terms of volunteers mimicking movements that they would typically perform in surgery to assess comfortability, functionality, and mobility. The volunteers will then be given questionnaires to rate comfortability, freedom of movement, back pain, neck pain, shoulder pain, and hip pain in order to grade the prototype's effectiveness at decreasing orthopedic stress and its wearability allowing the prototype to be adjusted accordingly.

The expected results of the technical project are to have a new and improved fully functioning lead garment that effectively reduces and/or eliminates orthopedic pain as well as allows proper functionality and ease of movement. The results of the technical project will be presented in a journal style paper and the timeline of the project is presented in Figure 2.

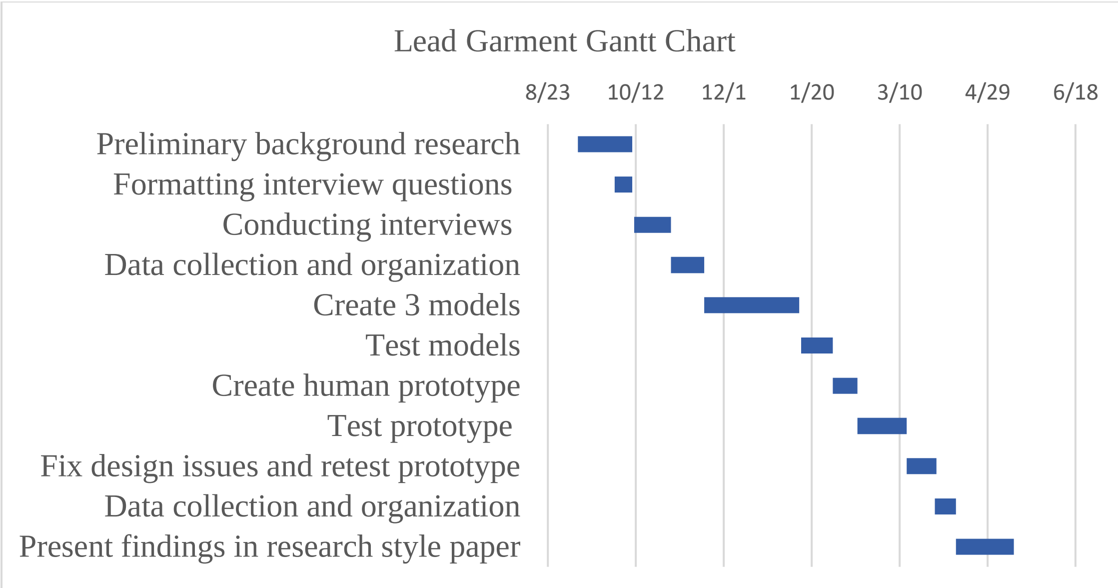

Figure 2. Gantt Chart. Displays the timeline for the Lead Garment Project. (Awasthi, 2019)

THE EFFECTS OF LEADERSHIP ON FEMALE SURGEON SUCCESS

The operating room holds many ergonomic challenges for surgeons from the lead garment to the operating table and everything in between. The field of surgery is a male dominated field with only 19% of all surgeons in the United States being women (Almendrala, 2017). This has caused significant challenges for women not only in advancing in the field but also in operating and managing devices in the operating room. In data obtained by the American Medical Association it was shown that in 2017 the number of female students enrolled in medical schools was higher than male students and the trend continued to persist through 2018 (Association of American Medical Colleges, 2017). This is significant as this was the first time ever that the number of female students enrolling in medical school has been higher than male students although the number of female students enrolling has steadily been on the rise since 2002 as seen in Figure 3 (Henry J. Kaiser Family Foundation, 2019). However, female surgeons are still experiencing a significant amount of ergonomic pain in operating medical devices, especially in the operating room.

