Resuscitation Rescue

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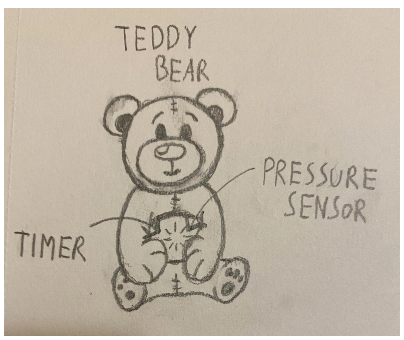


Introduction:

The Resuscitation Rescue project aims to promote not only the importance of CPR experience but a heightened sense of self-awareness. Self-awareness is essential to identifying emergency situations and the proactive steps that follow to ensure personal and public safety. Through providing the experience of performing CPR, users will begin to understand the statistics more intuitively, as they have something personal they are able to compare. For example, if the user is incorrectly performing CPR with too much pressure and very fast paced compression intervals, the data from previous CPR attempts would find that the target of the user's CPR has an unlikely chance of survival. While an unlikely chance of survival would not interest most people, it would be better understood by them if it is their own statistic. With personalized experience and data, they can relate their own experience and statistics back. This will show the user how to improve their overall CPR performance and feel more confident with their knowledge of CPR. This will show the user if they were put into an emergency situation how they would perform, ultimately affecting the improvement of performance when it suddenly applies to the user.

Broader Context:

The Resuscitation Rescue project introduces a new experience for users to come and learn the importance of quick and effective CPR action. Users will be presented with the opportunity to test their CPR skills through a stuffed teddy bear enhanced with a pressure sensor. The pressure input will be gathered from the teddy bear based on user interaction; this data will be compared against ideal CPR pressure to produce a positive or negative audio cue to the user to improve their performance. While the user is performing CPR on the teddy bear, they will actively be able to monitor their progress through sound cues and led lights from the bear's stomach that are representative of the user's input pressure. While not all perfectly performed CPR attempts can save someone, this project aims to improve the user's skills and the rate of successful resuscitation.

Related Work and Inspirations:

While Resuscitation Rescue presents the opportunity for users to come and practice performing CPR on a teddy bear, there exist many other forms of interactive design that also promote the CPR experience. CPR can take the form of digitalization into an interactive augmented reality. This method of CPR allows for alternative forms of "advantage[s] [such as] maintain[ing] natural posture while reducing the learner's cognitive load by superimposing feedback information with real-world objects."(Javaheri et al, 2018). Much like our project, this will allow user interaction with CPR data, creating a new digital experience. A digital interaction allows for an easier transition for users struggling with navigating social pressures or confidence when performing CPR. This user interaction practice data is very relevant to improving CPR skill development. However, virtual CPR can also have many missing components, for example, user pressure. While it is simple for the user to imagine how much pressure they are applying to the subject chest surface, this will not be the case in person. Without a surface for proper compression form, the digital interaction experience loses essential CPR factors that go into saving lives. In addition to digital CPR experience, there are many ways to compare different CPR methods. Through research in tubular structures, we can assess a variety of CPR images that will correspond to the type of CPR performed. By utilizing technology, we can generate "A tube-phantom…with Computed Tomography (CT) to illustrate the properties of the different CPR methods." (Kanitsar et al, 2002). This overall relates

Design Concept:

After the user has completed their first compression on the bear, a timer will be initiated for exactly two minutes. This timer allows for enough time in order to collect a sufficient amount of user interaction input for the project's sample space. Once the timer has ended the Resuscitation Rescue experience has come to an end, the teddy bear will play a sound cue to represent the end. "[A]round 70% of Americans are reluctant to perform CPR because they have no training or [knowledge]"(Martin, 2022). This causes a major increase in the number of individuals dying because of the observer's lack of confidence in CPR abilities or knowledge. Individuals in the healthcare department will see the impact this has on communities and those around them. To gain access to desired users, we can visit highschools and universities to find students with a passion for healthcare. This will allow us to showcase our project to students and get their opinion of the CPR experience.

