# SENIOR DESIGN

## 2021-2022 | Annual Report

**N** SCHOOL OF COMPUTING

## SENIOR DESIGN MISSION

Senior Design provides a project-based capstone course that gives students a design-centered educational experience. Our students focus on the applications of software and systems engineering principles to solve complex problems through the design, development, and implementation of innovative computing systems.

## SENIOR DESIGN CORE VALUES

Our core values reflect the School of Computing's 53-year history, mission, and beliefs:

By teaching essential skills and providing globally-recognized research and training opportunities, we prepare students for the most challenging, innovative, and fastest-growing careers of the 21st Century. Featuring world-class facilities and a groundbreaking curriculum, the University of Nebraska–Lincoln's School of Computing is one of the country's top computer science and engineering programs.

## MESSAGE FROM THE DIRECTOR



Dear friends,

Welcome to the School of Computing's Senior Design Year in Review Report for 2021-2022.

Thank you for taking the time to learn about the projects that our students tackled as part of this year's portfolio. This has been a fantastic year, unlike any in the past: combining good remote practices discovered during the pandemic with good in-person practices, the Senior Design faculty, staff, students, and sponsors found highly-effective ways to work together. In the pages that follow, you will find summaries of their collective efforts to satisfy the project-based capstone requirements, thereby preparing the next generation of computing professionals.

Our students' talent and efforts continue to amaze us, and we are extremely proud of them.

It has been our privilege to guide the School of Computing's students through their capstone experience, but we didn't do it alone. Other faculty and staff in the School of Computing and across the University of Nebraska prepared them for their Senior Design success. We also thank our students' families and friends who supported them during their college years.

I also offer my personal thanks to the capstone program's staff and faculty, and to the nearly two dozen volunteer coaches from industry, for their dedication this year. You demonstrated true commitment to student success, and because of you, our students will have many future successes.

Chris Bohn
Assistant Director for Capstone
School of Computing
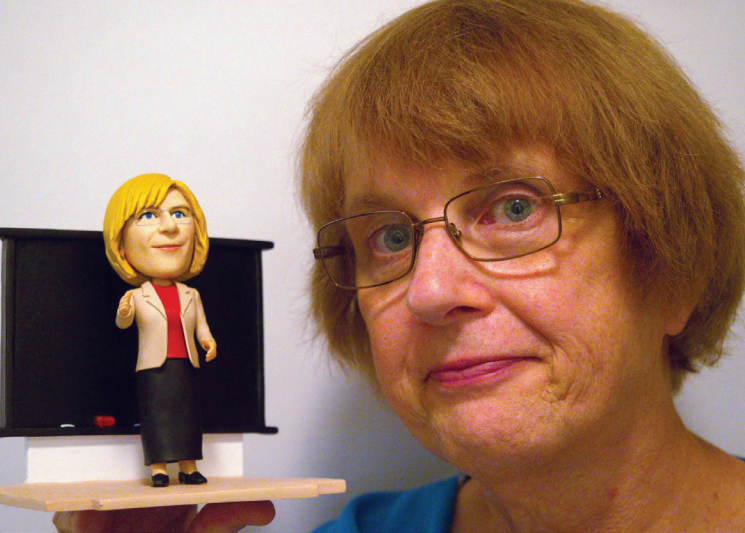
## MARILYN C. WOLF

Koch Professor of Engineering and Founding Director

School of Computing

Capstone is one of the most important components of our educational mission. This year-long project allows students to synthesize what they have learned throughout their UNL experience. Putting together the pieces gives students a deeper understanding of why we have put them through their paces in so many diverse courses. Senior Design also teaches them important skills in project management that will hold them in good stead no matter what career they may pursue. Students work on projects together with other students who encompass a range of backgrounds, skills, and experience. Our Capstone staff and faculty are passionate about guiding students through challenges—both big and small—to arrive at a successful conclusion.

## SENIOR DESIGN OVERVIEW

We are the School of Computings Capstone program. Our students have experience in multiple programing languages and development platforms and can offer you a wide variety of project types.

- Web Development
- Mobile Apps
- Data Analytics
- Internet of Things
- VR / AR
- Machine Learning
- Gaming
- Geographic Info Systems

We work with industry and academic partners to create great software, hardware, and/or IoT applications.

## INTERESTED IN SPONSORING A PROJECT?

Please fill out the project proposal form:
**go.unl.edu/senior_design_project_proposal**

## CONTACT SENIOR DESIGN ABOUT YOUR NEXT PROJECT VIA EMAIL AT:

**cse-seniordesign@unl.edu**

## VISIT OUR WEBSITE FOR MORE INFORMATION:

**computing.unl.edu/senior-design**

## TECHNOLOGIES USED

## PROJECT DOMAINS

| | |
|---|---|
| 15 BUSINESS WEB DEVELOPMENT | 1 INTERNET OF THINGS |
| 5 MOBILE APP | 1 MACHINE LEARNING |
| 4 DATA ANALYTICS | 1 PROGRESSIVE WEB APP |
| 2 ALGORITHM | 1 RESEARCH & DEVELOPMENT |
| 2 GAMING | 1 SCIENCE GATEWAY |
| 2 GEOGRAPHIC INFORMATION SYSTEMS | 1 WORKFLOW |
| 2 VIRTUAL REALITY | |

## SENIOR DESIGN STATISTICS

| 144 | 24 |
|---|---|
| # OF STUDENTS | # OF PROJECTS/ SPONSORS |

| 28,808 | 668 |
|---|---|
| HOURS OF STUDENT DEVELOPMENT | HOURS OF SPONSOR MEETINGS |

| 6 | 3 |
|---|---|
| # OF TEAMS USING AWS | # OF NONPROFIT ORGANIZATI ONS PROJECTS/SPONSORS |

| 4 | 5 |
|---|---|
| # OF RESEARCH AND DEVELOPMENT PROJECTS | # OF PROJECTS BENEFITTING NEBRASKA |

| 8 | 22 |
|---|---|
| FACULTY AND STAFF | COACHES |
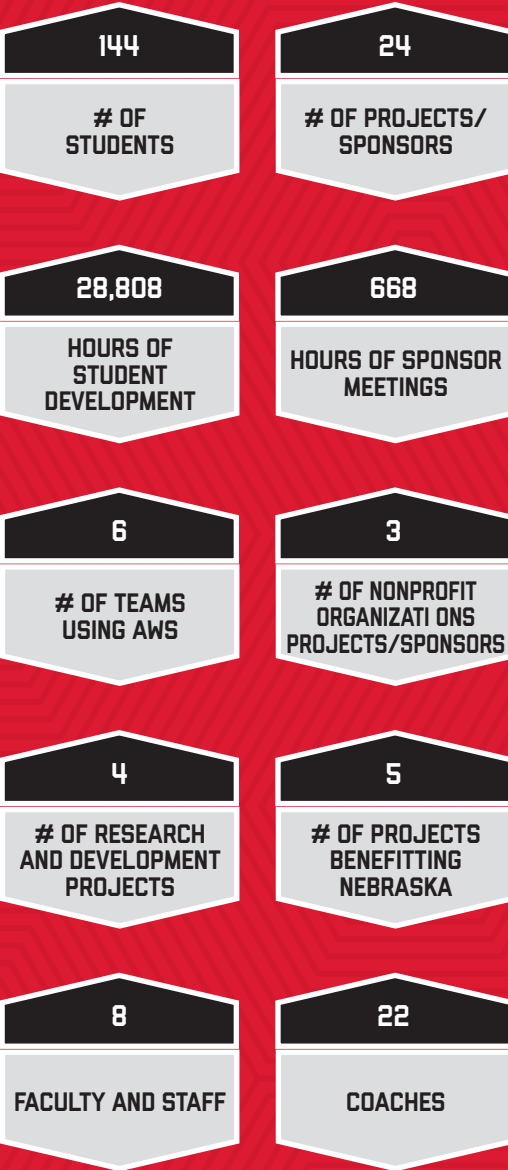
Sponsor: **Care Bridge International**

Project: **Claims Intelligence Platform**

Care Bridge International proposed a project to predict the future lifetime medical cost of patients with extreme medical claims. This initial proposal was shifted to designing a process for training models to predict future medical costs of any claimant. This solution was better since the process and recommendations from the team allowed the sponsor to train models after the team handed over the project.

Dataset analysis and preparation are important parts of the process of creating machine learning models. The team familiarized themselves with the available data and adjusted their goals to create reasonable expectations for the models. Throughout the development process, the team altered the training data by including or removing certain attributes or combining files along certain attributes. After each revision, the team retrained the models and evaluated the performance.

To train a successful model, the team needed to determine the most appropriate model architectures. The team researched a variety of architectures and determined which were most appropriate. These architectures were tested and evaluated. The team documented all of their research and results to provide the sponsors with a recommendation for the most promising model architectures.

The final product was a detailed training process, a set of recommendations, and a series of scripts to train models. To facilitate an easy handoff, the team recorded the research process and our reasons behind certain decisions. Based on the research, the team provided recommendations for model architectures and data-formatting for optimal performance. The team also tested the training scripts locally and on the sponsor's server, so that the code would run successfully, and the sponsor could train their own models with improved data in the future.

