

Preliminary Premise

TECH 69700-001 LEC

Graham Allgood

TEAM MEMBER RESPONSIBILITIES

Note: We did not calculate any percentages for the contributions as we believe each team member went above and beyond the expectations to deliver the output and tackle all the various hurdles throughout the project. This was the most resilient team we ever worked with, and one of the smoothest working experiences we had. If any one of the team members was missing, this project would not have been pulled off. Hats off to the team! Great work guys!

Hassaan: The technical guy within the team who led the technical setup and the coding part (Arduino connections, P5.js and web sockets). Equally participated with the entire group in the ideation phases. Hassaan further devised and executed the prototype evaluation plan.

Graham: Graham led the overall concept, UX, and project management. He designed the visuals for the screens, content design (video and information compile) for each Heroes, completed feature prioritization, and worked on the physical aspects of the installation.

Hugo: Hugo is the all-rounder who tackled both the design and technical aspects of the project. Hugo was in charge of the card design, poster design, and the documentation of the project. He also coded the codes for two working RFID readers on a single Arduino and added micro-animation to the interactive UI (albeit the circle was pulsing at a very slow pace).

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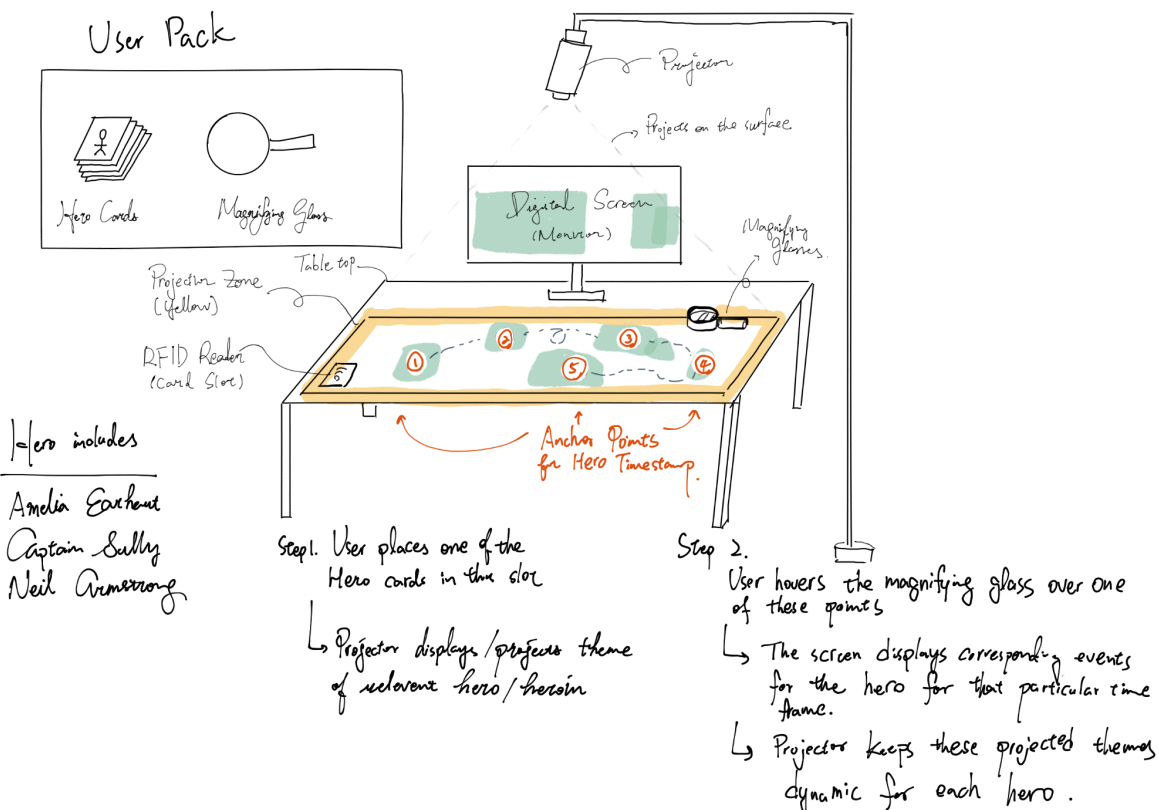
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1. Understanding the Opportunity Space

1.1 Concept

To celebrate the return of commercial air service to West Lafayette and Purdue University's rich aviation and aerospace heritage, our team proposes an interactive display for the newly announced Purdue terminal. This engaging experience will utilize a novel interaction pattern that combines RFIDs with projection mapping to educate and entertain airline passengers of all ages. By showcasing Purdue's notable "Heroes" in the field and the university's lasting impact on the industry, the display aims to inspire future boilermakers and announce Purdue's footprint.