User Characterization:

This project is geared towards people pursuing additional education in the healthcare department, more specifically, first responders. The project targets users from the ages of 18-24, who do not have any CPR experience, but base knowledge of healthcare. More specifically, males who are part of North American culture. If the user is a student studying healthcare, then they will already be fascinated by CPR training. This will make it easier to get more individuals into perfecting their CPR training. This project targets a young group of people in order to inspire people at a young age. If a user finds that they have a passion for CPR training, then they will have the ability and the resources around them being a student to pursue that passion. The reason this project targets the male group is because "Women represented the majority of paid care workers" (Khanam et al, 2022). By inspiring more males into health care we can attempt to break the gender gap within the field. North Americans, among many other cultures, find plush toys to be charming and approachable. By using

a plush bear as our body, we make using our device accessible.

Usage Scenarios:

Scenario 1 - Resuscitation Rescue CPR Workshop at University, *Vignette:*

The Resuscitation Rescue team has a booth setup at a university club fair. Students pursuing healthcare degrees attending meet the target age of 18-24, and some of them, especially those in first year, may not have much CPR experience. The project introduces them to the idea of CPR and first aid, while presenting in a fun and interactive way. A first year student who hasn't thought too much about CPR training walks up to the booth and asks to give the teddy bear a try. They place their hands on the bear's chest and start compressing. As the compressions continue, the pressure sensor inside the bear collects real-time data, which is processed by the microcontroller. The student hears several sound cues letting them know that they need to change their compression speed, but they haven't quite gotten the hang of it. They can see the quality of their compressions as well, since the bear is emitting red lights. Two minutes pass, a sound cue is played, and the trial is over. The student remembers their performance based on how the bear reacted, and realizes that while their technique wasn't bad, it was better than they expected. As well, the bear has piqued their interest in certified CPR courses, and they're thinking about enrolling in some. Before the student leaves, they urge their friend to try the bear out, as the student's friend is well trained in CPR. They begin the timer again, and this time things look different. The friend is adapting well to the constant feedback loop they are given, and eventually are able to maintain the correct CPR techniques. They perform remarkably. The two didn't initially think of CPR training as a fun process, but now leave with better technique after an enjoyable experience.

Scenario 2 - Resuscitation Rescue Home Training and Practice, *Vignette*:

The user is a high school student currently enrolled in CPR training. To sharpen up their skills, they set aside an evening to use a teddy bear provided by the Resuscitation Rescue team, which they thought

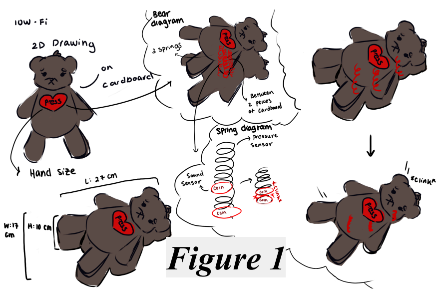


Figure 1

looked appealing. After they turn on the teddy bear and connect the related equipment, they start compressing the chest of the plush. The pressure sensor detects their compression force, and the two minute timer has begun. During this length of time, the user continues to compress onto the plush and is given feedback through audio cues and the glowing lights. They immediately realize they are making a mistake due to the sounds, and remember their CPR training to correct their technique. After their corrections, they are pleased to see green lights. When the timer ends, the user is given simple feedback on how they could've improved, and where they excelled. This proves to be very useful for the user, as they have no other way to currently brush up on their CPR techniques. The convenience of having a training tool that not only tracks their performance but is also available at home for the duration of their training is highly appreciated by the user.

Design:

To create a successful high-fidelity prototype, our team used the design process to ensure a successful build. To begin, we started with the empathize and design stages, allowing us to brainstorm ideas by getting into the mindset of our user. Through research our team chose a field like health care and found that many people don't do CPR because of lack of experience. In addition, we wanted to apply a novel element that allowed data physicalization of user data. Once we had defined the problem, we researched the key factors that go into CPR, such as chest compressions and speed. This allowed for our team to create sketches of how we might physicalize these factors into our low and high-fidelity build. The blueprints gave rise to the idea for the low-fidelity prototype (figure 1). By setting dimensions and using cheap materials to replicate hardware materials, we were on our way to the low-fidelity build. To build the prototype we used cardboard and pencil crayons to replicate the interface of the teddy bear, a design choice to make the experience less stressful. To mimic a pressure sensor we decided to use a spring alongside six quarters. Upon compressing springs, the coils inside the springs collide with each other when enough pressure is applied. By gluing coins to the