### THE TEAM

| | |
|---|---|
| Simon Schoenbeck | Squad Lead and Project Manager |
| Ujwal Ghatamaneni | Development Manager |
| Wencheng Bao | Developer |
| Sam Rilett | Developer |
| Sajal Risal | Developer |
| Serigne Toure | Developer |



LSTM Architecture



Model Accuracy



Model Training Process



Multi-Level Model



Two Tower Recommender
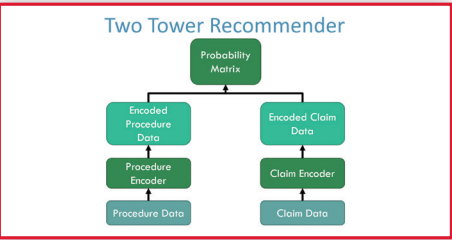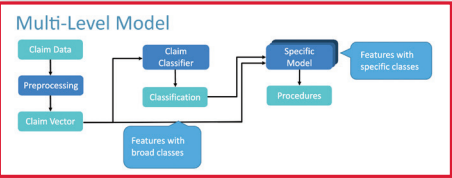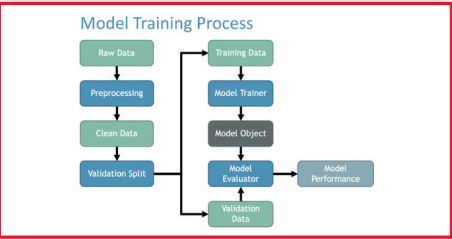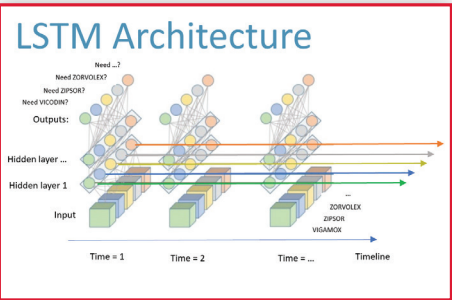
Sponsor: **City of Lincoln**

Project: **Renter & Landlord Community Education Tool**

The team was tasked with the development of a Web application that would digitize the process of eviction-reducing courses offered by the City of Lincoln and the Nebraska Housing Developers Association. RentWise is a course for renters that teaches them the ins and outs of renting and how to be a good tenant. Fair Housing Education is the other course, which is offered to housing providers to reduce occurrences of unfair and discriminatory behavior. Both courses were administered only in-person, and the goal was to create an app that provides these courses in an online environment so that they are more accessible while still providing the same educational value.

Offering a course online should maintain the elements of an in-person course and offer additional functionality and convenience. Things such as activities, quizzes, videos, and other interactive activities assure that taking the course online provides the same, if not improved, experience that the in-person course did. In-person courses also have instructors or agencies that would guide the course curriculum. Users are provided with agency contact information in case they have questions. For this, the team developed a system for administrators or agencies to oversee their users split between two tiers. An agency admin should only be able to view users enrolled in a course under their agency, while a super admin has rights to all parts of the website, including the process of inviting new admins, viewing all users, and editing some of the course content itself.

The team initially had to decide on a tech stack, choosing MEAN (MongoDB, Express, Angular, NodeJS). Release 1 was mostly planning out features and designing the database for this application. For Release 2, the bare framework of the front-end was started. User registration and login were created, as well as the functionality for resetting passwords. Release 3 had a focus on course registration, as well as getting the content for the courses integrated in a basic way. Release 4 was about polishing the course content, adding activities, and creating the quiz system. Release 5 had a focus on creating the admin portal, which allows super-administrators (the sponsors) to view the progress of users, add/edit quiz questions, and maintain a list of properties all through their Web browser, while agency administrators have access to a subset of those features.

### THE TEAM

| | |
|---|---|
| Taylor Satterfield | Squad Lead and Development Manager |
| Benjamin Reisen | Product Manager |
| Austin Aldana | Developer |
| Dalton Hulett | Developer |
| Alexander Kupec | Developer |
| Gianni Young | Developer |
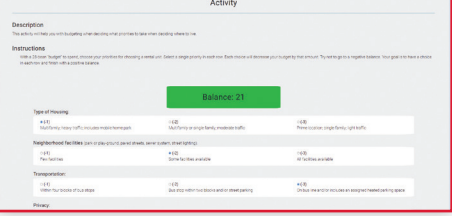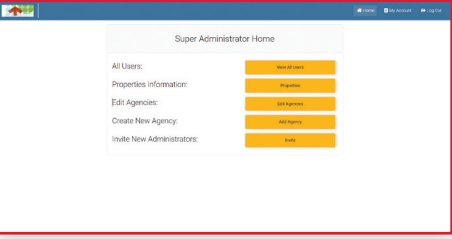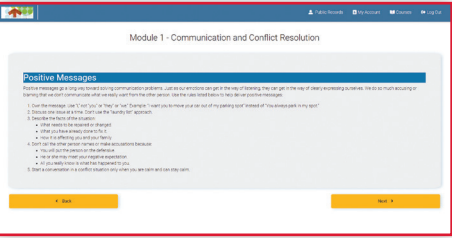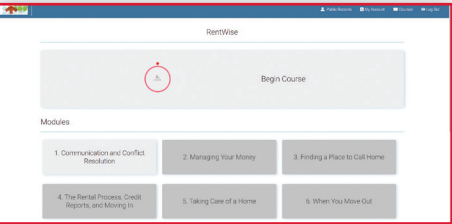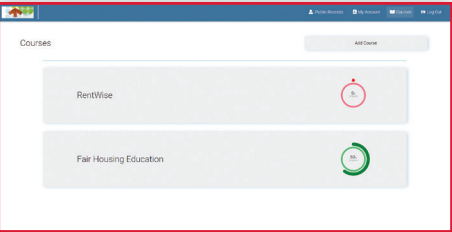
## Sponsor: **Civic Nebraska**
## Project: **Election Protection Program**

The challenge posed by the Election Protection Program was how to allow authenticated users to fill out observation forms in a secure and easy-to-use manor. Throughout a lot of design testing and learning, our progress led us to the first version of the Election Protection Program.

The first major challenge posed was what technologies to use, since we did not know who would be taking over maintenance of the application after the year was over. We decided to move forward with a React Application since it had wide support throughout the development community and it would not be as hard for Civic Nebraska to find a company to work with to support the application.

From there, the next challenge posed was how to effectively transfer the three forms Civic Nebraska used into a digital format. We used initial wireframes to get the initial design. From there, user testing, combined with testing by the sponsor, led us through multiple iterations of each form. We learned how a user naturally wants to interact with each element and tried to increase the usability of each form. We also took an early approach to make sure each form translated well to a mobile view.

After we had reached a final version of each form, it was time to tackle the security of the application and other functionality required of the application other then form submission. For authentication and authorization, the team utilized Auth0 as it allowed for a third party authentication that was plug and play and easy to implement. After handling the authentication of a user, we needed to create admin functionality. Admin users need to have extra security levels to add new users, elections, and polling sites.
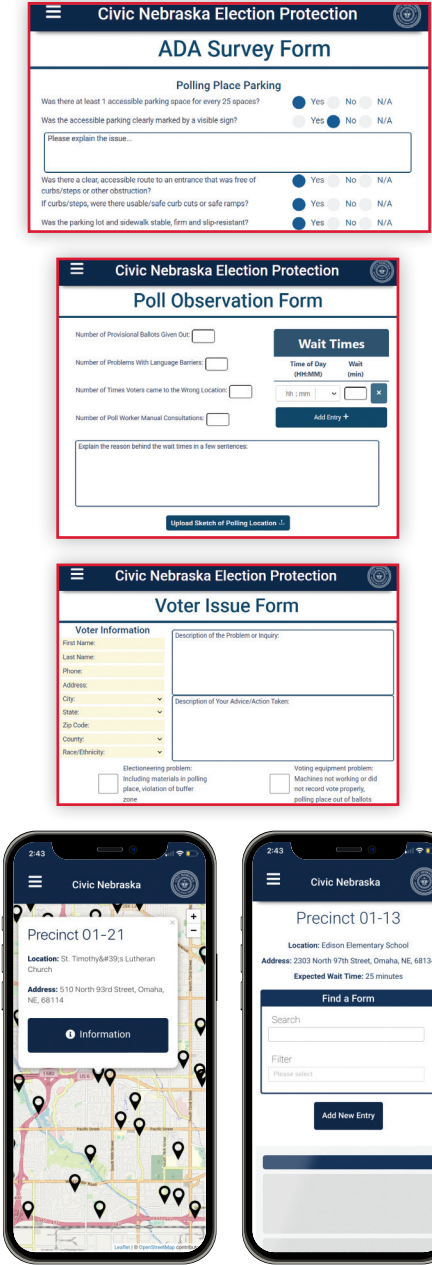
All of these parts combined formed the first version of the Election Protection Program Application. Hopefully, this application will be used at the upcoming Midterm elections in 2022 and will streamline work for Civic Nebraska.