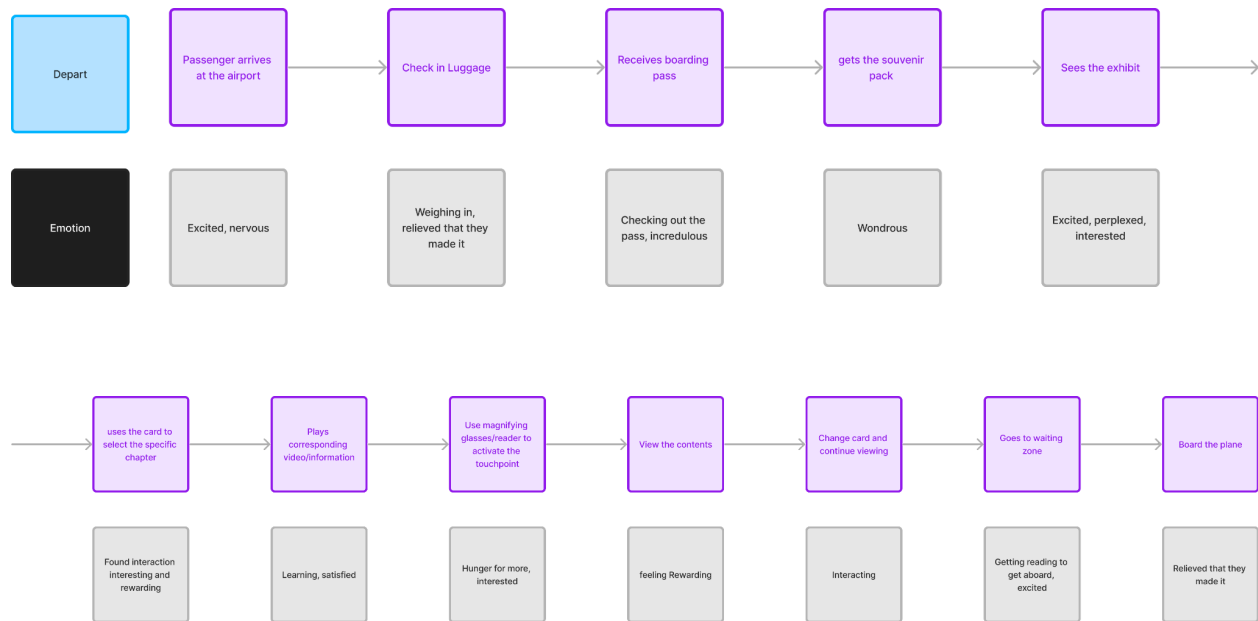
1.2 The Sketch



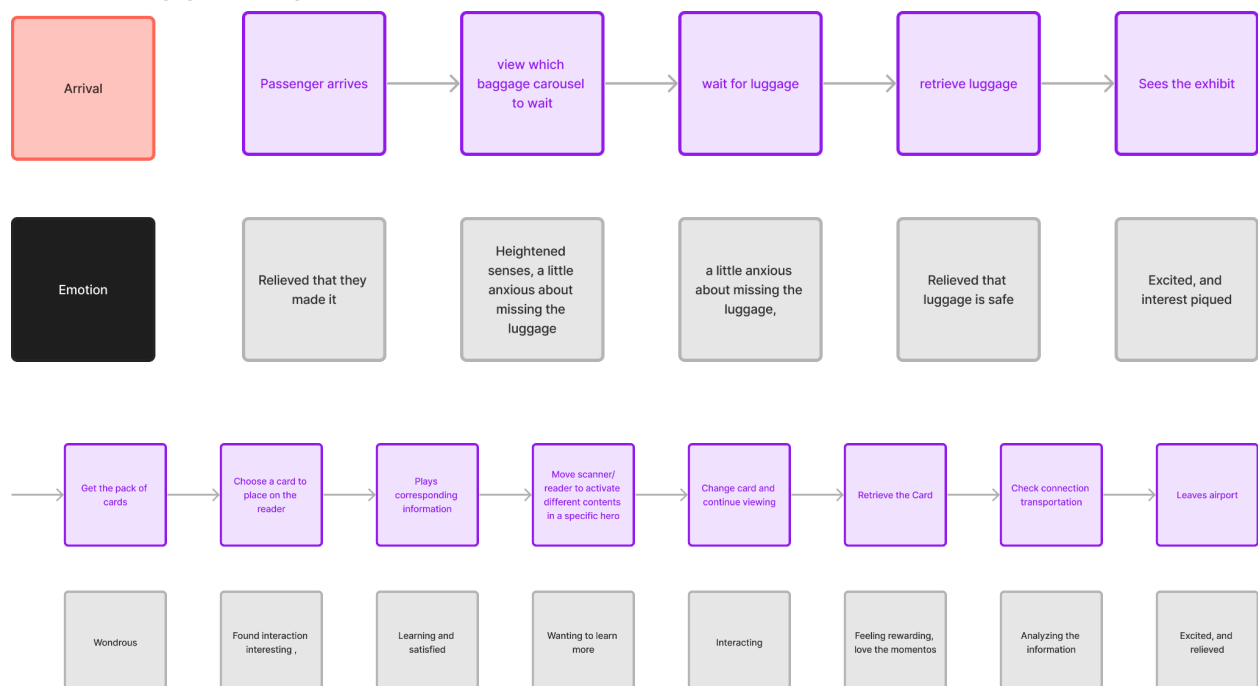
1.3 Proposed User Journey

After deciding on the device's details, we drafted the user journeys for tourists inbound and outbound from the airport and created an opportunity to introduce our concept into the current user journey flow.

User Journey (Outbound)

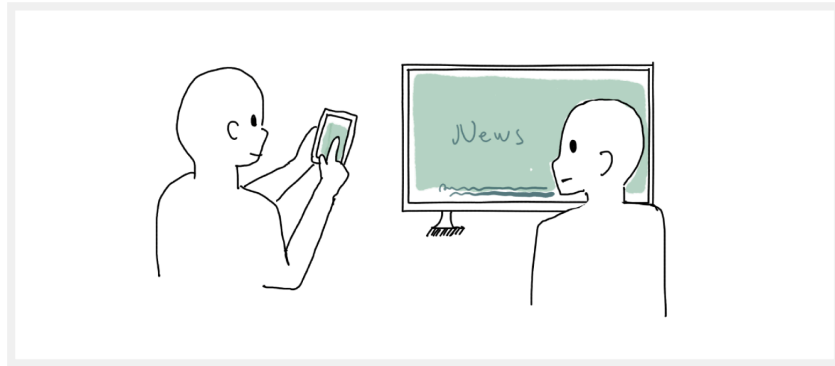


User Journey (Inbound)



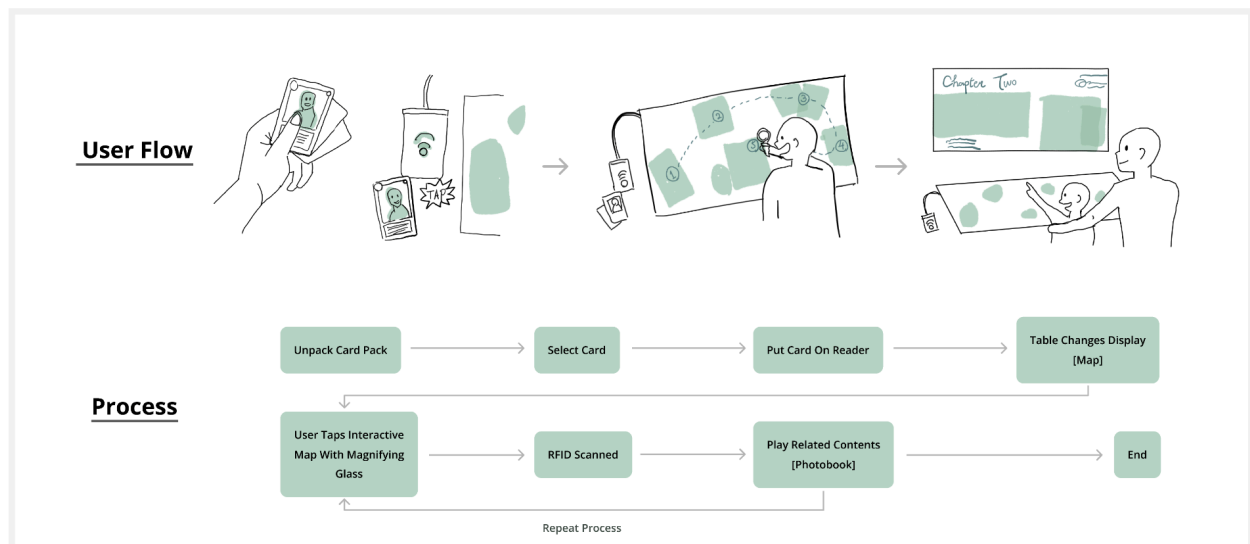
2. Design Process Rationale & Reflection

