

The Smart Volume: Moving Rock Climbing Hold
(Technical project)

**Masculine Design Of Weightlifting Technologies And Exercise Spaces Contributing To
Gender Bias In Gyms**
(STS project)

A Thesis Prospectus
In STS 4500
Presented to
The Faculty of the
School of Engineering and Applied Science
University of Virginia
In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science in Mechanical Engineering

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October 27, 2021

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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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Introduction

Exercise is important to human health and, therefore, should be as accessible and enticing as possible. Daily tasks, injury prevention, and some lasting benefits are improved with regular exercise. Some of these benefits include the prevention of osteoarthritis, cardiovascular disease, respiratory disease, and diabetes as well as help with agility and balance in older adults (Bean et al., 2004). Within the broad scope of exercise, my projects will narrow the focus to weightlifting and climbing. Weightlifting is generally more favored by the male population and less approachable by their female counterparts. When considering the origins of weightlifting, the reasoning behind these discrepancies become clearer. There are records of strongmen originating in the 18th and 19th century, with the first international competition in 1891 and an inaugural appearance in the 1896 Olympics (Augustyn, n.d.). In comparison, “female strength sports first officially came to powerlifting in 1978 and women competed at the World Weightlifting Championships for the first time in 1987” (Heffernan, 2019). The late access for females to the sport of weightlifting has translated and contributed to modern gym environments.

There are many reasons behind why women are more hesitant to engage in weightlifting activities. Personally, I have noticed the emphasis toward cardio and lightweight dumbbell workouts when searching for exercise inspiration. Oftentimes I search, “workouts for men” to find a barbell workout in which I am more interested. This can be seen when doing a quick Google image search as seen in Fig. 1. Outside of my personal experience, studies indicate that there is “a cultural dissociation between women and strength-related exercise goals” (Salvatore & Marecek, 2010, p. 556). In another related study conducted by Fisher et. al. (2018), they found women experienced discomfort when worrying about how they were perceived and from internal pressures about burning calories. Similarly, I often hear, directly or indirectly, of women

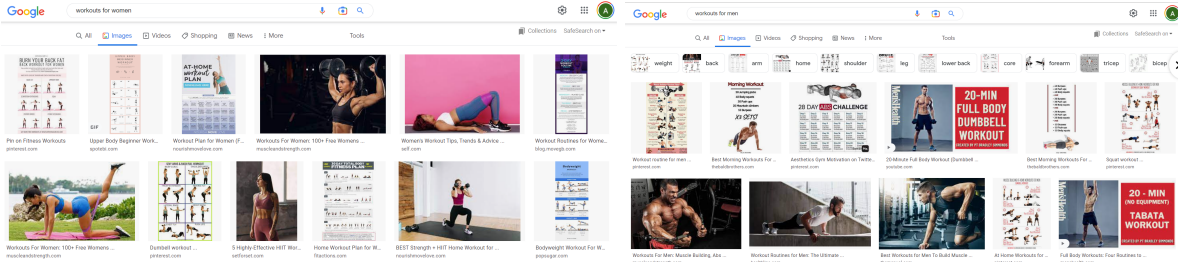


Fig. 1. Top search results from Google Images (Oct. 26, 2002) for “Workouts for Women” and “Workouts for Men”

being concerned about lifting heavy weights as they don’t want to “bulk up”. These cultural perceptions of lifting are very influential in creating the gender bias in modern gyms.

With many external influences having already been researched and established, I was interested in turning to the internal technologies themselves. I acknowledge the great societal and historical influences that shape the culture of weightlifting but wonder: are some of the technologies themselves inherently masculine? When lifting, I have noticed some equipment that has primarily been associated with exercises for men, being more structured toward the average male body. These observations inspired my STS project which is considering how some of the lifting equipment and physical design of gyms have been created to favor male over female engagement.

In a similar effort to make exercise more accessible, my technical project will focus on the sport of climbing. My group is creating a climbing volume, a wooden hollow shape that can be mounted on the wall to give it more features. This volume will have a moving climbing hold on the front face, allowing more dynamic routes. Currently, there is no invention within climbing which allows for a single hold to move as someone climbs the route. With this innovative technology, we hope to engage people who may not otherwise try climbing as well as make climbing moves more accessible for people of different stature. Both the STS and technical project are efforts to make specific forms of exercise more accessible and engaging.