### THE TEAM

| | |
|---|---|
| **Troy Ogden** | **Squad Lead and Product Manager** |
| **Andrew Hazel** | **Development Manager** |
| **Sebastian Alegrett** | **Developer** |
| **Sean Hollibaugh** | **Developer** |
| **Kyle Kobza** | **Developer** |
| **Sam Thompson** | **Developer** |



## Sponsor: **Connections Homes**
## Project: **Youth Matching Tool**

Connections Homes is a nonprofit organization based in Georgia that aims to help youth who have aged out of foster care. They match these youth with mentoring families who can help them with various needs and supports. These needs and supports can range anywhere from housing and medical assistance to simply a place to go during the holidays.

To ensure the needs of these youth in Georgia, and now Texas, are properly met, Relationship Managers (RMs) at Connections Homes would carefully match a youth with a mentoring family. The RMs looked through a great deal of information about the youth to find the family that would best fulfill their needs and share similar attributes and beliefs. This was a time-consuming process because there was a lot of information that needed to be reviewed before the family could be contacted about a potential match with a youth. This is where the Youth Matching Tool comes in.

The goal of the matching tool was to make this process of matching youth and families faster and more comprehensive. The Senior Design team was tasked with creating an algorithm to select the families that would best match with a given youth. This algorithm also needed to have an interface to display the results to the RMs and provide justification for the scores.

The team's solution was to create a React application with a C# backend. They also utilized AWS services for hosting, and API/Lambda services. The sponsors had all their data stored on Airtable, which the team kept the same to reduce costs and information transfer.

### THE TEAM

| | |
|---|---|
| **Caleb Marcoux** | **Squad Lead and Frontend Developer** |
| **Jiakai Li** | **Frontend Developer** |
| **Alexis Linhardt** | **Frontend Developer** |
| **Rainier Sarreal** | **Backend Developer** |
| **Haley Shaw** | **Backend Developer** |
| **Jacob Sloup** | **Backend Developer and Product Manager** |
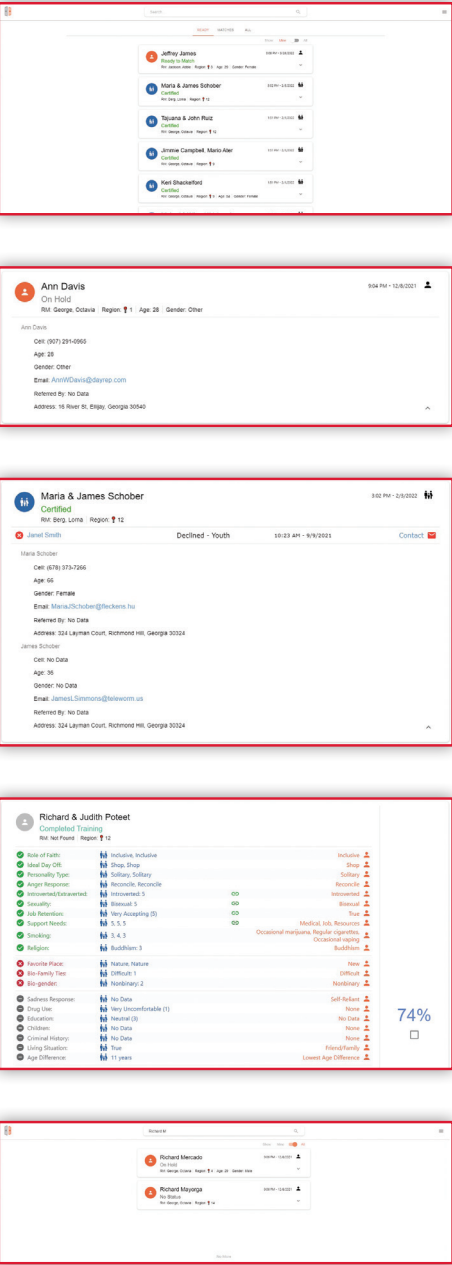
Sponsor: **DMSi**

Project: **Reman Mobile App**

DMSi is a company heavily involved in the lumber and building materials industry and is focused on providing software solutions to their customers. The goal of this project was to create a mobile application for the remanufacturing (reman) process that DMSi currently offers on their client/server-based ERP application. Having this process in the form of a mobile application helps to eliminate multistep processes and reduce paper usage for the customer. The efficiency this application brings to customers gives them more time to do other high-value tasks, as well as a simpler experience when applying the remanufacturing process. This will ultimately lead to more profits for the customer and help integrate them into DMSi's other mobile applications for their work.

The mobile application was created using React Native, which allowed the team to easily develop for both iOS and Android devices simultaneously. Most of the developers on the team had little experience with React Native before, so it took a bit of tinkering and trial-and-error before the team became proficient at utilizing the React Native framework to its fullest extent. Through the usage of mockups, the team designed numerous screens that would embody the reman mobile application, which were then implemented using React Native components. The front-end of the application is where most of the team's time was invested, and much effort was put into ensuring the consistency of

the design of the project as well as its usability. Expo was the primary tool used to build and test the application, which allowed the team to easily simulate running the application on a mobile device.

This, however, was only a portion of the overall project. Another aspect was how the application utilizes DMSi's API that they have already implemented in their existing software solutions. For this, the team used the Go programming language to create the middleware of the project that connects the mobile app with the existing API. With access to DMSi's API, the team could now make requests to retrieve and send information to a database. The team utilized a separate repository for this middleware solution that they would run once logged into the reman mobile application.

### THE TEAM

| | |
|---|---|
| Michael Westberg | Squad Lead and Development Manager |
| Ethan Fox | Product Manager |
| Adam Leppky | Developer |
| Sailesh Pujara | Developer |
| Emily Schnepel | Developer |
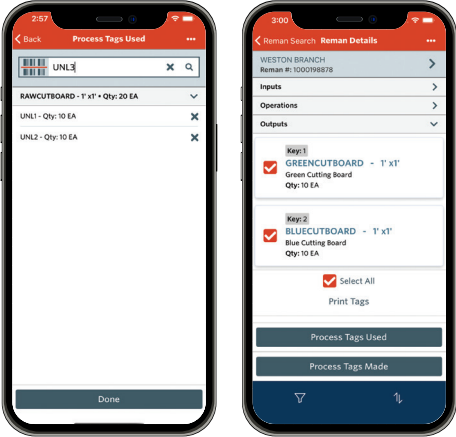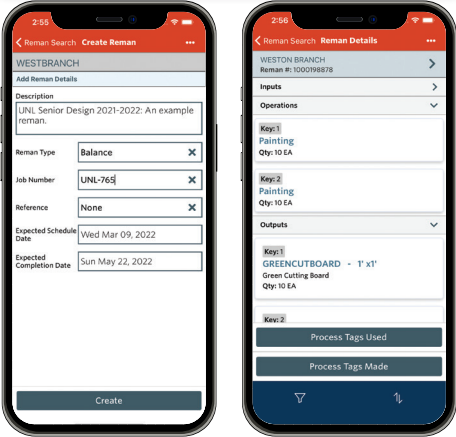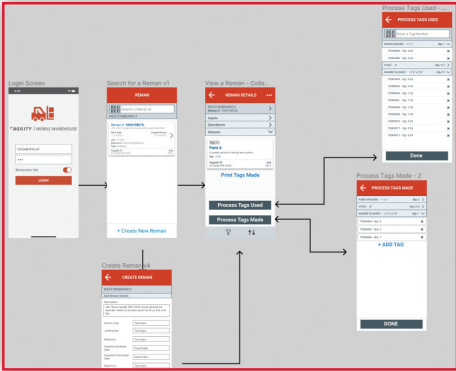
Sponsor: **Entreprenuer Team**

Project: **Neural Nest**

In a time when movement shooter games are making a comeback, there isn't much variety within the genre. To challenge this, the team aimed to create a unique movement shooter experience that no game had done before. The game incorporates themes of machine learning and transhumanism; a surreal, hand-drawn environment; wingsuit-like flight mechanics; and nonlinear, adventure-based gameplay.

One of the main goals of the game was to fill it with enemies and environments that appear "machine learning-generated," for story reasons. This was brought to life through surreal, uncanny enemies with human-like features, and levels that make the player feel disoriented with their scale. Even the video on the game's title screen incorporates these themes, as it was generated with a generative adversarial network that the team trained.

The game's unique nonlinear gameplay was achieved with levels that were designed to intertwine and loop back on themselves. Secrets are littered everywhere that encourage exploration and backtracking, making the player feel like they are fully immersed in the dystopian world. Abilities such as flight are unlocked over time, allowing the player to slowly gain access to more and more of the sprawling levels.

Neural Nest will be a fairly large game when fully completed. Through Senior Design, the team created a 30-minute playable demo of the game that they released on the Steam game store. The demo acts as a vertical slice of the game that they are now presenting to possible publishers. Through the feedback they receive from the demo, the team plans to build out the full game over the next year.