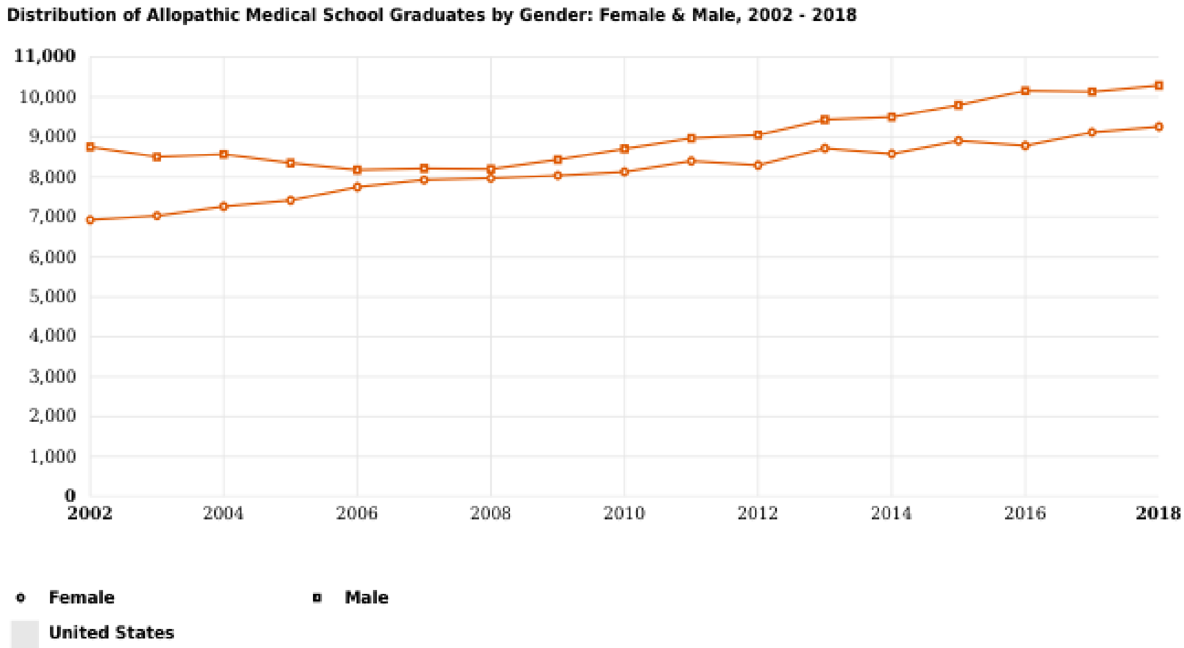

Figure 3. Distribution of Allopathic Medical School Graduates by Gender. Displays that there has been a rise in female medical students since 2002. (Henry J. Kaiser Family Foundation, 2019)

MEDICAL LEADERSHIP

The American Medical Association conducts a variety of tasks, from guiding public policy in terms of healthcare issues, to being in charge of medical schools, and establishing medical practice guidelines (American Medical Association, 2019). They also determine the rules and regulations physicians must follow in an operating room and the way they must conduct themselves. The current Board of Trustees that makes up the AMA, which helps establish these laws only has 7 female members out of a group of 21 members total (American Medical Association, 2019). The head leadership is 67% male which is making it difficult to resolve ergonomic issues for female physicians as they are underrepresented in the group that performs the decision making. It was also found that at the top 100 U.S. hospitals only 27% of women hold positions on a hospital board (Joyce, 2018). Hospital boards establish a lot of the guidelines and regulations that determine how a hospital is run as well as how medical devices are used and what the sterilization procedures should be. With this leadership also being comprised mostly of men, the guidelines and standards that are established for the usage of medical devices and in an operating room are more suited for male surgeons making it difficult for female surgeons.

ERGONOMIC AND SANITIZATION ISSUES

There are many examples of ergonomic issues taking place especially in operating rooms because of this difference in leadership. One example is the handle size of instruments. In a study conducted that looked at the relationship between hand size and difficulty in using surgical instruments it was determined that those individuals with smaller hands, typically females, had more difficulty in operating these devices as well as had to get treated in response to these factors (Berguer & Hreljac, 2004). In another study conducted that looked at the effects of medical devices on pain on hands, shoulder area, and neck it was shown that women experienced more pain compared to men and that more females had to get treated for pain in all of these areas than men in the same field (Sutton, Irvin, Zeigler, Lee, & Park, 2014). The standards for many of these devices are set by the AMA and the boards of hospitals and as those are mostly men these devices have traditionally accommodated them. But as the number of female medical students is increasing these problems need to be addressed for their success in the operating room as well as the healthcare and medical field in general.

Sanitation procedures also play a large role in how these devices are used. Devices used in an operating room must be thoroughly cleaned to prevent infections taking place among patients to keep them healthy. However, this causes difficulties in how these devices are used once again affecting female surgeons more than male surgeons. In a 2014 study, it was shown that the average height of female surgeons was 64.5 inches and for male surgeons was 70.5 inches (Sutton, Irvin, Zeigler, Lee, & Park, 2014). The traditional operating room table can be adjusted anywhere between 73-122 centimeters (28.7-48 inches) which has been shown to be too high for 95% of surgeons, particularly female surgeons (Sutton, Irvin, Zeigler, Lee, & Park, 2014). While the heights of tables can be adjusted a little, they can't be adjusted too much especially if surgical drapes are used in these procedures. These surgical drapes range in height from 44-100 inches (Halyard Health, 2018) and must be kept off of the floor to prevent bacterial infections. With this requirement adjusting the operating table height isn't as favorable and as male surgeons are generally taller than female surgeons this has caused more difficulty for them. The drapes are too long and even if a shorter length one is chosen lowering the operating table would still be cutting it close in terms of keeping it off the floor and keeping patients safe. Once again, these guidelines are established by the AMA and hospital boards and since these are comprised of mostly male leadership, they have established rules for these individuals. With the current increase in the number of female medical students these laws and regulations need to be addresses and reassessed to accommodate for female surgeons so they can also have success in this field. Female surgeons face a lot of more ergonomic issues in operating rooms because of old regulations and laws established by associations comprised mostly of men. Therefore, the objective of this research work is understanding the regulations established by leadership that guide an operating room and how these can be reworked to be set up for more female success in terms of ergonomic issues. This will be done by examining various ergonomic issues and comparing them to outdated regulations established by male leadership. The objective of this research work is to shine a greater spotlight on the causes of hinderance in advancing female surgeons because of organizational factors.

