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Cover Page Footnote

To our community partner, Brian Overshiner, to our advisors, Asem Aboelzahab and Hyowon Lee, to the Service Learning Grant for their financial support, to the Weldon School of Biomedical Engineering, and to the students that made these ideas into reality: Carl Russell, Emily Linder, Maya Godbole, Ella McCoy, Joey Schlosser, Trevor Sheehan, and Feargal Keenan.

WORKING OUT THE KINKS:

Creating Solutions to Assist Health Care Workers to Take Vital Signs Through Effective Cable Management

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STUDENT AUTHOR BIO SKETCHES

Carl Russell III is a junior in Biomedical Engineering at Purdue University. He has participated in EPICS since his freshman year and has been a project manager of the BME EPICS team for four semesters. Throughout his time in EPICS he has worked on projects ranging from a young boy's prosthetic to an automated CPR machine. He is active on the leadership teams of the Caduceus Club, Undergraduate Research Society of Purdue, and Alpha Eta Mu Beta. He is hoping to matriculate to medical school post-graduation.

Emily Linder is a first-year student participating in the first-year engineering program at Purdue University. She will soon transition into Biomedical Engineering. Emily is active in the Purdue University Dance Marathon and RIISE program at Purdue. She hopes to attend medical school post-graduation.

Maya Godbole is a student in the first-year engineering program at Purdue University. She plans on transitioning to a Biomedical Engineering major on the pre-med track. Maya is involved in the Women in Engineering Recruitment Program, Boiler Gold Standard Volunteering, and is a Teaching Assistant for an introductory engineering course.

ABSTRACT

EPICS (Engineering Projects in Community Service) is a service-learning design program run through Purdue University. It strives to teach students design skills through providing solutions for individuals, communities, and organizations in the surrounding area while mirroring engineering industry standards. BME (Biomedical Engineering) is a team within EPICS that strives to serve community partners through biomedical applications. Members of a health care team often spend valuable time organizing cables associated with machines used to take patients' vital signs. Due to time constraints and the fast-paced work environment, these cables may be mismanaged and damaged. The BME team is working on a solution to ensure that relevant cords will be easily managed, damage will be minimized, and most importantly, health care professionals' time will be saved.

INTRODUCTION

The Biomedical Engineering (BME) team at Purdue University is a service-learning program through EPICS. The BME EPICS team was established in the spring of 2017 and is just one of the many EPICS teams at Purdue University. The EPICS program as a whole consists of around 500 students and is run by the Purdue University

Figure 1. IU Simon Cancer Center. Image from IU School of Medicine.

College of Engineering. Students of all majors and disciplines at Purdue have the opportunity to participate in EPICS.

Within the EPICS BME program, students are given the opportunity to collaborate and utilize engineering principles in order to address medical problems that arise within the community. Currently, there are 24 students on the Biomedical Engineering team. The team includes students of various education levels, experience, and academic disciplines. The BME team also has four different subteams that are each working on various medical projects.

Figure 2. The project team discussing ideas with Brian at the 3D Innovations Lab.

More recently, a new subteam (Vital Management) was formed to develop a cable management system for hospital vital machines. This team was introduced with the help of Brian Overshiner, the lab program manager of the IU Health 3D Innovations Lab at the IU Health Simon Cancer Center (Figure 1). Brian's involvement in 3D printing began as an interest and eventually turned into a career that allows him to work with 3D printed medical devices to aid doctors in their practice. The projects Brian takes on are sparked by his observations of devices he thinks would be useful to those around him. Brian noticed that it was difficult for hospital staff to properly wrap up cables onto the vital machines in an efficient manner, which results in cables being run over, tangled, and consequently damaged. This leads to frustrated health care professionals, wasted time, and a greater economic cost for hospitals. Brian and hospital staff that interact with the vital machines are the main stakeholders of the team. All designs are developed with the intention of protecting cables in a fast-paced work environment and preserving health care professionals' time.

Throughout the duration of the project the project team has worked closely with Brian to ensure that all components of the design are compatible and feasible with the current vital machines at IU Health Simon Cancer Center (Figure 2).