### THE TEAM

| | |
|---|---|
| Jaden Goter | Squad Lead and Development Manager |
| Ethan Dyas | Programmer |
| Matt Lowe | Product Manager and Marketing |
| Camden Obertop | 2D Art and Level Design |
| Tanner Skelton | 3D Art |
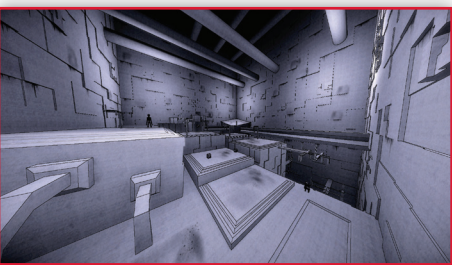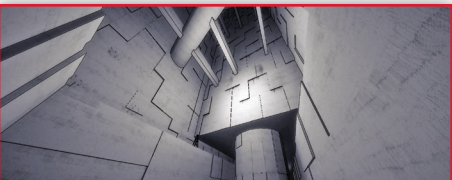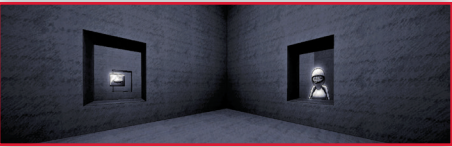
Sponsor: **Dr. Shelley Freeman**

Project: **Freeman Preparation Program**

The challenge presented to our team was to work with psychologist Dr. Shelley Freeman to help modernize the distribution of her content. Dr. Freeman was previously selling mp3 players and CDs with her content on them and needed a more modern way to distribute. We were tasked with creating an app that connected with hospitals and, more specifically, gave patients access to the app where Dr. Freeman's content would be accessible. We had to build this from the ground up with limited knowledge of app development.

One of the first challenges we tackled was choosing a tech stack. We needed a development technology that would be easy enough to pick up with limited experience, one that also didn't restrict the requirements we needed to meet, and finally, one that would give us the most flexible distribution process—as Dr. Shelley wanted this to be available globally and on any type of device. This led us to choose a PWA (Progressive Web app) that would be designed in React-JS. This gave us a very flexible framework with accessibility on any device.

The next challenge was to choose a suitable backend. We needed one to host our user pool, store table date and host our app for testing. AWS provided us with an all-in-one tool called amplify studio for these needs. It provided us with a user pool to keep track of all users

and admin, a no sql database for storage and structure and a hosting service for live testing and sponsor distribution.

Lastly, we had to get underway with the design and creation of the app. Our implementation is one which includes an app that, once signed in, allows a user account that can be linked to a hospital, where they can navigate the app to access their content. This app is managed through three main sections: the home page, which allows users to find their favorite content and see messages from Dr. Shelley herself; the explore page, which is the main way to access her content; and lastly, the profile page, which in the future will allow users to manage their subscription and admins to add content to the app (which currently is only doable in the AWS backend). This all comes together to form a success minimum viable product for a sponsor with much room to grow.

**THE TEAM**

| | |
|---|---|
| Alex Stumpff | Squad Lead and Product Manager |
| Calvin Shafer | Development Manager |
| Salman Djingueinabaye | Developer |
| Ze Han | Developer |
| Emily Pfeiler | Developer |
| Jayden Smith | Developer |







Sponsor: **Jackson Family Foundation**

Project: **Grant Tracking Interactive Map**

The Jackson Family Foundation interacts with many global partners and is actively managing their partnership portfolio; however, prior to this project, they did not have a usable interface to support their strategic goals as it relates to partner and project management. The Interactive Mapping team developed a Web-based interface that enables the Jackson Family Foundation to determine the geographic areas that have sufficient and insufficient partnerships and projects.

The user interface developed by the Interactive Mapping team implements many features to support the Jackson Family Foundation in their goal of project and partner management. Such features include file uploading (used to enable updating and replacing stored information), geographic visualization of grant funding, a grant list that provides in-depth information regarding grants, and a User login. Each of these features ultimately provides the Jackson Family Foundation with an easy-to-use interface that supports effectively managing and developing strategic goals.
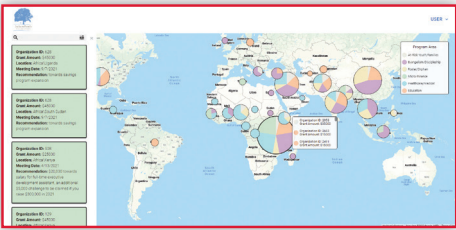
The backend implemented for the project is designed to support all features implemented by the frontend. Some of the features integrated by the Interactive Map backend include: support for data storage, data searching, and data filtering. The Interactive Map backend supports the existing Jackson Family Foundation software stack and deployment services. Integrating the Jackson Family Foundation software stack and deployment services enabled an easy project transition and created a familiar development environment for future maintenance.

**THE TEAM**

| | |
|---|---|
| Evan Palmer | Squad Lead and Product Manager |
| Joshua Baesler | Development Manager |
| Matthew Kerian | Developer |
| Shelby Miller | Developer |
| Andres Ruiz | Developer |

Sponsor: **UNL School of Computing**

Project: **Matching And Grouping of Interests for Capstone (MAGIC)**

For the Senior Design Program, the UNL School of Computing tasked the team with creating an algorithm that would automate the process of matching students to an available sponsored project. In the process, students were given a "Project Preferences" survey in which they each stack-ranked available projects, 1 being their top choice to x (the number of available projects). Students were then matched based on their project preferences, majors, leadership preferences, prerequisite performance, teammate preferences, and the preferences of the Senior Design student-base overall. With over 100 results to sift through, this presented hours of manual labor with a short turnaround time for staff to make decisions.

To start, the team assessed the manual process. This workflow involved three main files including the student roster, prerequisites, and results from the preferences survey. The three files were then combined and referred to during the grouping procedure. Executed in passes, the first pass designated students in their second year of Senior Design ("second-year students") to projects, followed by a second pass where students in their first-year of the Senior Design program ("first year students") were assigned to projects.

To solve the problem, the team created a Web-based application which used a merging and sorting algorithm to delegate students to an available project based on the aforementioned criteria. A front-end component was developed to specify the required files and run the submitted data through the program. To ensure the process ran smoothly, templates were established for each of the three files.

The algorithm began by reading the three files and using a common point to merge them. Afterwards, the algorithm created a database using the sponsored project name, student's name, NUID, and preference ranking. The program then assigned students at random while taking into account their top-ranked preferences. Since the system worked at random, the algorithm gave second-year students priority so that they could receive their best possible preference outcome. The assignment of first-year students followed thereafter. This program reduced the original hours of labor to a few seconds.

### THE TEAM

**Brent Miller**  **Squad Lead, Development Manager and Developer**

**Amy Tran**  **Product Manager and Developer**

**Ikhlaas Mungloo**  **Developer**











Sponsor: **Nebraska Game and Parks**

Project: **Field App for Fisheries Field Sampling**

The Fisheries Division of the Nebraska Game and Parks Commission conducts field sampling of fish populations across the state and throughout the year. Studies are conducted by biologists, specialists, researchers, and graduate students on the data collected by the Fisheries Division. The information collected by these studies helps the division strike a healthy balance for fish, people, and water quality throughout the state.

The previous solution for data collection was data sheets to be used on lakes, rivers, and other bodies of water. While collecting data this way was very efficient, all that data needed to be manually input into a database developed in 1997. The Fisheries Division was developing a new software system to keep up with industry standards and wanted data collection to match that. The problem with this was making an application that was just as efficient and flexible as pen and paper. The sponsors took the team to Holmes Lake to get a better understanding of the process in order to make a compact and innovative UI design that would fit within their requirements.

The tablet application recorded fisheries data to be used by the Nebraska Game and Parks Commission Fisheries Division. The tablet-based data entry application allows users to capture fish sampling data under chaotic

and diverse field conditions. The application includes a robust solution to send data from the local device to the server database. As part of this, authentication and authorization were implemented through Auth0. All software and solutions are well documented including installation and instruction manuals. The final goal was to create a cutting-edge, nation-leading product.

The product includes multiple cutting-edge elements. The application is a Progressive Web App (PWA) allowing it to be OS-independent and used as a deployed website on a server or an application downloaded on the device. The product is also able to securely upload sensitive data through implementing Auth0: an authentication and authorization solution. Data being uploaded also goes through a series of validations to ensure the data is correct. Light and dark themes are provided for the best viewing experience in any condition.

### THE TEAM

**Jadyn Larsen**  **Squad Lead and Product Manager**

**Patrick Orel**  **Development Manager**

**Michael Kawamoto**  **Process Specialist**

**Cameron Collingham**  **Developer**

**Hunter Oestmann**  **Developer**

**Aleka Schlake**  **Developer**

Sponsor: **Nebraska Water Center**

Project: **Vadose Zone Database & User Interface**

The Vadose Zone Database & User Interface project was tasked with developing a website and database that are capable of handling large amounts of soil data obtained by parsing an Excel file. Before the project, all data was submitted via third parties to the Nebraska Water Center (NWC) through email. All data in this Excel file was then verified and entered into the database manually by an NWC administrator, which could take exorbitant amounts of time for a single Excel file. The Vadose Zone team then set out to make the process easier by having all Excel files uploaded directly to the Vadose Zone website.