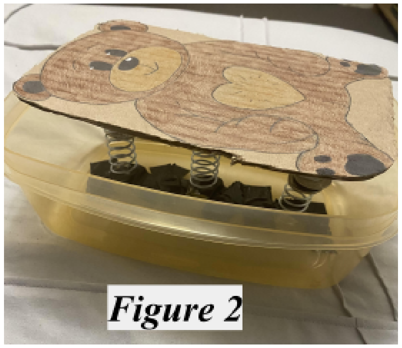


Figure 2

Figure 3

ends of the coils we could determine when enough pressure was being applied in our low-fidelity prototype. To replicate the auditory feedback we were able to play audio clips from a phone upon hearing the sound of the coin collision. If the sound of a coin was heard a successful audio cue would be played and a green piece of paper would cover the heart of the cardboard bear (figure 2). The low-fidelity prototype would be made inside a plastic container to keep the cardboard interface properly balanced and contained within the container. The materials for the low-fidelity prototype consisted of springs, coins, cardboard, a plastic container, and pencil crayons. After the prototype phase was done it was time to test and create the high-fidelity prototype. The high-fidelity prototype was originally going to be designed with a monitor to represent user compressions alongside LED lights to represent good and bad compression respectively. However to physicalize the data the design decision to use auditory feedback instead of a monitor was made. This allowed users to focus on their CPR and make an overall more aesthetic design to the high-fidelity prototype. The materials for the high-fidelity prototype are a stuffed teddy bear, aluminum foil, velostat plastic, alligator clips, a circuit playground, and two LED's. The velostat and aluminum act as a pressure sensor while the LEDs and circuit playground are used for light and audio actualizers to differentiate positive from negative compressions (figure 3). On a continuum from "exactly like the original" to "completely different" the final high-fidelity build lands a 7/10 for exactly like the original. The only difference was scrapping the idea of a monitor and implementing more auditory feedback. Some technical accomplishments that have been made during the building of the high-fidelity prototype have been developing a deeper understanding of the circuit playground and using the pins to transfer data.

Prototype Development:

Our high-fidelity prototype made a significant developmental jump from our low-fidelity prototype. Whereas our earlier prototype was makeshift and impromptu, our latest prototype most closely resembles our vision of the final product. We started

with the physical build, which began with the most straightforward step, albeit slightly strenuous. This involved preparing the stuffed teddy bear for housing the electronics, by essentially taking out some of the stuffing to make room. Afterwards, we added some LEDs attached to alligator clips so that they were poking out of the bear. We used the Adafruit Circuit Playground, the microcontroller we would be using to control these lights as well as the pressure sensor we'd soon implement. To implement the actual physical pressure sensor, we attached aluminum sheets to the end of alligator clips, then attached them to certain pins on the microcontroller. The idea was to have a piece of Velostat (a semi-conductive sheet), in between the two aluminum sheets, that essentially returned a greater signal if more pressure was applied to the top of the aluminum. This was not as easy to implement as we initially planned however, so multiple rounds of debugging were necessary. At first, we used MakeCode to write code for all the logic that would control the two-minute CPR trial, but we hadn't verified if the Velostat method would even work at the time. One of our members debugged this using the Arduino IDE, and found that sending a current from the 3.3V output pin and having the A2 pin take that as an analog input worked well to detect whether the aluminum and Velostat were touching, and output that as an analog variable. However, another bug occurred where if they weren't, the signal would oscillate between being detected and not being detected. Additionally, although the output was analog, it didn't vary much from being either around 0 or 1000, when we wanted it to detect multiple levels of sensitivity. After more debugging, we found that adding a resistor with a resistance of 10k Ω between the A2 pin and the ground pin. This acts as a pull-down resistor, which helped with the interferences in the current we were getting. This also gave us those levels of sensitivity we wanted. This is exactly what we were looking for. After modifying the existing MakeCode to work with our newly built circuit, we were able to connect it up to the bear in addition to the LEDs, and the rest was fairly straightforward to implement.