INTEGRATED APPROACH TO SPARK CHANGE

In order for a new cultural movement to take place within an operating room Pacey's Triangle Model, as seen in Figure 4, must result.

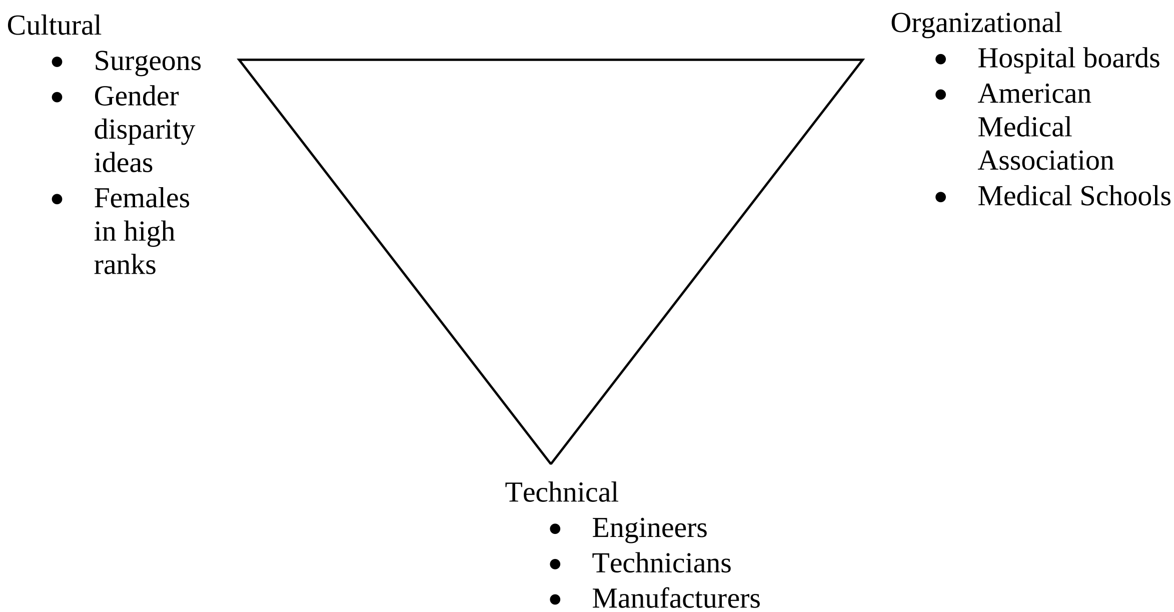

Figure 4. Social Construction of Technology Model: Pacey's Triangle. Displays the relationship of how every actor is influenced by another actor. (Adapted by Rohni Awasthi from Arnold Pacey, 1983)

With the cultural, organizational, and technical aspects all connected the main stakeholders are surgeons, hospital boards, medical schools, American Medical Association, engineers, technicians, and manufacturers as well as the idea of not wanting women in high ranks of leadership positions. All of these factors are integrated with one another as the engineers, technicians, and manufacturers would be responsible for creating the new ergonomic devices, which would be organized by hospital boards and the AMA in establishing new procedures and guidelines that have been adapted to the current time. This facilitates information between all parties involved and helps determine what needs to be assessed and improved. The general Social Construction of Technology model shows how a variety of social factors have shaped a technology and how the way it is used has a powerful effect on society. The different actors under each aspect serve as watchdogs for each other. The surgeons make sure that the devices in the operating room are serving all individuals equally and can inform the engineers and technicians who can in turn create better technologies to address unfilled needs. These needs are then implemented by hospitals through their boards which organize the operating rooms and address the guidelines by which the rooms must run. The American Medical Association creates new laws and regulations that medical schools and hospitals must abide by. This creates an interconnectedness between all aspects of the model as each cannot advance and change without the other. The STS research project will be a scholarly article outlining the ergonomic challenges faced by female surgeons trying to create a fairer environment by looking at how the makeup of leadership is affecting these individuals in succeeding in the operating room as well as the surgical field.

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