To begin, the team was able to break the project into two major sections: the website and database. The main functionality of the website is that it allows users to upload an Excel file containing multiple sheets, each with up to 500 rows filled with assorted soil data. On upload, all data in this Excel file is parsed and placed into the correct spot in the database. The website also allows users to create their account, which is then classified into one of two categories. If the account is created to upload data, the account is classified as a 'data contributor' which allows the user to see all data they've previously uploaded, organized by project. If a project is pending, it's waiting for an administrator to verify the project. When an admin labels a project as accepted,

it's then fully integrated into the database. The second type of account is an 'admin', which can perform all tasks that data contributors can, as well as see all data currently living in the database. This makes it easier for admins to quickly identify all information that's in the database and modify its status accordingly.

The second major section of the Vadose Zone Database & User Interface project is the database. For this project, the team had to design a database capable of housing all data found in the Excel file while also separating 'accepted' data from 'pending' data. After working extensively with the sponsors, the team settled on a system based on flags, which allows different amounts of data from each project to be accepted and rejected. Furthermore, any errors found when the data is placed in the database are then stored, allowing administrators to quickly diagnose any data-related issues in the database.

### THE TEAM

Cody Binder — Squad Lead and Product Manager

Patrick McManigal — Development Manager

Collin Sipple — Developer

William Swiston — Developer

Cole Vaske — Developer








Sponsor: **UNL Concussion and Vestibular Evaluation (CAVE) Lab**

Project: **Husker Concussion Mobile App**

Student-athletes who receive care from the UNL CAVE Lab on campus are given a personalized treatment plan geared towards their needs. The CAVE Lab team is skilled at what they do however, like all rehab treatment plans, results are dependent on the athlete's commitment to doing their prescribed exercises. If the athlete isn't making improvements, it could be hard to tell if it is because they are not doing their exercises diligently or if their treatment plan needs to be adjusted. Storing and recording data on each athlete's progress throughout their whole treatment will also aid in further concussion rehab research.

The team was tasked with creating an application suite that would make it easier to assign specific exercises to athletes, track an athlete's symptoms over time, and ensure that athletes were completing their prescribed treatment regimen. To accomplish this, the team worked on three deliverables: A Web-based application for use by CAVE Lab staff to enter athletes into the system, assign them exercises, and monitor their progress through their assigned treatments; and two mobile applications—one for Android and one for iOS—for use by athletes to perform their exercises and rate their symptoms during those exercises.

For the project's second year, the team reorganized the system to add new functionality for role-based authentication and to re-align

data-saving to meet sponsor needs. In the process, the team identified more useful data points for the sponsor and completed data exportation features on the Web portal. The team was also able to finish the athlete's treatment prescription. On the mobile front, the team successfully implemented the database API and updated the styling for a more modern feel.

The team also addressed several longer-term issues that were key to ensuring the app was ready for users. One critical issue was the addition of various security features, such as log-in functionality on the Web and mobile applications and adding user permissions. Additionally, to aid with research within the CAVE Lab, the team implemented data exportation which allows clinicians to better access athlete data in the system with which they can conduct various studies as to treatment effectiveness.

### THE TEAM

Bethany Krull — Squad Lead and Project Manager

Nina Ong — Development Manager

Garrett Roth — Process Specialist and Developer

J.P. Jensen — Developer

Martin Nguyen — Developer

Michael Vipond — Developer

## GUDMUNDSEN SANDHILLS LABORATORY
### Institute of Agriculture and Natural Resources

Sponsor: **Gudmundsen Sandhills Laboratory**

Project: **Livestock Data Analytics**

The team created a cloud-based cattle livestock management and visualization Web application solution for the Gudmundsen Sandhills Laboratory (GSL), a university research facility. The Gudmundsen Laboratory is a research ranch conducting many research projects, especially focusing on range livestock nutrition and beef cattle production. GSL research technicians needed a solution for searching, sorting, and organizing animals into groups and visualizing animal data. Large amounts of animal data—including weights, body condition, and docility—is collected as a part of regular ranch operations and needs to be associated with animals. GSL also conducts experiments measuring different beef cattle characteristics. The large amount of heterogenous data creates a unique operational challenge for GSL. Before the Senior Design team's cloud-based Web application, GSL managed animals and animal data with a complex, inefficient Microsoft Excel solution that made data analysis and aggregation difficult. Furthermore, the previous Excel based system was not scalable.

The team's Web application enabled GSL to visualize all animals in a single, easy to use interface that allowed searching and sorting the active herd of animals. Adding cows could be easily accomplished through upload. All historical data associated with a single cow was easily accessible, searchable, and sortable in a single cow view interface. The team's

solution allowed GSL to create research projects with custom treatments and data collection variables. Data points collected as part of a research project were automatically linked with the corresponding animals. All data in a project could be viewed, searched, and sorted from a single project view interface. The team also created an interface for uploading data collected as part of ranch operations, which featured automatic file upload template creation and automatic data to animal linking.

The team leveraged Amazon Web Services (AWS) cloud ecosystem to deliver a powerful, scalable solution for GSL. While designing the cloud application, the team focused on scalability. Creating an application that could handle GSL as their data storage needs grew was an essential requirement. AWS also enabled the team to build a solution with low latency and limited downtime, allowing GSL to have constant, fast access to their data.

### THE TEAM

| | |
|---|---|
| Andrew Wiedenmann | Squad Lead and Product Manager |
| Isaac Werner | Development Manager |
| Riley Ellwanger | Developer |
| John Erwin | Developer |
| David Estrada | Developer |
| Mario Gomez | Developer |



## HOLLAND COMPUTING CENTER
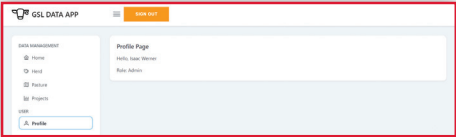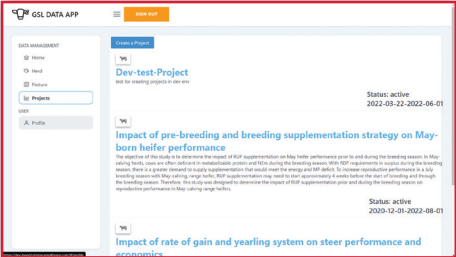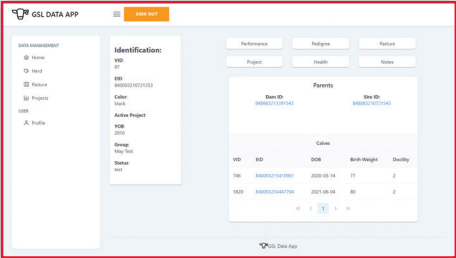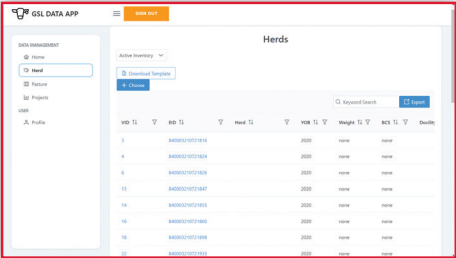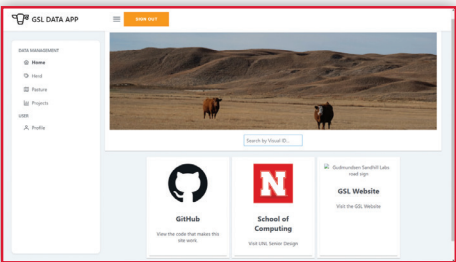
Sponsor: **UNL Holland Computing**

Project: **RNAMake**

Since the team inherited the project from a previous Senior Design team, the first challenge was having the application running locally for development. The team worked with the sponsors to understand the technologies involved in development and got the environment running. With the previous environment, the largest issue was that the user interface was unappealing and not easy to use. The goal of the project was to create a user-friendly and usable frontend application for RNAMake.

To design a frontend application for RNAMake, the team decided to create a React-JS frontend application. Initially, the React-JS frontend was created independent of the Airavata Django Portal. The team was going to initially create the app completely independent of the Airavata Django Portal while using the Airavata API; however, this would have meant creating a lot of features from scratch that are normally handled by the Airavata Django Portal—such as handling users and logins.

After discussions with the University of Indiana, who operate and maintain the Airavata Django Portal, they suggested using the cookie cutter plugin to create a custom UI that lives and operates within the Airavata Django Portal. This was a good idea as the team would have the creative freedom to create a UI that the sponsors were asking for.

A part of the project challenge was handling communication for important parts of the project that dealt with the backend. The team had to work with the University of Indiana and the sponsors to figure out the actions that needed to be taken for the software to be functional. One of which was the HTCondor integration which allows for compute resources to be allocated for running jobs.