User Evaluation:

The method we chose for collecting data was in-person supervised testing followed by surveys for feedback. We made the experience fully interactive to replicate a similar environment to that of a real CPR emergency. Before setting up the user experience instructions were given to the user on how to perform CPR properly through the soft teddy bear. Users were also told that the experience would last for 2 minutes and that they would be guided by auditory feedback and LED lights during the experience to help improve their CPR during the experience. When setting up the experience we were able to connect a laptop to the circuit playground to provide it with power and simply turn on the circuit playground from within to start. This allowed users to interact with the teddy

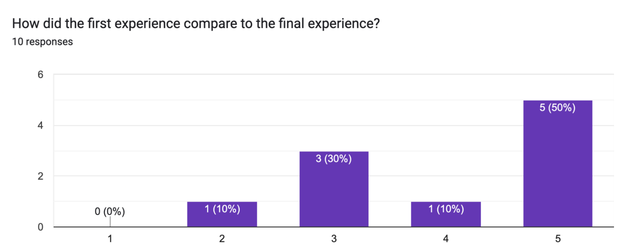


Figure 4

bear by compressing his chest. After the experience was over the users were then able to fill out a survey

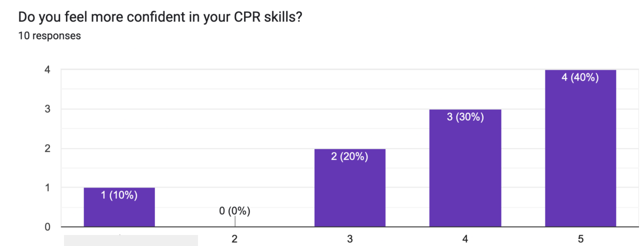


Figure 5

regarding the experience. This allowed our group to gather data on the experience from the user's perspective. The data captured information in regards to whether they felt more confident in their CPR abilities as well as how comfortable they felt while performing CPR (figure 4). Users were also assigned to fill out a survey in regards to their age, CPR experience background, and interest in the field of health care. This allowed us to capture data on user characteristics from a medium sample (figure 5). The user experience goal of this experience was to improve user CPR skills and confidence levels through a stuffed teddy bear. To meet experience goals we looked at our low-fidelity survey to determine the changes needed for the high-fidelity prototype. A common suggestion was being able to perform a balanced compression that would not drift to the left or right. For the high-fidelity prototype, we have decided to use our velostat materials so users would be able to compress on aluminum instead of springs, thus making compressions easier and balanced for the user. Through the use of a comforting and soft plush alongside auditory feedback users were able to meet experience goals regarding CPR skills as indicated in the survey. When interacting with the stuffed teddy bear users do have restricted interactions. Users are meant to interact with the teddy bear through pressure, this means the user can only interact with the teddy bear with a range of pressure that can be applied. The main limitation of the pressure sensor is the range at

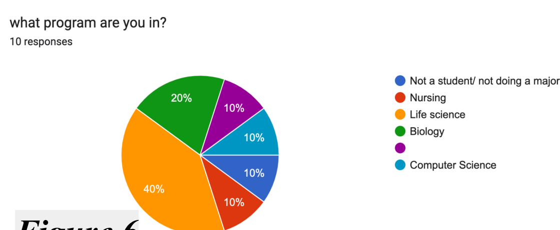
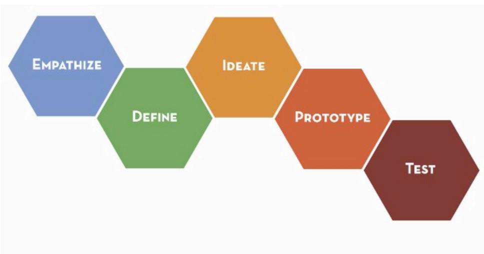
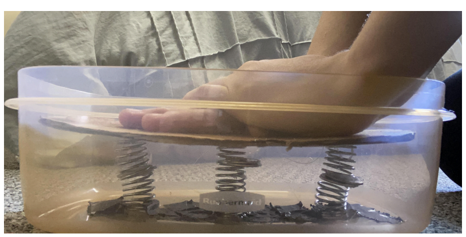


