Preliminary Design of Vests for the VEST Hackathon

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The purpose of this project was to analyze the high visibility safety vest as currently designed and recreate a safety vest for use in the construction industry. Safety vests play a prevalent role in the construction industry relating to safety and productivity on site. A vest is used for being a high visibility (hi-vis) personal protective equipment (PPE) device that provides 360-degree visibility for its wearers while simultaneously working to help carry small, necessary items. In recent years, the design of safety vests is shifting with the increase of females in the industry, representing a larger variety of body types to be protected on a jobsite. This project is focused on the preliminary design of three newly created vests designed for use and discussion for the Verifying Everyone's Safety Together (VEST) Hackathon, which promoted the development of vest that fit varying body types for both safety and inclusion. This paper analyzes the uprising issue of vest fit, questioning the safety that the vests are providing, as well as how they are making females and other non-conforming sizing people feel. After reviewing data on fit, three preliminary designs were created with the goal of accommodating multiple body types.

Key Words: Safety Vest, Females, Inclusivity, Construction Industry, Design

Background

Galvez's (2021) study on the fit of safety vests found that the average vest is ill-fitting in traits such as waist and length fit being too large or long, lack of utility for pockets, and not enough adjustability. Galvez (2021) sparked attention towards the inadequacy of the standard safety vest and, from her survey, a hackathon event was inspired. A hackathon is an event that uses the expertise of a group of people to come together to collaborate on a project (Hengsberger 2021). A hackathon usually focuses on an imperfect item or concept that has room to be reenvisioned and upgraded, and, following the results of her survey, it became apparent that the safety vest needs hacking. For this project, the goal was to reinvent the high visibility (hi-vis) safety vest that is worn by construction workers on a construction site. Based on the feedback from Galvez's (2021) survey, the common, standard safety vest is usually too large and loose-fitting for the average person on site, and, with the increasing presence of females in the field, it is rare to find a vest that properly fits either a female or smaller

figure. Based on Galvez's (2021) survey, 30 to 40% of all respondents stated their vest fit just right in specific areas including the shoulders, overall length, waist, hips, and chest. There is a wide variety of body types, yet there is not a variety of well-fitting vests that accommodate these body types. The goal of the hackathon was not only to create a vest that is adjustable and accommodating for all body types and styles, but also to accommodate the growing need for more tools and technology on a project site, such as an iPad. A diverse group of individuals came together for the hackathon including a wide variety of expertise and experience, from faculty, students, to industry professionals. The event was structured around coming together to collaborate and reinvent the flawed vest and create the most plausible, accurately needed vest in the field. For this project, creating preliminary designed vests prior to the hackathon was established to contemplate and analyze what redesigning the safety vest can look like from conceptual ideas, to rough blueprints, to cutting up and creating a new vest.

Hackathons bring about positive change regarding getting knowledge and experience from different sources and people, and using that to collaborate on creating something new (Kelman, 2021). In preparation for the Verifying Everyone's Safety Together (VEST) Hackathon, having preliminary designs was thought to be beneficial for the group to promote creative thoughts and spark ideas. Using the raw data from Galvez's (2021) survey, three preliminary example vests were created for the event for display. This was established so that the hackathon planning group could learn from design and logistical successes and mistakes to support a strong design. Explaining the positives and negatives of the designs would help give the event an authentic feel for creating something realistic for the construction industry for everyone.

With most of the preliminary design inspiration coming from the feedback of Galvez's (2021) survey, and as much as they were derived from raw experience and authentic feedback, creating a vest that meets code requirements that can be manufactured one day is the goal. The main regulation for creating a safety vest is that there is a minimum coverage that is up to code. ANSI 107 requires that class 2 garments (vests) have at least 775 square inches of high-visibility, fluorescent background material and at least 201 square inches of reflective material. (Reflective Apparel 2022) When designing the vests throughout the hackathon, it was a goal for the designs to not be constrained by the code, since designing within the code would not be able to accommodate many of the adjustments to size and fit required to fit smaller body types. The preliminary designs did not account for the incorporation of the code, and this was to be communicated and accounted for at the hackathon. This project's goal with designing vests was to be a transparent example of recreating a vest and discussing the constraints of the code was important. This paper will evaluate the design process of the preliminary designed vests and the process of bringing them to life.

Design

In this section, the three different vests' designs will be discussed including their inspiration, challenges, and successes. As stated above, the preliminary designs of these vests were created to help foster ideas for the VEST Hackathon.