### THE TEAM

| | |
|---|---|
| Abdullah Hamad | Squad Lead and Development Manager |
| Josh Bearden | Developer |
| Katie Gerot | Developer |
| Trent McElmury | Developer |
| Kevin Wertz | Developer |
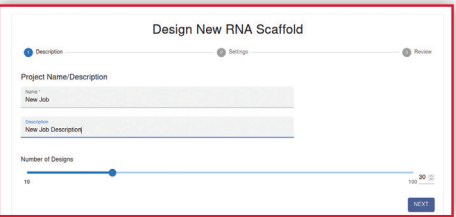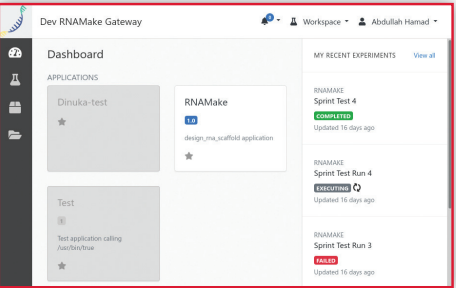
Sponsor: **UNL School of Natural Resources Water Quality**

Project: **StreamNet**

StreamNet was a continuation project from the 2020-2021 Senior Design program. Last year's team created an application to aggregate data from sensors across Nebraska and display the data on a Web page. This year's team was tasked with securely connecting the sensors to the application server to pull in real-time data to the site, and to focus on improving the user experience in terms of viewing and interpreting the data. The team also made improvements to the admin page to give admins more options, such as managing banners on the "Charts" page.

The data visualizations are produced by the Plotly.js charting library and provide time-series graphs of a chosen variable over a period of time which can be changed by the user. A user can select the variables they want to analyze, such as temperature or chemical concentration, and compare multiple charts at once. Each chart can be configured to include data from every sensor available, or any subset of them. A user can also choose to view the data on a logarithmic scale, which allows for more dynamic data analysis.

Any user who makes an account with StreamNet can download a CSV file containing daily averages of their chosen variables and sensors. If a user wants access to the raw hourly data, they can submit a request through their account page, and upon approval they will be granted access to download the raw data. This allows StreamNet to monitor what kinds of users are interested in the data, and it allows users to perform their own analyses on the raw data directly.

**THE TEAM**

| | |
|---|---|
| Cortney Oltjenbruns | Squad Lead and Development Manager |
| Thi Nguyen | Product Manager |
| Lukas Didrichsons | Developer |
| Drew Lauby | Developer |
| Reed Lawrence | Developer |
| Davey Winter | Developer |
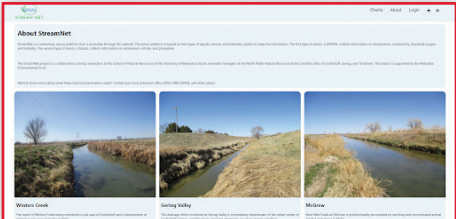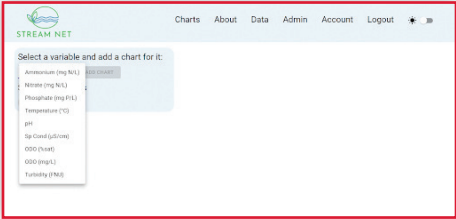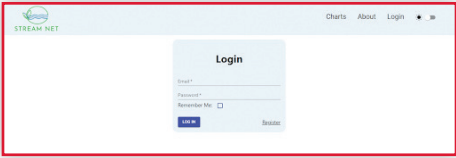
Sponsor: **Chris Bourke**

Project: **Project 046**

Project 046 follows the journey of a scientist that wakes up to find themselves trapped in a mysterious, rundown facility. The doors are completely blocked, and they quickly discover that the only way forward is to go deeper. Throughout the facility, a strange creature toys with the scientist as they attempt to find a way out. While the whole truth of what is going on may never be clear, the happenings that led to this moment are slowly uncovered through flashbacks to the past. As the scientist begins to understand the role they played in the horrors, they must decide whether to fix their mistakes or repeat them.

The team started by creating a Unity 3D Project linked to a GitHub repository. They worked with the Carson Center for Emerging Media Arts (CEMA) team on how the game should look, feel, and what events should take place. The CEMA team also provided level layouts, assets, animations, sound files, and cutscenes to be integrated into the project. The team moved to Unity Collaborate for version control and then progressed to using Plastic SCM for more efficient team development. They continued to implement functionality for player control, AI control, opening doors, picking up objects, and moving between levels. The team created triggers for the objectives, cutscenes, and audio queues among other requirements to finalize the project. Outside help was brought in to assist with playtesting to isolate bugs and ensure a smooth experience for any prospective players.

Starting with the knowledge of C# was helpful for beginning such a project, though an IDE designed to create video games like Unity is far different from typical solutions like Visual Studio or Jet Brains. Once the team had gotten their bearings in the programming environment, they had to learn the interaction between code and objects in the game. The implementation of version control with development of a program like a video game is harder than with text-based projects. The "scenes" or other assets are not as easy to compare when resolving merge conflicts for example. Making sure each team was on the same understanding of the project was crucial to the completion of a well refined project.

**THE TEAM**

| | |
|---|---|
| Jonathan Svoboda | Squad Lead and Development Manager |
| Cade Rasmussen | Product Manager |
| Daniel Rudebusch | Process Specialist |
| Trevor Ives | Developer |
| Kayla LaPoure | Art Director |
| Allison Lund | Modeling Lead |
| Angela Walsh | Writer and Modeler |
| Megan Whisenhunt | Animator |

## SCHOOL OF COMPUTING

Sponsor: **Falkinburg-Daniel**

Project: **Husker Scope**
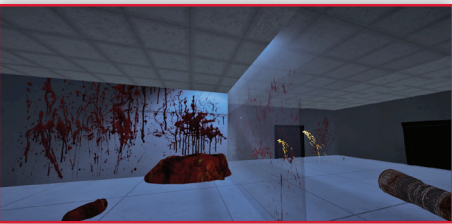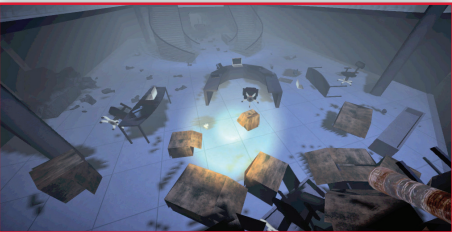
The team was tasked to help alleviate issues that existed for students in Advanced Embedded Systems (CSCE 436). The main issue was the lack of free audio testing apps that contained both a function generator and oscilloscope and that existed on both IOS and Android. The team was made up of computer scientists, computer engineers, and software engineers, so not all the team members were "experts" on how to use function generators and oscilloscopes. The team spent the first few weeks of the project working with lab grade equipment to get a feel for how the app should function and creating wireframes and mockups for the User Interface (UI).
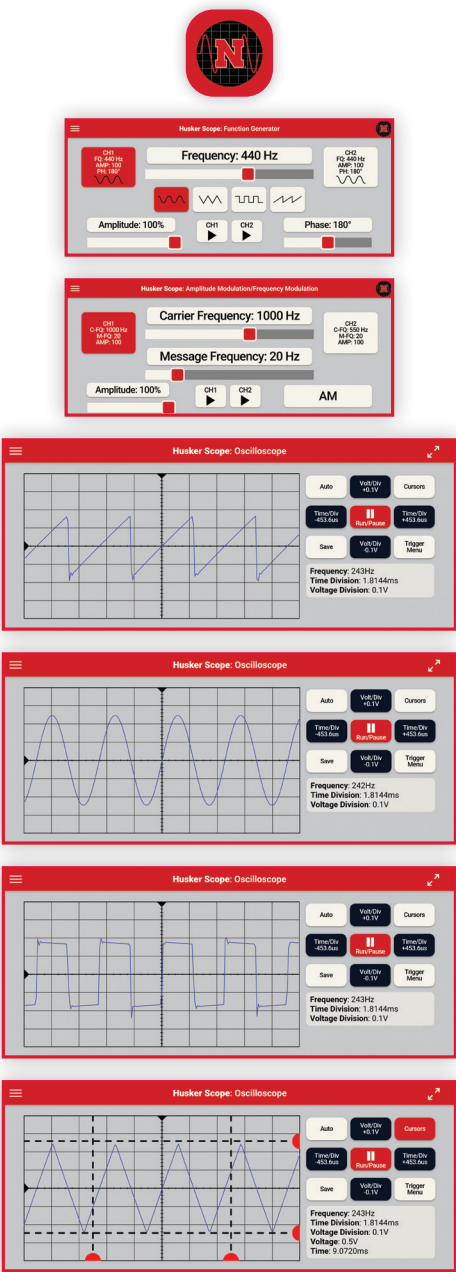
When it came to the beginning of development, the team initially started with the functionality of the Function Generator. The team was able to use a JavaScript library to produce different sound waves of varying frequencies. With frequencies from 20 Hz to 20 KHz, the app was able to produce four different sound waves, sine, triangle, square, and sawtooth and change the amplitude and phase of the waveform. Using the left and right channel of the mobile device's audio output, we were able to produce and manipulate the two separate waveforms.