The Vital Management team is currently developing a push-lever retractable storage encasement for the cables to help reduce cable damage and safeguard the valuable time of health care professionals. Since beginning in the fall of 2021, the team has developed a working 3D prototype of the proposed system with plans to more efficiently model the system and begin testing in the fall 2022 semester.

DESCRIPTION

A vital machine usually consists of about 3–4 measurement devices, each with long cables. On the front of the vital machine there is a box for storage. On the sides of the machine there are clamps that the cables can be wound up on. However, due to the minimal time nurses have throughout the day and the greater need to attend to patients, vital machine cables usually do not get wound up properly and instead are left hanging off the vital machine. This leads to the cables getting run over and caught in the wheels of the machine, consequently leading to damage. Cables can be very expensive to replace and therefore increase hospital costs.

Since this project is associated with the EPICS program at Purdue, the workflow for the project is reliant on the EPICS design process (Figure 3). The process was employed to ensure that all components of design are considered. This will lead to a quality product that meets the stakeholder requirements.

During the initial design and planning stages of the project, the team worked through selecting a general design concept for managing cables. Initial ideas introduced included foldable clips, retraction, and levers. While in theory the majority of these designs could work to store cables, there were additional design criteria that were relevant to a fast-paced hospital environment, which narrowed possible solutions.

The main stakeholders are nurses and other hospital staff using the machines on a daily basis. Since they would use

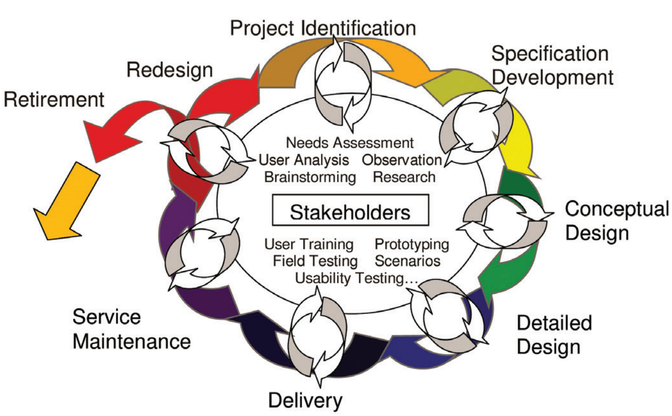

Figure 3. The EPICS design process flowchart. Image from EPICS—Purdue.

the design the most, the team wanted to make sure that their interactions would be easy and convenient. Benji Milanowski, RN, helped shed light on certain issues that needed to be considered during brainstorming. He mentioned that working in a hospital environment requires efficiency and speed, so any interaction with the cable management design needs to be quick and automatic. Spending additional time manually wrapping cables or applying clips would take time away from other important tasks and could lead to more user frustration. Thus, initial design proposals with time-intensive interactions were soon ruled out. After considering these factors and the user needs outlined in Table 1, the team selected a rotational system as the foundation for the design. This was inspired by the team's deconstruction of common retractable dog leashes and portable computer mouse systems. A retractable system would allow for access to the cables in a simple pulling motion, while an easy press of a lever would wind the cable back into place. With cleanliness also a critical user need in a hospital, the design was developed in a way that would allow the cables inside the device to be easily accessible for performing sanitation procedures.

The overall design the team has developed is a rotating circular front face and an attached stationary axle. This front face allows for various types of cord to run from the outside to the inside of a storage container and vice versa. When a user wants to pull the cord out of the box, the front face is meant to be free-spinning until the user stops pulling. As the user pulls the cable, a brake will be engaged so the cable does not retract while it is in use. The brake system acts via a passive tension spring that compresses a one-way bearing onto a track located

Table 1. A User Needs List for the Device

Need #	Stakeholder	User Need
1	Nurse	Must attach to vital machine pole
2	Hospital	Must protect cables
3	Hospital	Material must be compliant with sanitation procedures
4	Nurse	Must keep cable neat and tangle free
5	Nurse	Must be easily dismantled for cleaning
6	Hospital	Must be economical
7	Patient	Must not affect VI machine results
8	Hospital	Must be easily assembled
9	Hospital	Must be adaptable to different pole types

Image by Emily Linder.