Vest 1

Vest 1 was inspired by and designed with the image of accommodating multiple body types, as well as a body that is ever changing (weight gain, loss or pregnancy). Hook and loop tape was the main innovative item established on this vest to help with adjustability. The design came with the concept of both width and length of a vest, which was disclosed as a problem regarding fit. According to

Galvez's (2021) survey, only 24.5% of all respondents felt the width of their vest fit correctly and only 40.2% felt the length was correctly fitting. This shows that there is a majority of people that feel the length and width of the vest is ill-fitting to their body type. Width poses an issue when the vest is large; it is much more prone to be caught, hooked, and snagged on items and moving things on site. This is a safety concern, as well as an issue with how it makes people feel when they are overly small in their vest. A multi-row system was designed of hook and loop tape patches on the waist so that, depending on the waist size, someone can adjust the vest to their desired fit. With material from a scrapped vest, a strap was cut to be attached to the back of Vest 1, so that a belt like strap could be easily attached and moveable around the entire waist of the vest. Regarding length of the vest, there is often an issue with the vest being long on people, especially people who are shorter. This can be very distracting for someone on site and brings up the issue of how someone feels in their vest. The background of the design was to give the option for the wearer to adjust the length per their desire and based on their height. The shoulders were cut so that hook and loop tape patches could be added as well so that as you attach the shoulder you can bring it down per their choosing. This helps bring the back and front of the vest up vertically. With the incorporation of the waist strap and the shoulder straps, the vest is accommodating for width and length of a smaller, or more unique body style. Figures 1 and 2 provide the preliminary designs for Vest 1.

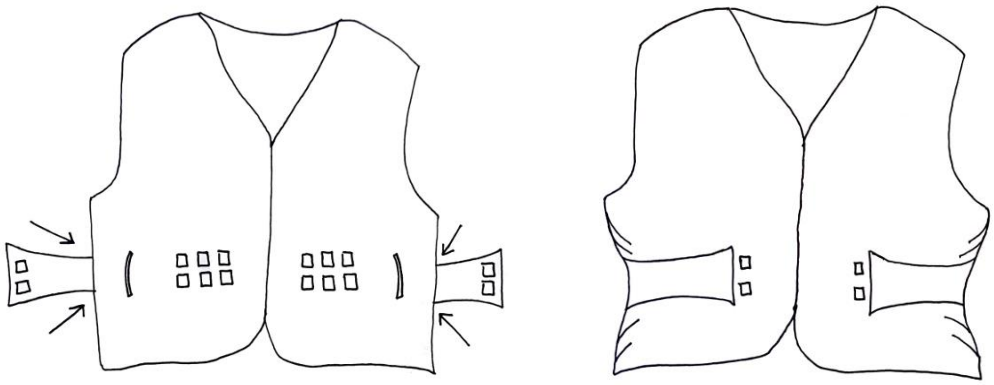

Figure 1: Vest 1 Hook and Loop Tape Waist Blueprint

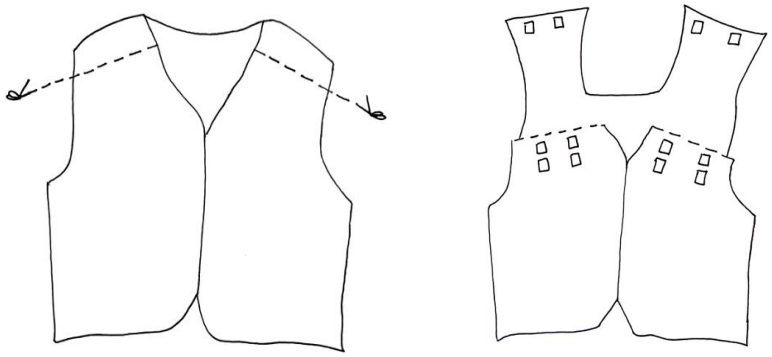

Figure 2: Vest 1 Hook and Loop Tape Shoulder Blueprint

Vest 2

Vest 2 was focused on the similar goal of adjustability to varying body types, including changing ones. Vest 2's main incorporating material was having a drawstring at the waist that went all the way around. Vest 2 was focused more on the width issue with vests and worked to pull in the waist without having loose, dangling items causing a hazard. Close to the center zipper, both sides of the waist would have adjusters for the drawstring so that each side can be pulled and adjusted. This is accommodating for slimmer body types, while still being easily fit for a wider figure. Regarding length for this vest, tucking up the vest once it has been tightened was additionally an option. Figure 3 provides the preliminary design for Vest 2.