Once the development of the function generator was complete, the team was able to move onto development of the oscilloscope. Due to limitations of mobile device hardware, the app was only able to have one channel input instead of dual-channel input that was originally requested. With this limitation understood by the sponsors, the team was able to get to work on developing the oscilloscope. The components of the oscilloscope consisted of wave visualization, trigger manipulation, cursors for measurements, autoset, voltage and time division manipulation, pausing the graph, and the ability to export the data coming into the oscilloscope as a CSV file.

### THE TEAM

| | |
|---|---|
| Brandon Ramos | Squad Lead and Development Manager |
| Isaac Lien | Product Manager |
| Ben Buckwalter | Developer |
| Christian Lampe | Developer |
| Riddock Moran | Developer |
| Michael Rahe | Developer |



## SCHOOL OF COMPUTING

Sponsor: **Falkinburg-Palmer**

Project: **Husker STEM VR**

Over the course of the year, the team worked hard to use the Unity game engine to create an app for the Oculus Quest that will be used for outreach and recruitment for STEM majors at UNL. The team was tasked with creating an experience focused in and around Memorial Stadium, but was otherwise given a lot of creative freedom in what the final product would look like. The decision was made to focus on the three majors currently provided by the School of Computing: Computer Science, Computer Engineering, and Software Engineering.

The user starts out in Memorial Stadium's East Lobby, which they can explore to read about each major and view a number of videos relating to the School of Computing. From there, they can enter a portal taking them to an activity relating to each major. Each of these activities asks the user to use a Scratch-like visual block coding system to complete a certain task, which focuses on what makes each of these majors unique. The Computer Science activity requires the user to direct a number of cameras to view the center of the football field, the Software Engineering activity requires the user to figure out why an automated system isn't reacting to the current weather, and the

Computer Engineering activity requires the user to guide a robot through a maze in order to complete a power circuit. When the user successfully completes each activity, they are congratulated and guided towards one of the other activities.

The app was created using the Unity game engine, which provides built-in support for VR platforms such as Oculus Quest. Most of the models and environments were created by members of the team, using the 3D modeling software Blender. The visual block coding system used in each of the activities was an external asset that was purchased by the team, but the team still had to modify it to get it to work with the VR systems.

### THE TEAM

| | |
|---|---|
| Parker Brown | Squad Lead and Product Manager |
| Tyler Senne | Development Manager |
| Jackson Herman | Developer |
| Jackson Maschman | Developer |
| Ryan Schumacher | Developer |
| Connor Unger | Developer |

## SCHOOL OF COMPUTING

Sponsor: **Samal-Koopmann**

Project: **Learning Assistant Program Management Tool**
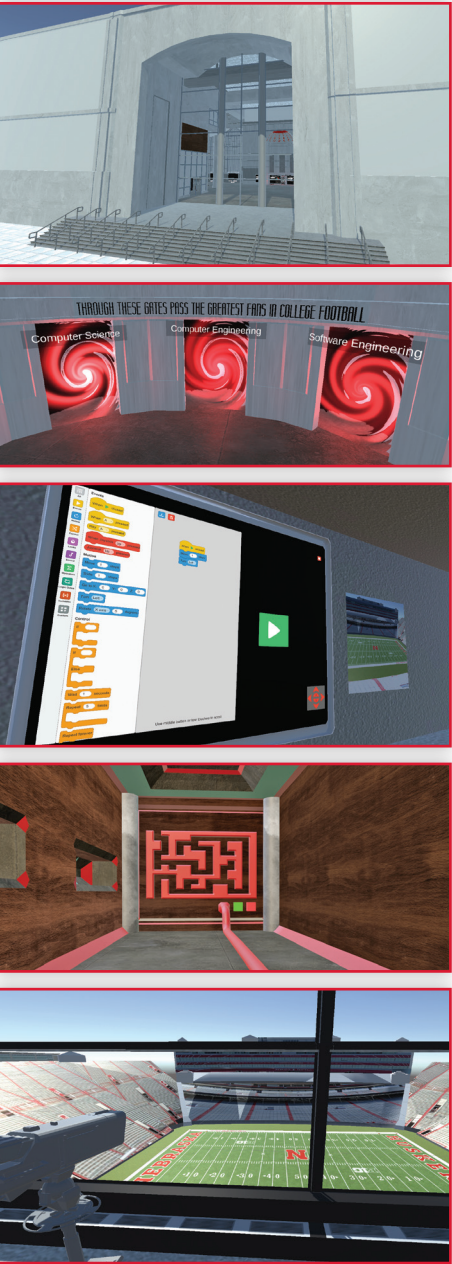
Management of many individuals is a complex problem. The UNL Learning Assistant Program (LAP) has a staff of approximately 40-50 undergraduate students to support peer learning in multiple first-year computer science courses. Currently, the program supports over 500 students every semester. The management of the program requires recruitment, hiring, retention, status tracking, and evaluations. Automation of this management has become necessary due to scale and expansion.

The team undertook the extension of LAProMT to support a fully-featured evaluation system. The team created a solution to allow the LAP administrators to create new evaluations using a custom form builder, providing flexibility while integrating with the existing application and database. The evaluation system includes a dashboard to manage existing evaluations by editing, copying, archiving, or exporting them. Learning Assistants (LAs) are notified via email to complete the evaluations designated for them. Administrators can then view responses from individual LAs and a summary of all responses.

The team worked on several auxiliary features and fixes. An integrated form was implemented so that students may give feedback about LAs they interacted with during on-demand appointments. The team integrated an external system that the LAP used to gather feedback from students during regularly scheduled office hours and merged it with this new feedback system for on-demand appointments. They also added a frequently asked questions (FAQ) page in which administrators can i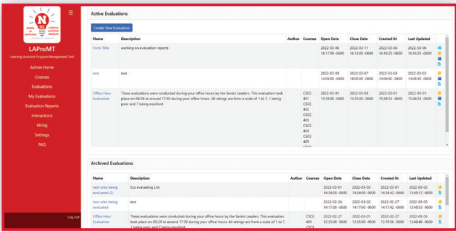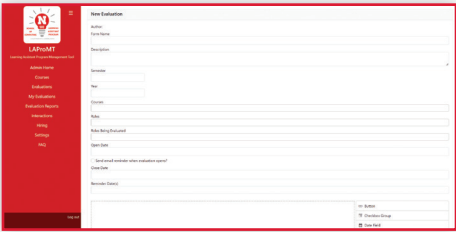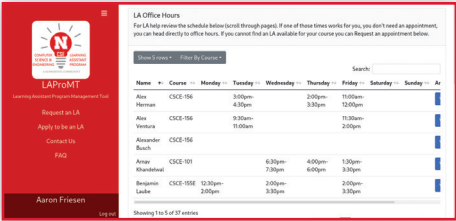nteractively create, edit, and delete questions and answers. Overall, the team's contributions have consolidated multiple functionalities into LAProMT, streamlining the operation of the Learning Assistant Program.

### THE TEAM

| | |
|---|---|
| Aaron Friesen | Squad Lead and Product Manager Development Manager |
| Ethan Weber | Developer |
| Joel Hernandez | Developer |
| ZhiWei Jin | Developer |
| Dan Navarro | Developer |

## SCHOOL OF COMPUTING

Sponsor: **Vuran**

Project: **OneLNK – A Link to Rule All Radios**

OneLNK is a software defined radio system where researchers can run a variety of experiments on wireless testbeds. These experiments can be used to resolve real world problems. However, the system for creating experiments and handling the radios required a high amount of command line knowledge.

The team was tasked with building a system that could streamline the process of running experiments and create a health check system for the radios that could concurrently run with experiments.

The team created a system for radio management and health. The system was broken into two main components: an AWS EC2 instance that hosted the OneLNK website, and the OneLNK Radio Network which handled radio management services. These two components were joined by an AWS IoT Core MQTT Broker that handled radio configuration data. On the AWS EC2 side, the website was designed with an MVC architecture utilizing Laravel/PHP because of its built-in security

features for handling user login data, and its simplicity for database seeding. The database is handled in AWS RDS with MySQL. The team sent website data through an MQTT client to the IoT Core Broker. On the Radio Management Server side, the team created a health check script for radios that is required to be added to an experiment as a plugin block in GNURadio. GNURadio is an open-source program utilized to run experiments directly on radios. From there, a worker sends health check data to the IoT Core MQTT Broker. The AWS IoT Core MQTT Broker handles configurations and displays charts and graphs created from health check data using AWS CloudWatch.

### THE TEAM

| | |
|---|---|
| Chris Galusha | Squad Lead and Development Manager |
| Alex Rechsteiner | Product Manager |
| Guy Richard | Process Specialist |
| Noah Anderson | Developer |
| Jonah Burke | Developer |
| Chase Prochnow | Developer |

**SCHOOL OF COMPUTING**

Sponsor: **Qiuming Yao**

Project: **The New pyP3DB**

In the area of bioinformatics, Web services and online databases play a significant role for scientists to store and query biological data in an efficient and user-friendly manner. Bioinformatic websites are great platforms of open-science and reproducible research. The Yao Lab is fortunate to have developed and maintained such a product that has been recognized by worldwide plant scientists. In the past 12 years, the Plant Protein Phosphorylation Database has become one of the most significant Vivo Data resources for studying plant proteins and their modifications.