Figure 6

which you must perform the compression. In CPR a compression must be done within a certain area of the body, however, to make sure users have an easy time performing a compression the surface area on the interface was increased. This limitation presents easier usability with less accuracy for the compression. If a user were to do something unexpected such as squeeze the teddy bear instead of providing a compression the data may still be captured. However since our key components are arranged such that a compression will not harm our damage to the project, this may not apply to squeezing. This will most likely provide enough pressure to turn on the LED lights and give an audio cue but also harm the electronic components. The one thing about the prototype that was interesting for the user was the interface of the resuscitation rescue project. Users loved the interface since it was a warm soft and comfortable teddy bear and not as intimidating as a real CPR scenario would be. The most challenging thing for our users was identifying the correct speed of their compression. While the auditory cue gave positive and negative feedback for compression pressure, there was no





feedback for speed. This became challenging for users to determine the correct speed of CPR while they were focusing more on the pressure they were applying rather than the speed of the CPR. The most inspiring thing about our project in comparison to other technologies is the prototype user relationship. While the majority of interactive electronics you might see as museums and art galleries present information about history in an inspiring way, our project aims to present information regarding the user. By providing information on the user the information would become more relevant and interesting to them, for example, the auditory feedback. If others chose to build on our work our team would recommend incorporating user compression speed into the project. This design could be implemented with a timer linked to the pressure sensor that would mark each compression. The pressure sensor would be used to indicate the time and an actualizer could be another auditory feedback. This will allow users to identify when enough pressure is being made and enough speed is being applied to each compression. This also does not distract the user since they are actively looking for auditory feedback to improve their compressions.

Discussion/Reflection:

Throughout the Resuscitation Rescue Project, the group has learned through experience the application of innovation and the benefits of prototyping that led to a successful high-fidelity prototype. Upon beginning the project, the group needed an effective way to innovate and create creative ideas. Our group used design thinking as our innovation method and took inspiration from the posted inspiration board. Using design thinking, we challenged each other's ideas when defining the problem statement. Throughout the experience, we collaborated, brainstormed, and built upon each other's ideas. We were able to redefine the problem by looking through the lens of our users. After defining our problem statement, it was time to make the low-fidelity prototype and get user feedback. Testing the low-fidelity prototype created a new way of looking at our problem and its solution now that our solution was physically tangible. The group was able to see the solution through a tangible lens. By cycling through the prototyping and construction phase in the design process, we recognized the benefits of a low-fidelity prototype and how it shows in the final build of the high-fidelity prototype (figure 3). Throughout the project, guided by the design process, led us to our final high-fidelity prototype.While working on the Resuscitation Rescue, there was one limitation the group had to face: time. With everyone on the team working on other courses, it was difficult to align schedules to meet or devise plans that everyone would follow. As the deadline neared, the project lost the factor to calculate time for the user's compressions but maintained its core design of a pressure sensor under a time restriction. Overall, the time impacted the total build, causing the final high-fidelity prototype to lose some cpr factors but still allow users to perform CPR. If given more time in the future, our group would like to improve the Resuscitation Rescue project by adding more actualizers and sensors to the teddy bear for different cpr factors that go into saving lives. Our project aims to focus on CPR through compressions. However, more factors go into saving lives. The Resuscitation Rescue, if given more time, could add touch sensory components to the head of the teddy bear. Auditory sounds could be implemented, such as breathing to tell users if the teddy bear is breathing when checking for air. If our group could restart, we would start working and gathering materials for the high-fidelity prototype faster. While our group worked on the final prototype, attention was on the report, impacting the construction of the high-fidelity prototype. If our group could tell designers and engineers something after our build, don't get caught up in the low-fidelity prototype. Many projects that people start have so much put into the low-fidelity prototype that it starts to derail the purpose of the low-fidelity prototype. Many groups are reluctant to make changes after their first low-fidelity prototype and keep with the original idea. Teams must make user changes to improve their prototype for their targeted user.

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