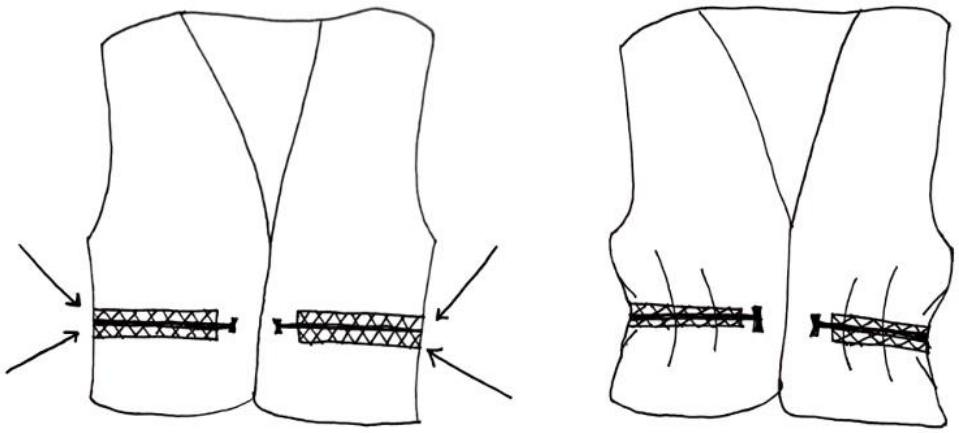

Figure 3: Vest 2 Drawstring Waist Blueprint

Vest 3

Vest 3 was oriented around both fit and productivity on site. Based on feedback from Galvez's (2021) survey, the most requested change to the vest was an incorporation of a large back pocket that could fit an iPad. When designing Vest 3, it was important to incorporate both the pocket and an adjusted fit to the vest for primal adequacy for mobility and comfort on site. To do this, a buckle and cinch to the back of the vest were incorporated into the vest design which could be tightened. The straps for the buckle were sewn on at the waist middle point so that when the buckle attaches to the back, each side will be evenly pulled back, giving a folded over, tighter look and feel. Once the buckle and cinch were set in place, another layer of high visibility fabric was measured and overlapped so that there was an opportunity for a large back pocket for the desired iPad. Figure 4 provides the preliminary designs for Vest 3.

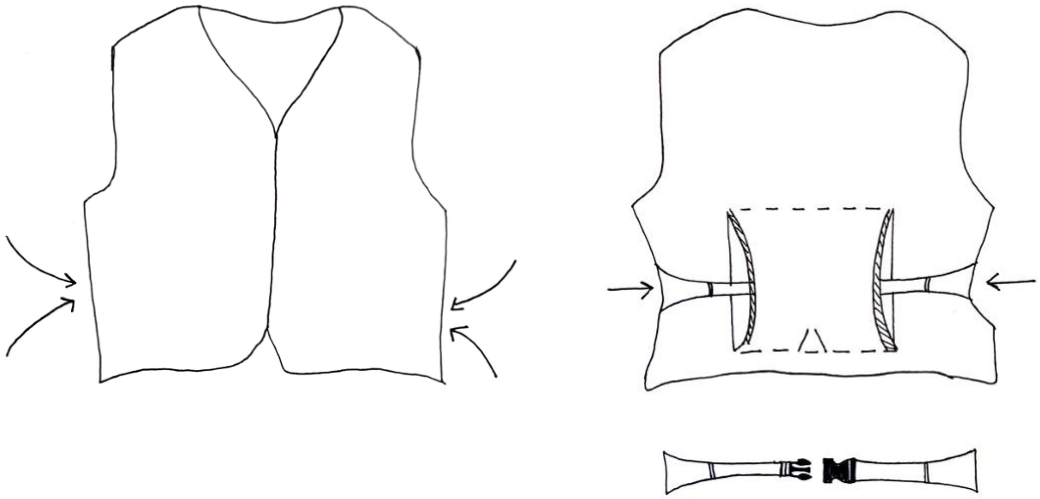

Figure 4: Vest 3 Buckle with Back Pocket Blueprint

Development

Once the design of the vests was finished, it was time to create the vests. The main materials used were donated, old vests, a needle and thread, drawstrings, buckles, and hook and loop tape. The blueprints (Figures 1 through 4) were referenced to help create the vests and bring the designs to fruition. Throughout the development process, the vest adjustments were continually checked for fit and adjustments. Each vest was started and finished before the next was focused on so that any potential design defects that were found could be prevented in the next vest.