2.1 Conventional Media Consumption



We aim to change the way we consume media. Normally, people consume media in a single-channel fashion, the only interaction concerned is the browsing phase. Once the information was located, the experience was fairly static.

2.2 Our Proposed User Flow



Tourists first got their own pack of Purdue Hero Cards. They can keep it as a souvenir and trade it with their friends. When they arrive at the airport, the users can use the card to interact with our kiosk to learn more about the history of Purdue aviation and its heroes.

Imagine the card acting as a “character selection,” based on the card, the table-top display (using the projector) will change to the table of the said “target hero.” From there, the visitor could use the attached “Magnifying glass (a.k.a. RFID Reader),” to interact with the pre-programmed touchpoint, which are RFID tags embedded beneath the projection screen on the table. Once activated, the related information and videos will be played on the monitor on the wall. Our goal is to help the visitors of the Purdue Airport learn more about the rich history of aviation in Purdue and its connection to the “Heroes of Purdue” while providing a novel and interactive experience that could hopefully foster engaging communications among the visitors.

For that purpose, we mirrored the interaction design based on analog behaviors such as using magnifying glasses to browse the maps and flipping through the photo books. We hope that such touch points could bring a welcoming and enjoyable sensation for both young children and elderly visitors.

2.3 Design Process

Once we decided on the scope of the project, we experimented and researched a wide range of different inputs and interaction options for the visitors to engage with. Some of the initial ideas include figurine input, scrollable map, pin-based input system, etc.

Ultimately, to promote the collectible nature, we opted to use RFID cards as a means of user input. Since the goal is to promote Purdue Spirit, we brainstormed and decided on designing the cards as collectible Purdue Hero cards.

We investigated a wide range of possibilities for the interactive map, from physical scrollable maps to touchscreen inputs. It should be noted that different methods provide a different sense of engagement to the users. With that in mind, we crossed out the option of touchscreen inputs as the user interaction is too similar to the existing products such as iPads. On the other hand, the physical scrollable maps require a lot of motor and calibration. Having taken all of those aspects into consideration, we decided to use screen projection as the means to project the interactive maps.

To promote a sense of interactivity, we contemplated using a reader to read different tags. Based on the 1-to-many nature shared between the reader and the tags, it's decided to attach the reader to the magnifying glass and have the multiple RFID tags embedded underneath the projection screen on the table. This decision of users moving the reader to read the tag is a novel solution to our problem space. Otherwise, many readers will be needed for the conventional configuration, which significantly cuts down on the cost of the materials. For the software front, we decided to utilize p5.js to create two windows of separate screens, in which one will be projected and another will be displayed on the monitor. Specifically, the content displayed on the monitor is directly controlled by the inputs gathered on the projection via RFID tags. By combining the hardware and software parts, a seamless experience is

generated. It should also be stressed that we encountered quite a few trouble-shooting incidents during this project, which will be elaborated and explained in the following chapter.

2.4 Reflection

The original concept for this final project was aviation data visualization of live flight data. Graham pitched this concept in class. He identified a market of individuals passionate about their local regional airport. Many private pilot license holders keep tabs on their local airport, and the concept was to passively show their local airport's flight activity — possibly in a professional's home office. The product concept was exciting but niche and didn't allow for much input from the user to interact with the data.

Once the full team was determined, after the class pitch, Graham opened the floor to adjust the concept based on what others were interested in. The collective team decided to pivot the project based on: interests, what could realistically come to market, and current skill stack. This process lasted a couple of weeks as team members presented ideas and brainstormed back and forth. The collaborative approach and "riffing" helped land the updated concept of an interactive multimedia exhibition for Purdue Airport.

The pivot in the project concept brought a collective interest in the topic, boosting enthusiasm, and drive. The new concept broadened market potential and allowed for more user interaction, making it a more engaging and dynamic project. This shift opened up exciting new possibilities, igniting a wave of motivation and inspiration within the team.

The project finished exceptionally well, and each member learned how to rapidly prototype to bring a new product idea from 0 to 1. The team was in sync and respectfully executed their duties above and beyond what was asked out of respect to each other.

3. Prototyping

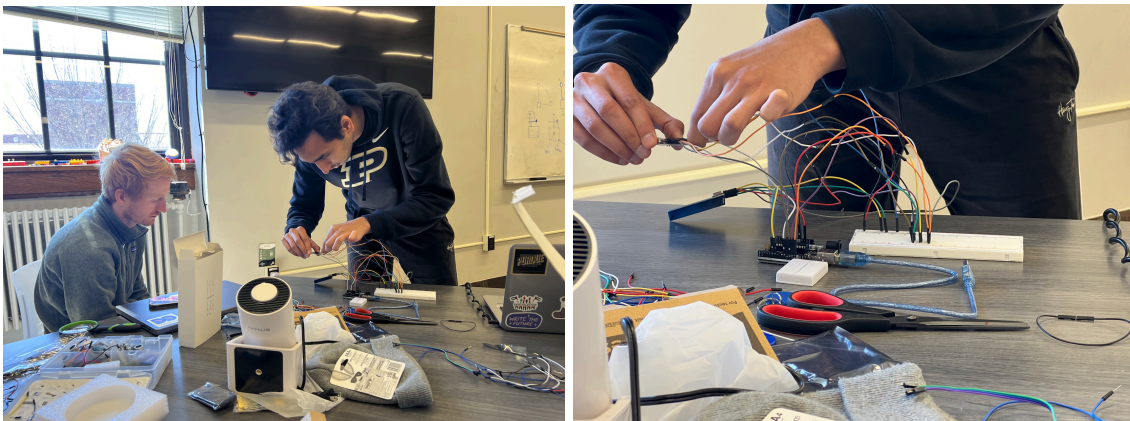
What is interesting about this physical prototyping project was that we encountered quite a number of troubles and bugs throughout our journey, both in terms of hardware and software.