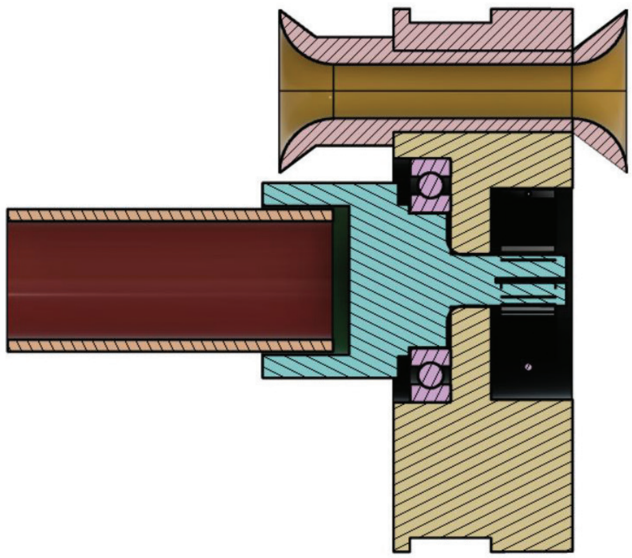

Figure 4. Cross-sectional view of the retraction mechanism. Image by Carl Russell.

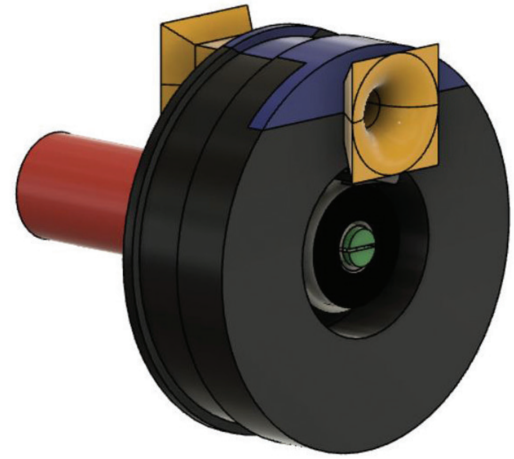

Figure 5. Angled view of the retraction mechanism. Image by Carl Russell.

around the diameter of the front face of the device. When the user wants to retract the cable, the brake system can be manually disengaged with a push of a button to allow the front face of the device to spin. This wraps up the cord around a stationary pipe to allow the cord to be accessed later. Since the cord is not being kept under constant stress when it self-wraps around the pipe, the integrity of the cord is maintained while the cord is in storage. In-progress renderings of the design are shown with a cross-sectional view (Figure 4) and a full view or angled view (Figure 5).

The team spent the duration of the spring 2022 semester finalizing the CAD pieces of the design and ordering the necessary PVC pipe, bearings, and springs needed for the proposed design. A working prototype was developed using the 3D printed parts and the ordered parts. The team plans to use the fall 2022 semester to finalize the brake system and the encasement for the prototype and then begin testing in the spring of 2023. Delivery of the final project will be made to Brian Overshiner and his team.

With the current prototype, the team has participated in various showcases and events. This project was the second-place winner at the 2022 Purdue University Engagement and Service-Learning Summit. It was also presented at the 2022 Celebrate Purdue's Thinkers, Creators, & Experimenters event. The team is also currently working closely with the Office of Technology Commercialization at Purdue to place a patent on the device. Finalizations for the provisional patent application will occur by February 2023.

Currently, there are three alternate projects for the EPICS team. One team is developing an automated CPR device to support first responders in underserved communities in Ecuador to provide effective CPR during long transits. Another team is developing a child-resistant weekly pill-minder device that also provides easy access for the prescription user. The third is creating a game modeled after Flappy Bird (Flappy Bird, 2013) that takes inputs from muscle contractions. Each week it is expected that a team member commits to two hours of in lab work and two hours of outside lab work. Team members are also expected to document details related to their personal contributions to the project. If any of these projects happen to be of interest, please contact the EPICS office at epics@purdue.edu.