Final Vest Considerations and Lessons Learned

Although the preliminary designs could still be improved upon, successfully developing them prior to the hackathon proved valuable as they were able to support the hacking teams in fostering ideas for their own vest. Reviewing the positives and negatives of designing the vest before the event was the backbone of this project in encouraging creative, practical designs of a vest. Explaining the strengths of each vest showed what was successful in the design stage to the building phase, as well as elaborating on the mistakes and shortcomings of each vest to help prevent similar errors when each team started designing and building. Communicating personal experiences of how vests fit my body versus other construction employees was an aspect that inspired the developments and designs of the vests and that was relayed to the group that attended the hackathon. This was very beneficial for my role at the hackathon in describing the expectations of a design and comparing it to the output of the design brought to life on the vest. This raw feedback helped give the hackathon participants the opportunity to be as creative and successful with their designs as they saw fit, based on the preliminary vests and the explanation of where the designs were rooted from.

Vest 1

Vest 1 was a more typical design, and the main use of materials was hook and loop tape. In hindsight, incorporating hook and loop tape into the design of the vest is not as plausible as it seems. In a situation where someone was to fall or still potentially get caught or tugged on by something, it would separate easier than another material would. This could be problematic as it is desirable to have a durable vest and the unpredictability of Velcro coming apart can become a hazard on site. However, in some cases, if someone were to be caught on something with their vest, the option for it to come apart may be beneficial as well so that someone could get away quickly from a dangerous situation. Vest 1 brings up good reasoning for hypothetical safety scenarios, questioning if the vest coming apart is for the better or worse. Regarding the shoulder hook and loop tape straps, as much as bringing it up high is a benefit, there is an issue with the armhole becoming uncomfortable and too small; this was an observation and realization made after the changes to the vest when trying it on. The adjustability is desirable but when considering the quality and life of the vest, it doesn't come out to be sustainable on a job site. Figure 5 shows the final design and Hackathon display of Vest 1.

Figure 5: Vest 1 Hackathon Display

Vest 2

Vest 2 was a simple yet productive design by incorporating just the waist drawstring. This was a proactive way to easily adjust the vest's fit per an ever-changing body and works for any body type. The main drawback of this vest was when the waist was cinched in at the waist, the excess material would puff out at the bottom of the vest, creating extra, unnecessary material and an unprofessional look and finish. Since the goal of the hackathon was to create a vest that fit well, increasing wearer confidence, this design was not ideal. A potential way to improve this design would be to add a

second drawstring at the bottom of the vest, to prevent the look of extra fabric. Figure 6 shows the final design and Hackathon display of Vest 2.

Figure 6: Vest 2 Hackathon Display

Vest 3

Vest 3 was the most plausible vest for the event as it was beneficial with both the fit and accommodating for the widely requested back iPad pocket. The lessons learned with this vest was to have zippers for the back pocket as this is the best way to keep items secure and have the material consistently lay flat. The back cinched buckle was successful and was an effective way of tightening the vest. This vest was a positive design to help cultivate a vest that accommodates fit with the buckle to cinch at the waist and productivity by having the pocket to carry extra desired items on site, such as an iPad. Figure 7 shows the final design and Hackathon display of Vest 3.

Figure 7: Vest 3 Hackathon Display

Conclusion

Overall, there was an immensely powerful, and positive outcome with the redesigning of the vests for the wide variety of people in the construction industry. The purpose of this project was for the preliminary design of the vests to start the momentum of redesigning the average ill-fitting construction vest. Through past research, raw feedback from Galvez's (2021) survey, and personal experience, three designs were created using a variety of materials and old vests. These innovative vests and the movement of the hackathon is just the start of a new standard of vests in the field. The redesigning and restructuring of the vests early on before the hackathon were used to help foster ideas, as well as breakdown what materials would be needed at the event for the most success of designs. Most modern safety vests in the construction industry are not inclusive; and the process of preliminary designs, to the designs that came from the hackathon are just a start to the movement in creating a vest that works for all people on site. The reason the hackathon was created was to make waves and bring about change to the ever-changing construction industry, and the support and turnout was positive in helping the safety vest be made into something better than ever, for everyone. The goal of the preliminary designs was to provide ideas to pull from when attendees of the hackathon were redesigning their own vests. Following the steps of this project from ideas on paper, to cutting up and rebuilding the vests, to explaining the redesigned vests at the hackathon; productive ideas and vests were created at the event.

Future research could include working with safety vest manufacturers to develop designs to test and bring to market that are code compliant. Additional research could evaluate the current code that governs the high-visibility safety vest to determine if the code is a hindrance to creating more inclusive vest designs that can consider various body types.

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