Issue #1 - Multiple RFID Readers on a Single Arduino Board

The first issue we encountered was that the RFID board took way more pins than we assumed it would (six pins to be precise). We briefly considered using two Arduino boards but we abandoned the option quickly since the data communication would be more complicated between the two readers and two boards.

Upon some research online, we opted to connect the two separate RFID readers in parallel by using the breadboard. This was proven successful as we can utilize the limiting amount of pins to connect to multiple devices.

We then changed the C++ code to form a new RFID reading object to facilitate two RFID readers working at the same time. After changing the code, we successfully got data from Readers A and B.



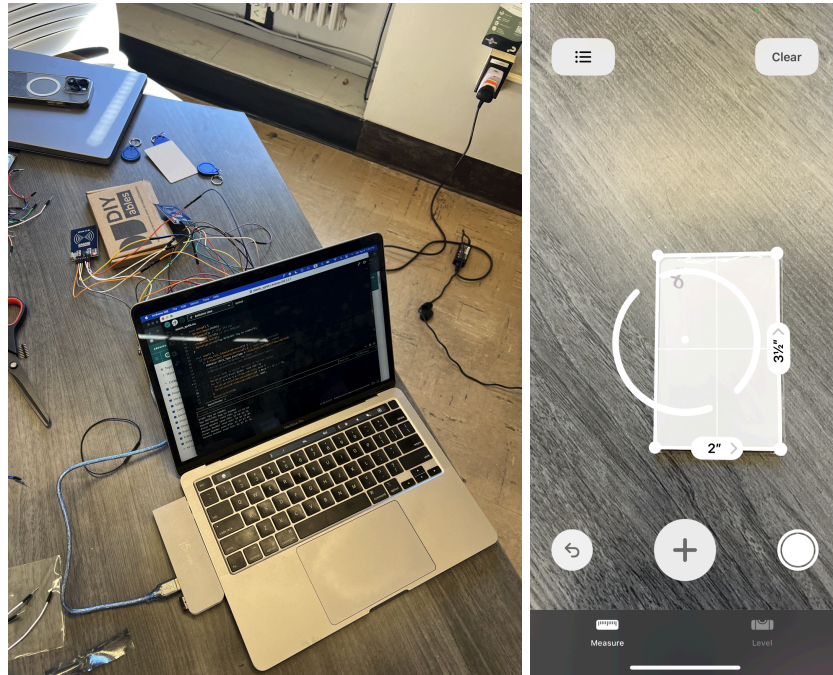
Worktime session on the Arduino Kit

Issue #2 - How to get the Conditionals Working?

The next step would be to gather the ID of each tag. As such, we scanned and recorded all of the IDs for all of the tags and cards. To design the logic of the code to govern whichever inputs would prompt the system to change screens, we originally considered utilizing a combination of conditional codes that checks if the Tag and Card IDs are a match to play the corresponding contents.

That method has its flaws though. Firstly, we need to write a lot of different combinations of the IDs. Secondly, a wide range of edge cases also needed to be considered for each display.

After determining that Reader A will only be used to scan the card while Reader B will only be used to scan the tags, we simplify the code to determine the scenario based on the ID of the RFID device and “from which reader did the signal originate.” By simplifying the code in this fashion, the complexity of the code and the time cost were significantly decreased.

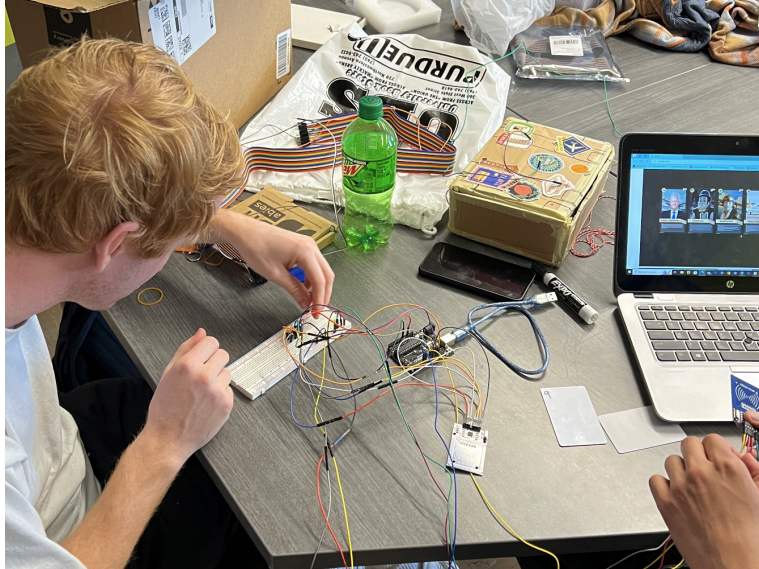


Worktime session on the Arduino Kit, Code Snippets, and RFID Card Dimensions

Issue #3 - Longer Wires Rendered the Device Inactive

During the final weeks of physical prototyping, we encountered yet another unforeseen problem. The longer the wires we attach to the RFID readers, the higher the chance they will cease to operate. At first, we assumed that it was faulty wires. Yet, after undergoing an intensive tried-and-true testing method, a.k.a removing each longer wire and reattaching the shorter ones to see when it would work again, we learned that they failed to operate due to the voltage being spread too thin.