Technical Topic

Within the sport of climbing, there are several common issues that arise for both the climbers and setters (individuals who create the routes on the wall). Routes are made up of imitation rocks called holds which are bolted into the climbing wall and often distinguished by color. For setters, they may have to make adjustments to the holds of their climb in order to make a certain difficulty level possible during the testing phase of their setting time. This may prove time-consuming, especially when setting roped climbs where the change may occur high up on the route. Additionally, setters may also be constrained by where they can place the hold due to predefined spacing of bolt holes in the wall. For the climbers interacting with the wall, some may struggle to span between holds or reach the next hold when doing a dynamic, jumping move due to their height or wingspan. Additionally, this technology may contribute a greater sense of excitement and engagement for participants due to its moving features.

Some technologies already exist that aim to create exciting climbing and training opportunities. Some of these training boards and moving climbing walls include the Moon Board, Tension Board, Treadwall, and the Freedom Climber (see Fig. 2). The Moon Board, Tension Board, and Kilter Board are examples of walls with stationary holds and LEDs that light



(a)

(b)

(c)

Fig. 2. Examples of current climbing technologies: (a) Moon Board, (b) Tension Board (c) Kilter Board from *Kilter, Moon, Grasshopper, and More: Interactive Climbing Training Boards Explained* by A. Beck-Doss, (2021) Gear Junkie.

up to depict the route, providing many possible variations of climbs and worldwide interaction of the same routes. As for moving wall technologies, a Treadwall, depicted in Fig. 3. is a rotating wall that helps athletes train endurance. While all of these are useful technologies within the sport of climbing, as mentioned in the introduction, there is no invention that moves individual holds while the climber is moving.

Therefore, we are creating a “smart” climbing volume. To reiterate, volumes are “giant prism features that are attached to the wall like any other



Fig. 3. Treadwall: a rotating, continuous climbing wall from *Products*. (2022). Treadwall Fitness.

climbing hold” (Walton, n.d.). Current volumes have bolt holes with t-nut in the back such that stationary holds can be mounted to the faces of the volumes. An example of a volume is shown in Fig. 4. by the yellow wall attachments. The climbing volume that we are designing and manufacturing will have a hold that moves linearly on its front face while the other side faces will maintain the typical function of having places to screw in additional,



Fig. 4. Professional climber Eliska Adamovska competing in the Briancon Climbing World Cup from *Ghisolfi and Adamovska Win in Briancon*. (2021). 8a News.

stationary holds. The general design concept, with the side panels removed to show the internal

components, is depicted in Fig. 5. The moving hold will be screwed into the top block and controlled by a program or manually by a remote, allowing individual climbers to influence the route they are climbing. To do this, we will build a skeleton frame out of aluminum that will contain the relevant electronics to make the hold move, then cover this skeleton with the more traditional wooden sides. We will test this product at the University of Virginia (UVA) climbing gym, Slaughter Recreation, to ensure it works.

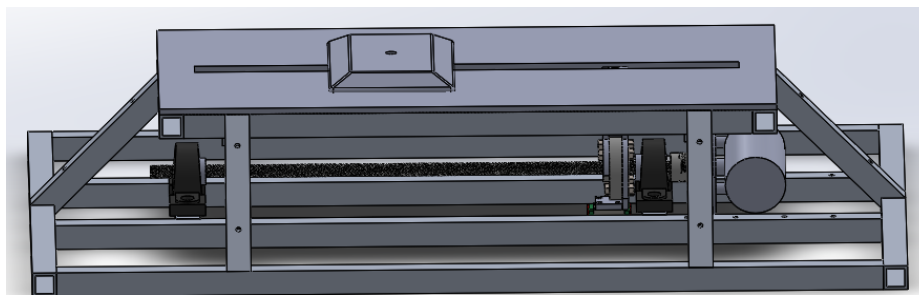


Fig. 5. Initial design for climbing volume with linear hold movement. Side panels are removed from the image to show internal mechanisms. Image from *The Smart Volume: Moving Climbing Hold* by Borden, A. et al. (2022).

This design could have many positive implications including creating a more entertaining climbing experience to encourage more participation in the sport, allowing for adaptable routes to increase the accessibility of climbs for different body types, and improving the ease of adjusting routes as they are set. This technical project as well as my STS investigation regarding the research of how technologies and interior design decisions influence gender bias in weightlifting both have the goal of making forms of exercise more accessible and inviting to a greater breadth of people.