COMMUNITY IMPACT

Until the prototype is complete, the team is not able to begin validation trials with the stakeholder. In the lab, the team was able to identify failure points for some of the 3D printed parts, but immediately redesigned and reprinted the parts to be more stable. The current prototype allows for the retraction of a thin cable. The measure of success for the device would be quantitatively measured with retraction efficiency and process time. Retraction efficiency would be a ratio of the length of cable outside of the device before unwrapping and after rewrapping the cord. Process time would be the time spent organizing the cables before and after retrieving the vital signs from a patient.

It is our hope that this project will have a positive impact in a variety of different hospital settings. The health care professionals who work with various types of cables would potentially benefit from the employment of this device not only on a portable vital machine but also as a stationary system. If the device is successful, it could not only help the IU Cancer Center but other hospital systems that struggle with the same issues. Time and money would be saved as cords would be protected and accessible. Priorities can then be shifted from cord management to patient care.

The nonspecific nature of the retractable cable management system allows a variety of different cables to effectively interface with it. This could range from pulse oximeters and blood pressure tubing on a vital machine to ultrasound wands. With this versatility, hospital settings would not be the only area in which this device could be employed. Office settings and server rooms are environments that have a high volume of cables and could potentially benefit from the design. The system can offer a retraction system for cables that need to be accessed quickly or need a place to be stored while still being attached to a device.

The team plans to deliver a finalized cable management prototype to Brian and IU Health by the middle of the fall 2023 semester. At this moment, the team has been focusing on the fabrication of the device. After fabrication is completed, the team will begin strength testing, dimension verification, and exploring potential 3D print materials.

STUDENT AUTHOR IMPACT

CARL: Working on this project has been a very rewarding experience. It has allowed me to not only design and prototype a device that might have a lasting impact in the healthcare field, but also to work with bright minds that are passionate about the work that they are doing. Managing this subteam along with the others as project manager has shown me the different scenarios that students are exposed to and has given me the opportunity to advise students on the different skills that they can use to achieve their objectives. I look forward to seeing this project through to its completion.

EMILY: In this project, I have gained both teamwork skills and technical skills. I have learned how to better communicate my ideas and opinions while also learning how to problem solve and brainstorm solutions. Being a part of the Vital Management BME EPICS team, I have taken part in many opportunities I would not have thought were possible. This team has made so much progress in the past two semesters due to our determination to not only develop a thorough project, but also to make a difference in the medical industry and the busy work lives of nurses and doctors.

MAYA: Being a part of BME EPICS has been a great opportunity that has allowed me to develop many skills that would not be possible to learn in a typical lecture/classroom setting. Working on a real-world problem related to the medical field has enriched my first year at Purdue and has shown me the importance of teamwork, strong communication, and seeking new learning opportunities. I am so glad to have been part of the Vital Management team and I am excited to continue our work in future semesters.

CONCLUSION

Cable management continues to be an issue that is prevalent in the health care setting. Mismanaged cables lead to damages that are expensive to repair and take time away from patient care. This team is designing a way to alleviate that issue through a novel concept for an interchangeable retraction system. It is our hope that this device increases efficiency for end users and produces better patient outcomes due to healthcare providers being able to spend more time on patient care.

REFERENCES

EPICS: BME. (n.d.). Retrieved from http://bmeepics.wixsite.com/bmeepics

EPICS—Purdue University. (n.d.). Retrieved from https://engineering.purdue.edu/EPICS

IU Simon Cancer Center awarded NCI funding to expand smoking cessation treatment. (2018, April 24). https://medicine.iu.edu/news/2018/04/iu-simon-cancer-center-awarded-nci-funding-to-expand-smoking-cessation-treatment. Retrieved March 15, 2022.

Flappy Bird [Computer Software]. (2013). dotGears.

Teams. (n.d.). Retrieved from https://engineering.purdue.edu/EPICS/teams

Vital Management. (n.d.). Retrieved from http://bmeepics.wixsite.com/bmeepics/vmcable

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