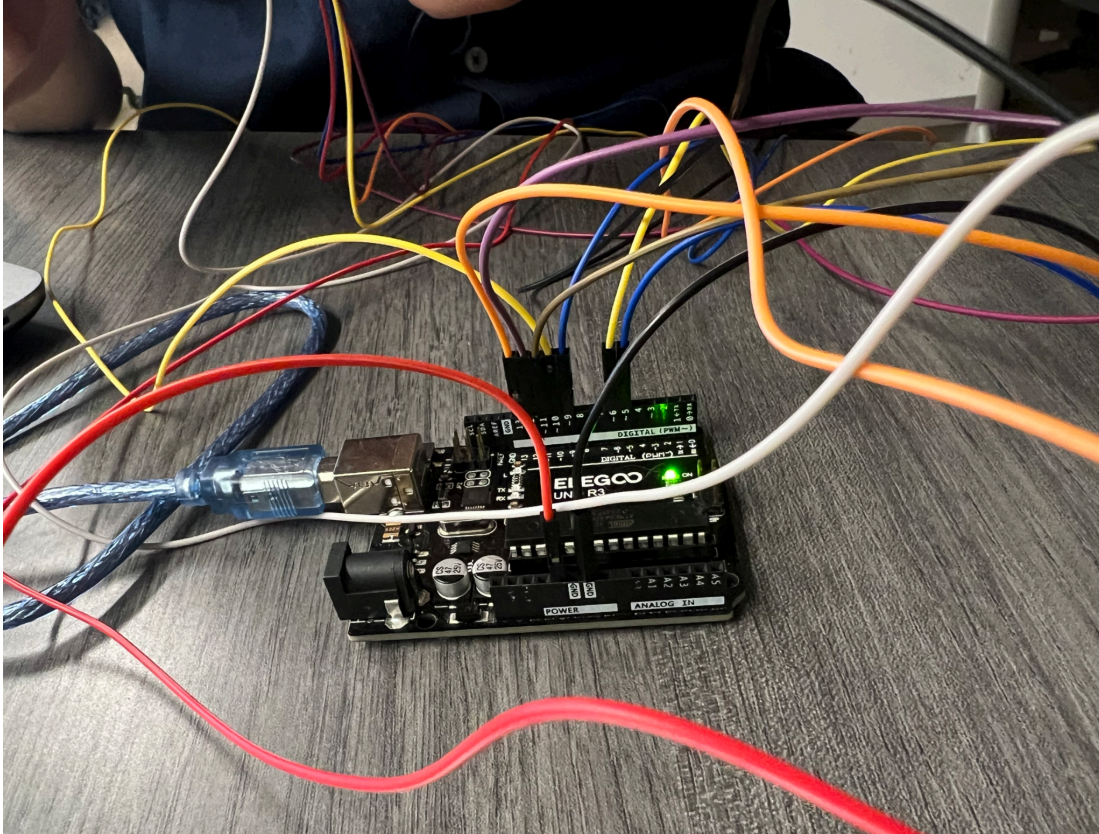
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Cleaning the schema and grouping the wires

To alleviate issue #1, we connected the wires in a parallel setting. We realized that not only does the parallel setting affect the voltage, but the length of the wire also contributes to the issue. Our solution was to change the voltage to 5V (from 3.3V). Luckily, the circuit started working again and we overcame yet another bug.



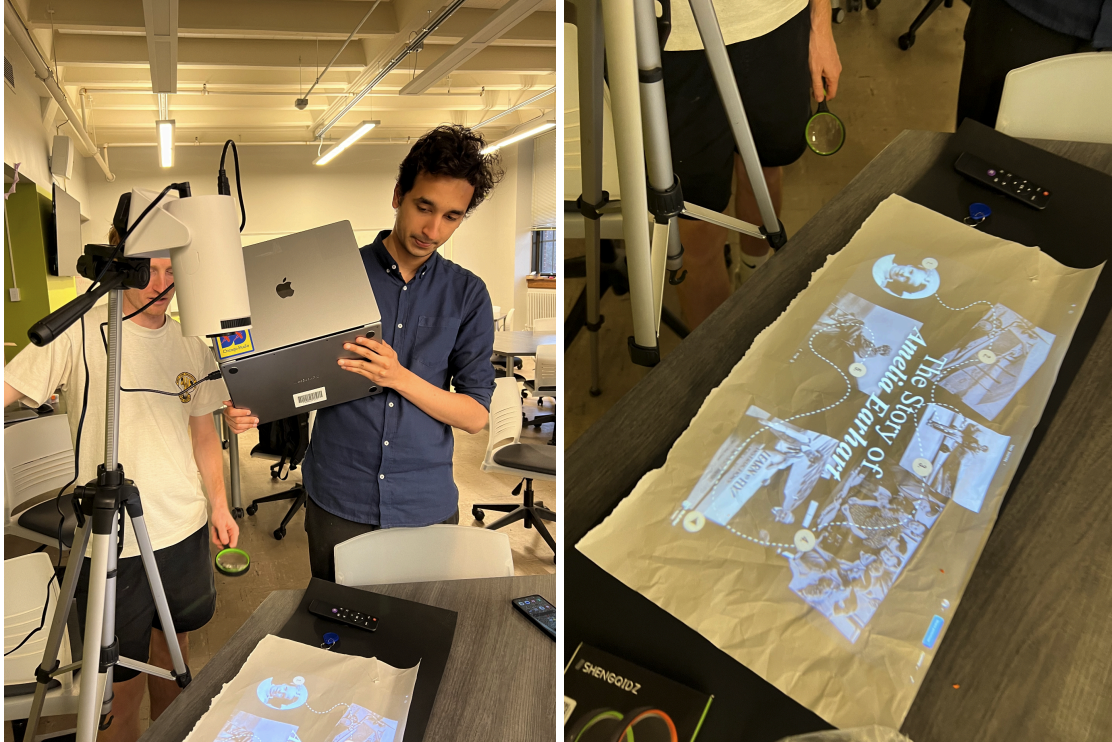


Close-up Shots of the RFID Reader and Magnifying Glass Prototype

Issue #4 - Projector and Table Setup

This problem originated from the design of the projector. Since it can only project at a set angle, we found it challenging to project it perpendicular to the table surface. To address this issue, multiple solutions were tested, including trying to tap the projector to a ladder, attaching the projector to a fixture, fixing it on the wall, etc. As readers can imagine, all of these options have some challenging factors to overcome.

Our solution is to attach the projector to a tripod. Since the tripod enables the user to change the orientation of the camera in a 90-degree setting, such capability is perfect for our scenario. After a couple of tests, we were able to realize our design in real life.



Projection Testing with Updated Projector-Tripod Configuration Setting

Thanks to Dr. He's support, we were able to borrow a fixture stick that could hold the projector mid-air. This final setting allows the projection to be even and distortion-free, ensuring the final user experience is as pleasant as possible.



Final Projector Setting

Issue #5 - Async Dual-Monitor Display and Projection

This issue stemmed from the limitation of broadcasting software. Currently, it is impossible to project a screen and move the monitor to a different screen, i.e., the projection perfectly mirrors the screen monitor, we found it difficult to project the screen projection while playing the corresponding contents concurrently.

We tried using third-party video call software, yet not only does the same issue persist, but the resolution was also sub-optimal. Separating the screen in two windows doesn't work as well since the serial port will be overwritten every time a signal is sent or received.