STS Topic

Weightlifting is a primarily male dominated sport. As found in Norris's observational study, "there were four times more men than women in the weight areas of gyms" (2019, p. 1). While female athletes are becoming more common in these spaces, there is still a clear discrepancy between how men workout versus women's fitness strategies. Men mostly lift with barbells and workout on plate weight machines, while women tend toward cardio machines, free weights, and cable machines. While many types of exercise are relevant and valid, it is important that anyone feels comfortable in a weightlifting environment.

There have been many barriers to women's participation in sports. One of which is the gear itself, tailored to more masculine bodies. For example, paralympic cyclist Hannah Dines came forward about needing to get labia surgery after years of riding due to cycling saddles not accommodating women's bodies. (Dines, 2019) Similarly, a former kickboxing instructor and now the founder of women's boxing and sportswear brand Society Nine, Lynn Le, gained inspiration for her company when "clients would show up to her classes wearing children's boxing gloves, or 'some brand's version of a pink glove, and they almost always didn't fit the wrist and feel supportive'" (Halton, 2020). There were no quality gloves that were made for a more narrow hand (Halton, 2020). While these stories are not directly related to weightlifting, they provide evidence of masculinity within sports equipment. I recognize that other external or intangible factors may have a large authority over how different genders approach their exercise as discussed in the introduction, however, I wanted to consider the physical technologies and design of the gym itself as there seems to be less information about this very relevant topic.

During my time lifting in gyms, I have become aware of some equipment that tends to lend itself better towards male athletes. For example, the grips on most pull up stations are large

in diameter and the stationary tricep dip bars are more widely spaced so that it is difficult for me to use them. A study conducted by Bardo et. al. “showed that males were significantly stronger than females for both absolute grip strength and relative grip strength [...]” (Bardo et al., 2021, p. 7). This may demonstrate that women are less likely to be successful when doing bar activities such as pull-ups, dead hangs, scap pull-ups, etc. just due to the fact they are less able to hold onto bars with a larger diameter. Other examples may include the width of the grips on lat pull-down machines and the height of the benches when bench pressing. These are typically seen as more masculine activities and are designed as such.

Beyond the technologies, I am also interested in viewing how the weightlifting space is constructed and if those orientations and interior design decisions have any impact on the demographic using those parts of the gyms. One of the factors that Craig and Liberti (2007) identified in their study when considering aspects of an all-female gym that made the members feel more comfortable was the physical setting. The layout of the gym could have a significant impact on accessibility. In a study conducted at Penn State University, an anonymous student stated, ““It is uncomfortable using certain parts of the recreational facilities because it is often divided into mostly women using the cardio machines and men in the weight section so, even though I like using weights, it can be a little intimidating going into a room full of guys by myself to work out with weights”” (Bohn, 2020). Each of the gyms on Grounds at UVA has a different environment which could help indicate if the surroundings influence lifting preferences.

To further investigate and support my claim that some lifting technologies and spaces have inherently male properties, I will utilize Actor Network Theory (ANT). This framework, “distinguishes itself from other sociotechnical approaches by considering both human and non-human elements equally as actors within a network” (Latour, 1996 cited in Cressman, 2009)

. Being able to consider artifacts as actors themselves will be very useful as I am considering how these artifacts act upon and influence human behavior just by how they exist. I am going to research if technologies and spaces within UVA gyms contribute to the current gender barrier in the sport of weightlifting.

Research Question and Methods

To investigate this discrepancy, I want to ask: How has the design of weightlifting equipment and gym spaces contributed to the creation of a primarily masculine environment? By evaluating if the technologies and interior design decisions surrounding weightlifting are inherently masculine, results could aid gym adaptations to create a more equitable space for all genders to exercise. To develop an answer to this question, I will be conducting a literature review, artifact analysis, and observational study. For the literature review, articles will be considered to determine relevant body proportions such as average grip size and height per gender as well as gather information regarding the aspects of interior design that influence how different genders tend to perceive their surroundings. The artifact analysis will be conducted within the three UVA gyms; Slaughter Recreation, the Aquatics and Fitness Center, and Memorial Gymnasium. I will be identifying common weightlifting and fitness equipment and measuring relevant dimensions including the height of benches, the grip diameter of pull up bars, the width of grips on the lat pulldown machine, width of tricep bars, and the grip width of barbells. Additionally, I will analyze the space itself and consider if the design choices favor a masculine audience. My observational study to determine the ratio of male to female participants exercising in strength training portions of the gyms will help clarify if the design affects the inclusivity of weightlifting spaces. The data from the artifact analysis and observational study

will be considered in relation to the information gathered in the literature review to determine a conclusion.