The goal of this project was to redesign and build a Django (Python-based website framework) for protein modification data, the main renovation for the new version of the project needed to be significantly redesigned and generalized to host and display data sets in a more flexible, comprehensive, and secure way. Python Django is used to connect the front-end Bootstrap design, and for more flexible database solutions the team used both MySQL and MongoDB to design the backend.

The team initially started by gathering project requirements from the sponsor. This included everything from what the frontend should look like, and which technologies to use on the backend. Once enough requirements had been gathered, the team then developed wireframe models of the website design and created a database schema of how data objects should interact with the design. During our time of development, the team practiced good software development practices such as daily, standups, Agile, and pair programming. Based on feedback from the stakeholders, the team implemented the final designs into the project and the new pyP3DB was reimagined.

### THE TEAM

| | |
|---|---|
| Todd Bush | Squad Lead and Development Manager |
| Jack Kieny | Product Manager |
| Linhan Li | Process Specialist |
| Michael Hunteman | Developer |
| Aryan Timla | Developer |
| Zhiyuan Weng | Developer |

**UNL TAPS**
TESTING AG PERFORMANCE SOLUTIONS
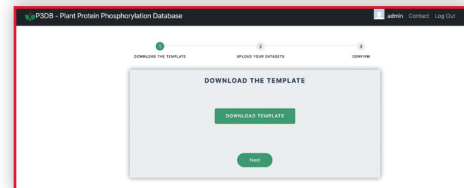
Sponsor: **UNL TAPS**

Project: **Streamlining TAPS Data**

The University of Nebraska–Lincoln's Testing Ag Performance Solutions (TAPS) program was started as a new way to engage agricultural producers. The TAPS program is a unique farm management competition that promotes profitability and efficiency through peer-to-peer interaction. Participants are responsible for making input decisions including hybrid selection and seeding rate, irrigation, insurance selection, marketing strategy, and nitrogen fertilizer management. The data is stored in Excel files that hold the information for a single farm in a competition or information about all the farms in a competition. The data is being input manually into these Excel files.

The team was tasked with creating a streamlined process for the recording of submitted decision data into the Excel files for the competitions. This was done by redesigning the way competitions are created in order to acquire all the necessary information about the competition. Then when a participant or UNL TAPS member submits new data, the data point is used to update the previously stored data, then the entire data of the competition is used to recreate the competition's Excel file along with the Excel files for the individual farm. These newly created files then replace the older versions on SharePoint.

With this stored information, searching for the data in these competitions is possible. This can be done by selecting certain parameters that one would like to use to query the data, and once queried, a dataset is shown that matches the selected parameter requirements.

The team overcame challenges while developing this solution. For example, the team originally decided to use a NoSQL database called Firebase to store the data in these competitions. However, Firebase has data limits on the storage and upload amounts and amounts over those limits would no longer be free. With the vast amount of data needed to create the Excel files and search the data in the competitions, it became apparent while developing that a new solution was needed, which is when the team switched to a SQL database.

### THE TEAM

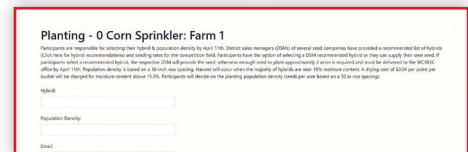| | |
|---|---|
| Ryan Lindsay | Squad Lead and Development Manager |
| Uyen Tran | Project Manager |
| Kai Guo | Developer |
| Stephanie Marsh | Developer |
| Yicong Mo | Developer |
| William Prewitt | Developer |

Sponsor: **UNMC College of Nursing**

Project: **VR AG SAFETY**

Workers in the agricultural field experience thousands of injuries and hundreds of deaths every year. Some of the most dangerous accidents are related to tractors, ATVs, and electrical components. The overall agricultural industry is one of the most injury-prone in the United States. Teaching safety in these three areas (tractor, ATV, and electrical) is important for creating safer farmers in the future.

Currently, there isn't a lot of coverage of agricultural safety in education. The University of Nebraska Medical Center's College of Nursing (UNMC) includes agricultural safety in its curriculum, but only in lecture format. UNMC has the unique position of being located within an agriculture-heavy state, meaning farm-related accidents are common. It is UNMC's goal to improve the current education using virtual reality to provide a more hands-on experience.

They also want student nurses to be conduits of change and educate farmers and future farmers by utilizing virtual reality at school and agricultural gatherings.

The team was asked to continue working on the existing game, *Rollover Ranch*. In this existing solution, players could complete various objectives riding a tractor and learning about tractor safety. This game was built to run on Oculus Quests using Unity. The team was tasked with finalizing existing tractor-related components, as well as adding new ATV and electrical safety components. The object of the game is to place the player in an open-world situation where they have to complete tasks related to ATV/Electrical/Tractor. The player then receives feedback and advice on what they did well or could have done differently.
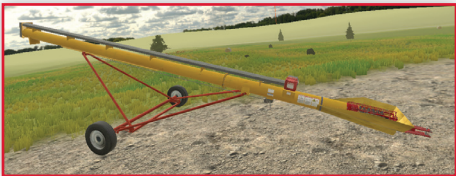
The game has eight different objectives that the player can choose to play through. Objectives involving the tractor and the ATV focus on completing tasks without rolling or flipping the vehicles. Objectives involving electrical safety have players transporting large equipment around power lines or digging around underground power lines. The game will be taken around the Midwest to conferences to educate agricultural workers and school children. It helps players learn about agricultural safety in a closed and safe environment with no real-life risks.

### THE TEAM

| | |
|---|---|
| Chris Zagurski | Squad Lead and Product Manager |
| Noah Liebers | Development Manager |
| Michael Ervin | Developer |
| Connor Pumilia | Developer |
| Alex Story | Developer |



Sponsor: **Werner Enterprises**

Project: **Trailer Tracking and Weather app**

The Werner Enterprises team was tasked with creating components that display trailer information and road conditions for truck drivers and other associates. The team aimed for modular code that could be integrated into the sponsor's existing application, Drive Werner Pro. To demonstrate the desired capabilities, the team began development on a cross-platform app using the Ionic Angular framework that leveraged the power of various mapping APIs to help drivers navigate safely and quickly.

As a semi-truck driver, being able to view wind and weather information is critical to safety. An example use case of the app is navigating to the Wind tab to view the current wind direction and speed. Drivers can use this information to determine if it is safe to continue driving or if they must take shelter (i.e., when wind speed is high or when winds are blowing perpendicular to the direction of travel). Another use case is using the Trailer tab to search for trailers in a particular city or view the information for a specific trailer. Using this tab, a truck driver can view various information about this trailer, including its precise latitude and longitude, its cargo status, and the date it last moved.

Throughout the year, the team faced many challenges including understanding the use of ZenHub, as well as how to get the most out of status meetings. After that, the team ran into a lot of technical problems using the various Mapping APIs. Documentation on these APIs was limited, some maps had trouble resizing correctly, and they did not interface very well with the other APIs. The team's coach, CJ O'Hara, provided guidance to overcome these problems. The biggest challenge was accessing a live database, since unfamiliar errors needed to be resolved in every step.

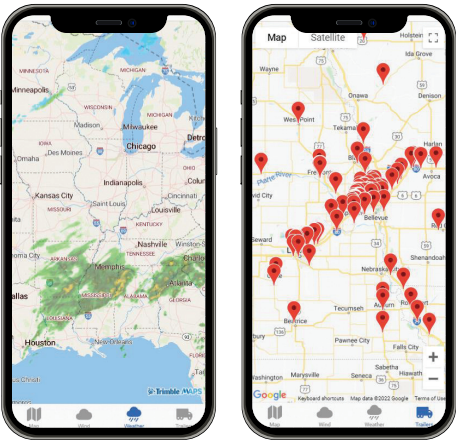The final product is a stand-alone application that demonstrates maps that show wind and weather, a map that displays the locations and the cargo status of trailers in Werner's area of operations.

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| Karnav Patel | Developer |
| Tai Vo | Developer |
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**Ben Buckwalter,** "Designing a Digital Electronics Lab"

**Jaden Goter,** "Balancing Data- vs. Art-Driven Decisions in Video Game Design"

**J.P. Jensen,** "Evaluation of Selected Computer Software for Concussion Recovery and Diagnosis"

**Caleb Marcoux,** "Data Management in Web Applications to Balance Performance and Security"

**Riddock Moran,** "Design of Hardware to Aid Phone-based Oscilloscope"

**Dan Navarro,** "Usability Analysis of a Learning Assistant Program Management Application"

**Camden Obertop,** "Developing Indie Games with Agile"

**Guy Richard,** "A Framework Comparison: .NET and Laravel"

**Michael Westberg,** "Analysis of the Effectiveness of Different Techniques for Creating Cross Platform Compatible Software"

**N**

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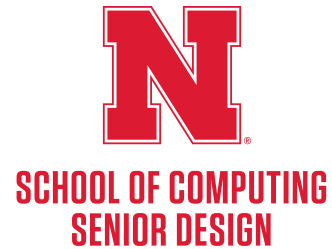
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