Our solution was to use socket programming to create an intermediate server which would listen to the serial port and pass on the message to the clients. This was a complicated task as we were not aware of networked systems and socket programming, however, we showed resilience and went the extra mile to implement this setup. This way, our original idea of showcasing both the projector and the screen was preserved and we accomplished yet another feat.

Issue #6 - Achieving High Quality of Video Transmission

Since we were using the Localhost setup for our socket programming, opening duplicate tabs reduced the quality of the transmitted video due to high memory constraints on the browser. The video would often lag and echo, deteriorating the experience of the viewers.

To fix this, we had to change the code significantly. We optimized it such that we split the canvases across two browser tabs, creating two dedicated clients. We used page parameters for this. One client displayed the image content only which will be projected across the table-top. The other client displayed the video content. This helped divide the load on the browsers.

We also optimized our code further. Instead of creating a video object every time the card/tag was read, we used checks to create any such media content only once, and then store it within the memory. Therefore, when the next time any of the previous content was called, it was immediately fetched and played. This improved the quality of the code up to 98% (self-reported figure). Perfect quality depends on the strength of the internet network. There might still be some lag initially, but that is beyond our control.

4. Evaluation

4.1 Protocol

The evaluation plan for our interactive kiosk to be set up at the Purdue Airport is as follows:

Objective: To understand how users perceive the functionality and working of the interactive kiosk, evaluate its usability, identify gulfs within understanding and execution, gauge user engagement and satisfaction, and obtain feedback for future improvements.

Target Audience: 3 students and faculty from different majors and backgrounds representing a diverse range of ages and technical backgrounds.

Context: Since we tend to set up the kiosk as a stand-alone, interactive artifact to be used by users independently, the testing should reflect that. We will hence set up our testing protocol accordingly.

Evaluation Methods: Our evaluation protocol will involve a combination of observational, empirical, and qualitative data. We will begin by setting up the entire system ready to be used by the public. Participants will interact with the system independently on their own, without any help or context provided by the testers. The testers would however observe the participants.

A minor difference from the actual setting would be that there will not be any monitor screen within the testing. Instead, we will use a laptop screen only as one display. The projector would be included though.

The evaluation will be divided into three phases:

- 1) In the first phase, participants will observe the kiosk and understand how it functions. We will encourage participants to 'think aloud' and share their expectations and understanding of the system with us.
- 2) In the second phase, participants will follow the instructions on the screen and projection, and interact with the system accordingly. This will be the phase of discovery. We will observe the participants, capture their reactions and body language, identify any issues that occur or gulfs that potentially exist (mismatched expectations or executions), and note down any other technical flaws that might arise.
- 3) In the third phase, we will capture participant's feedback, gauge their engagement and satisfaction, and obtain suggestions for the future.

All in all, we will use 1) the Heuristic Evaluation to evaluate the system's performance, 2) Usability testing to identify flaws within usability and issues faced, and 3) a 5-point Likert scale

based satisfaction and engagement survey that will be conducted at the end. This will be followed by a short qualitative feedback session to obtain further feedback from the users.

The feedback survey to be conducted at the end of the session is as follows:

Kiosk Interaction Feedback Survey

Please indicate your level of agreement with the following statements based on your experience with the interactive kiosk:

Use the 5-point scale to indicate your response: 1 (Strongly Disagree) to 5 (Strongly Agree).

1. **Ease of Use:** I found the interactive kiosk easy to use.
2. **Engagement:** The content presented by the kiosk was engaging and held my attention.
3. **Learning Experience:** I feel that I learned something new about Purdue aviation heroes from this interaction.
4. **Satisfaction with Technology:** The use of the Hero cards and magnifying glass was a satisfying way to interact with the information.
5. **Overall Satisfaction:** Overall, I am satisfied with my experience using the interactive kiosk.

Additional Comments:

(Please provide any other feedback or suggestions you have about your experience with the interactive kiosk.)

4.2 Findings and Analysis

We tested our design and prototype with 3 individuals and received positive and welcoming feedback. All three participants appreciated the idea and creativity, the interactive elements and the combination of physical and digital computing involved. They also left us with some useful feedback, most of which we incorporated for the final version.

Using **heuristic evaluations** proposed by the Nielsen Norman Group as guiding principles, we tested our interface design and interaction.

Criteria	Issue	Recommendation
Visibility of System Status	There was no response shown on the tabletop when the magnifying glass was hovered. There was no voice feedback when a new action took place.	Add a spotlight to the tabletop when a numbered icon is tapped. Add some sound music in

		the background.
Match Between System and the Real World	Participants were unclear whether to tap the magnifying glass or look through it.	Change the instructions on the screen and add instructions within the physical setup as well.
User Control and Freedom	There is no way for a user to go back except by tapping another card.	Add a back button to return to the home screen.
Consistency and Standards	No issues were found here	-
Error Prevention	No issues were found here. The system is error-proof as there was a good balance between the number of actions and the types of interactions possible.	-
Recognition Rather Than Recall	There was nothing to recall or memorize. Clear instructions were provided.	-
Flexibility and Efficiency of Use	The combination of physical and digital computing was splendid. It was interactive, well-balanced, creative and immersive.	-
Aesthetic and Minimalist Design	The design was appreciated. It was low-effort to interact with, yet immersive and engaging. The only feedback was to add a vertical support for the projector to prevent skew.	Align the projector vertically right above the tabletop, and move the monitor screen forward.
Help Users Recognize, Diagnose, and Recover from Errors	There were limited chances of error except faulty wiring which can be catered in a fully furnished installation.	-
Help and Documentation	Some participants struggled to understand where to begin from and where to tap the card.	Provide clear labeling of the various elements within the setup.

Observations

In addition to the evaluation we conducted, we also recorded live observations as the participants carried out the testing. We noticed that most participants did not follow the hero's journey in order (from 1 to 5). Instead, they began randomly in no order. Some of the participants did not understand where to tap the hero cards as there was no label near the RFID tag reader. Finally, we noticed that some participants did not understand how to use the magnifying glass. They were confused whether they had to look through, or tap the glass.