Conclusion

Exercise is a vital part of human health. By making sports more accessible to people who may have otherwise not been involved, individuals could gain better health both in the short and long terms. Through the research regarding gender bias in the gym and the invention of a new climbing device, more engagement could be achieved. While there are many influences to gender bias in the sport of weightlifting, one contributing factor is the equipment and the design of the space itself. Through this research, I anticipate some findings that will help identify which technologies or design aspects contribute to promoting the discrepancy between male and female lifters. Figuring out which technologies are primarily designed for male use could lead to more inclusive equipment not only at UVA, but also more commercial gyms outside of the Charlottesville area.

References

Augustyn, A. (n.d.). Weightlifting. Encyclopaedia Britannica.

<https://www.britannica.com/sports/weightlifting>

Bardo, A., Kivell, T. L., Town, K., Donati, G., Ballieux, H., Stamate, C., Edington, T., Forrester, G. S. (2021). Get A grip: Variation in human hand grip strength and implications for human evolution. *Symmetry-Basel*.

Bean, J. F., Vora, A., & Frontera, W. R. (2004). Benefits of exercise for community-dwelling Older Adults. *Archives of Physical Medicine and Rehabilitation*.

Beck-Doss, A. (2021). Kilter, Moon, grasshopper, and more: Interactive climbing training boards explained. *Gear Junkie*.

<https://gearjunkie.com/climbing/kilter-moon-grasshopper-more-interactive-climbing-training-boards-explained>

Bohn, K. (2020). Researchers study strength-training gender gap, possible solutions. *Penn State*.

<https://www.psu.edu/news/research/story/researchers-study-strength-training-gender-gap-possible-solutions/>

Borden, A., Gross, T., Moore, A., Steiner, G., Pommerenk, A., Whitt, E., (2022). The Smart Volume: Moving Climbing Hold [Unpublished engineering capstone project]. *University of Virginia*.

Craig, M. L., & Liberti, R. (2007). “Cause that's what girls do”- the making of a feminized gym. *Gender & Society*.

Cressman, D. (2009) A Brief Overview of Actor-Network Thoery: Punctualization, Heterogeneous Engineering & Translation. *Simon Fraser University*.

Dines, H. (2019). Hannah Dines on going public with her labia surgery: 'it started a big conversation'. *The Guardian*.

<https://www.theguardian.com/lifeandstyle/2019/dec/11/hannah-dines-on-going-public-with-her-labia-surgery-it-started-a-big-conversation>

Fisher, M.J.R., Barbary, L.A., & Misener, K.E. (2018) Narratives of Negotiation and Transformation: Women's Experiences within a Mixed-Gendered Gym, *Leisure Sciences*.

Ghisolfi and Adamovska Win in Briancon. (2021). *8a News*.

<https://www.8a.nu/news/briancon-finals>

Halton, M. (2020). Sports are designed around men - and that needs to change. *TED*.

<https://ideas.ted.com/sports-are-designed-around-men-and-that-needs-to-change/>

Heffernan, C. (2019). The untold history of women in strength sports. *BarBend*.

<https://barbend.com/women-strength-sports-history/>

Latour, B. (1996). "On Actor-Network Theory: A Few Clarifications" *Soziale Welt* pp.369-381.

Norris, C. (2019). Gender discrepancy in the weight room. *Bryant University*.

Products. (2022). Treadwall Fitness. <https://treadwallfitness.com/>

Salvatore, J., & Marecek, J. (2010). Gender in the gym: Evaluation concerns as barriers to women's weight lifting. *Sex Roles*.

Walton, C. (n.d.). Volumes: The new dimensions of indoor climbing. *Movement*.

<https://blog.movementgyms.com/volumes-the-new-dimensions-of-indoor-climbing>

Workouts for Men (n.d.) Google Images, *Google*.

Workouts for Women (n.d.) Google Images, *Google*.