Post-Test Survey

Finally, we also collected some quantitative data to summarize the experience of the participants. 2 out of the 3 participants filled it. The survey consisted of 5 quantitative questions that used a 5-point Likert scale for rating. The summary results are as follows:

Ease of Use	Engagement	Satisfaction	Learning	Overall
4.5	4.5	4.5	5	5

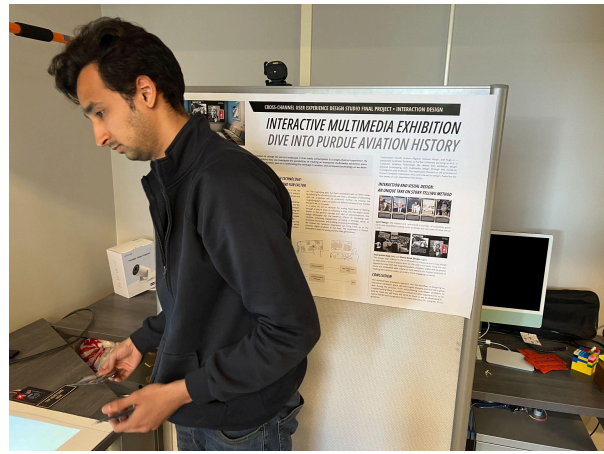
While the number of participants might be low, the results do capture a largely positive feedback of the interaction and experience.

Refinements

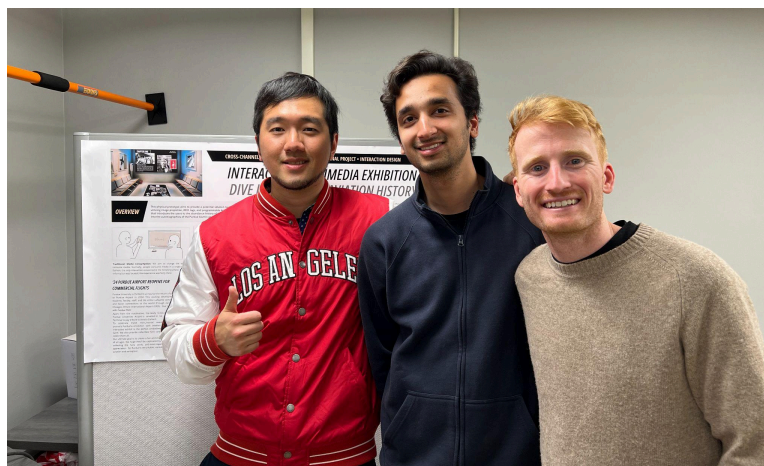
We incorporated as much feedback as possible before the deadline (which was less than 2 days away). The following are the changes we made.

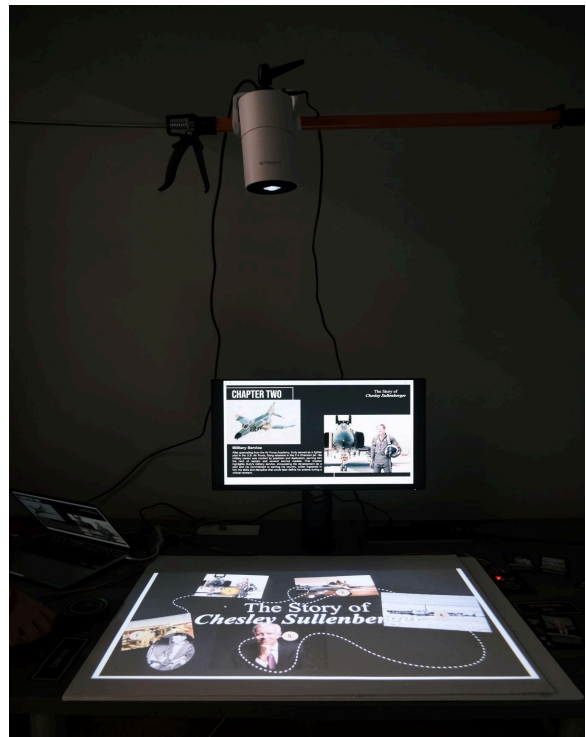
- Added a glowing spotlight effect to the numbered icons on the projection to make the tabletop interactive and provide more feedback.
- Added signage to the tabletop to help users navigate. These included 'Tap Hero Card Here' and 'Start Here'.
- Added instructions on one side of the magnifying glass which said: 'Tap on the numbered icons'.
- Changed the instructions on the screen to clarify how to use the magnifying glass.
- Setup the projector vertically above the tabletop and put the monitor at the front to provide a more immersive experience.
- Changed the placement of the RFID tags and the magnifying glass to encourage people to begin from the first tag, and go all the way to the last.

5. The Exhibition

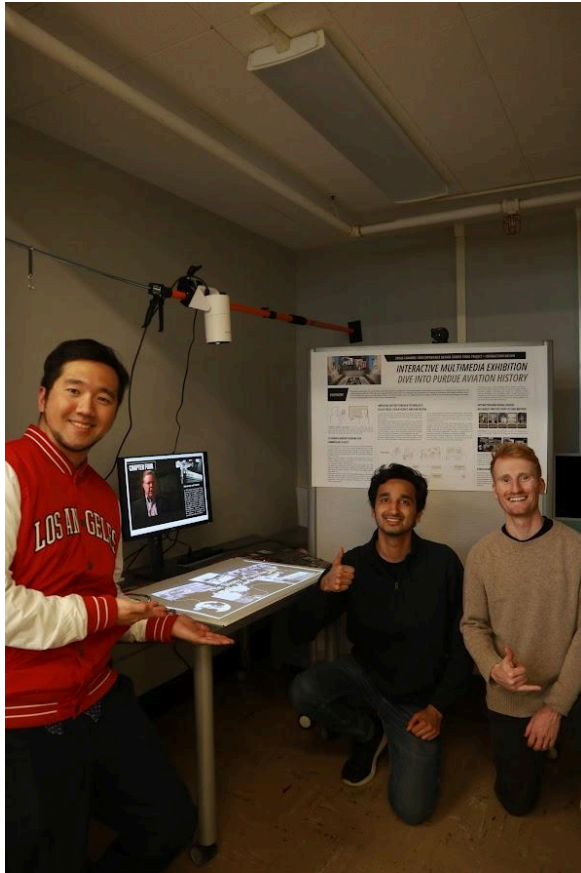
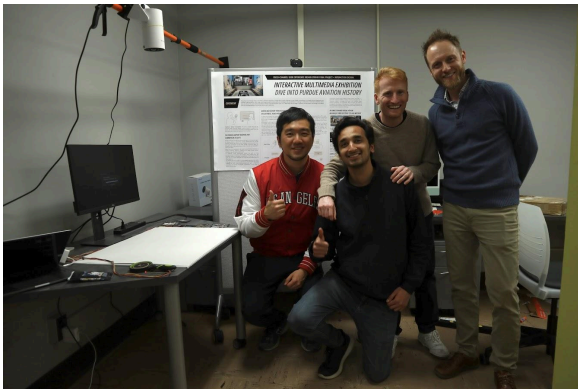
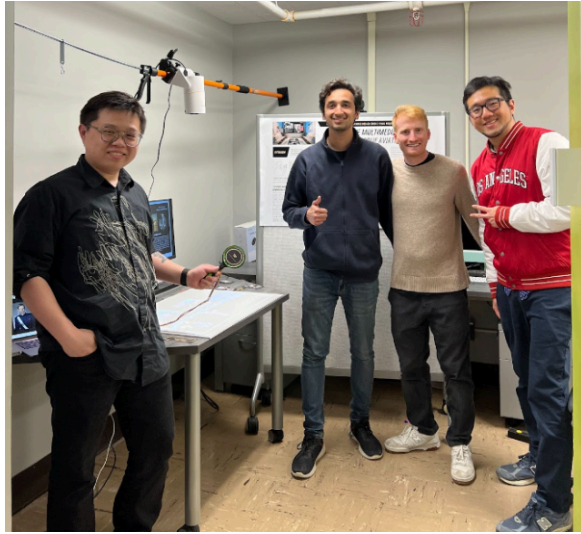


Setting up the final showcase (top). The Team (bottom)

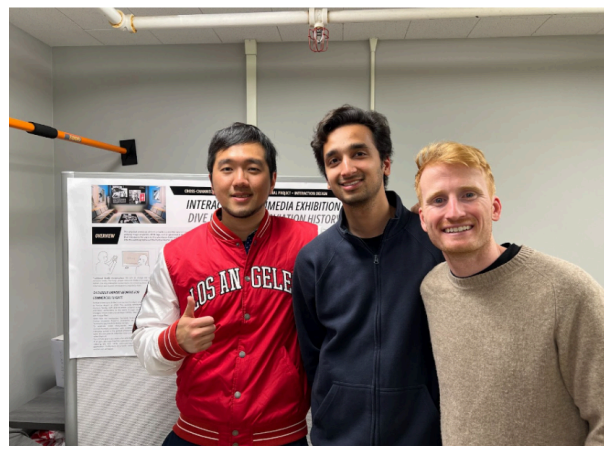
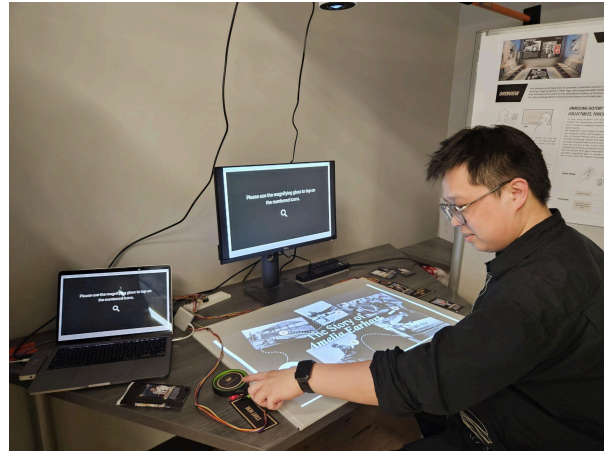
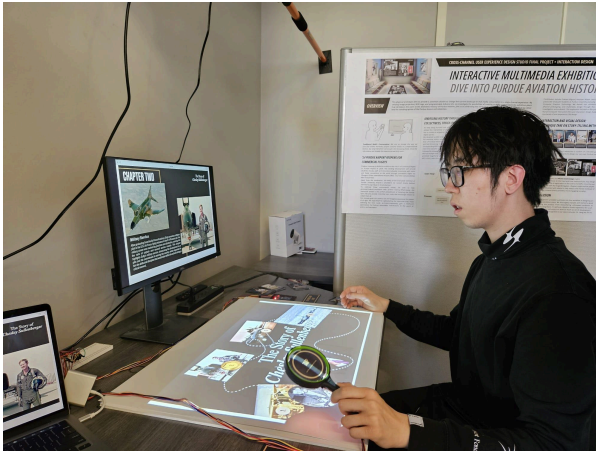




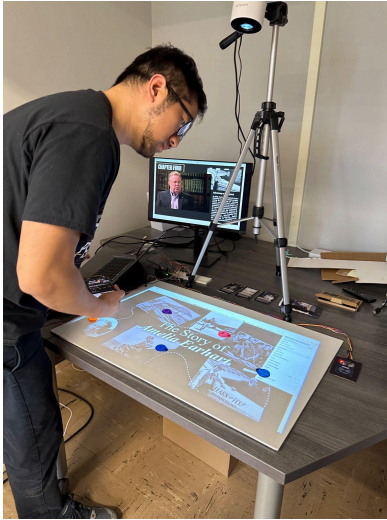
The Final Revelation!



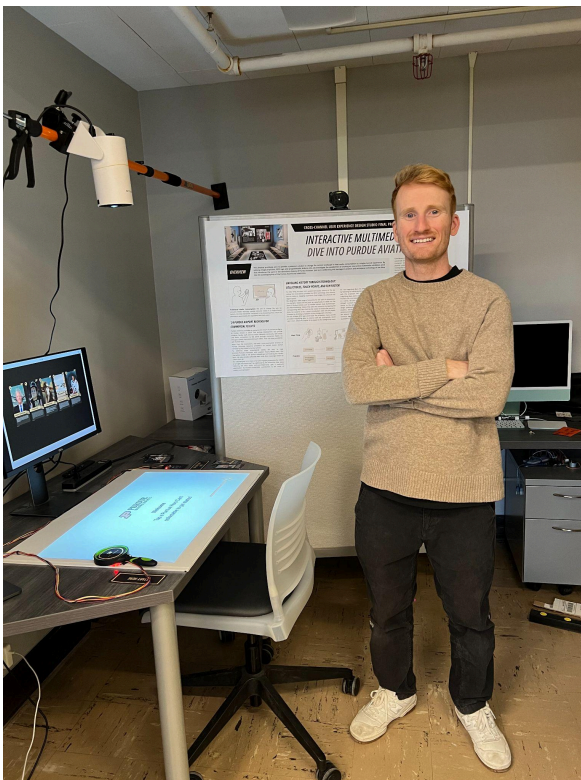
Our guests interact with our showcase. And members of the CGT faculty too!



Some more guests (and Dr. Liang) interact, and make us happy!



Behind the scenes and the making of this wonder

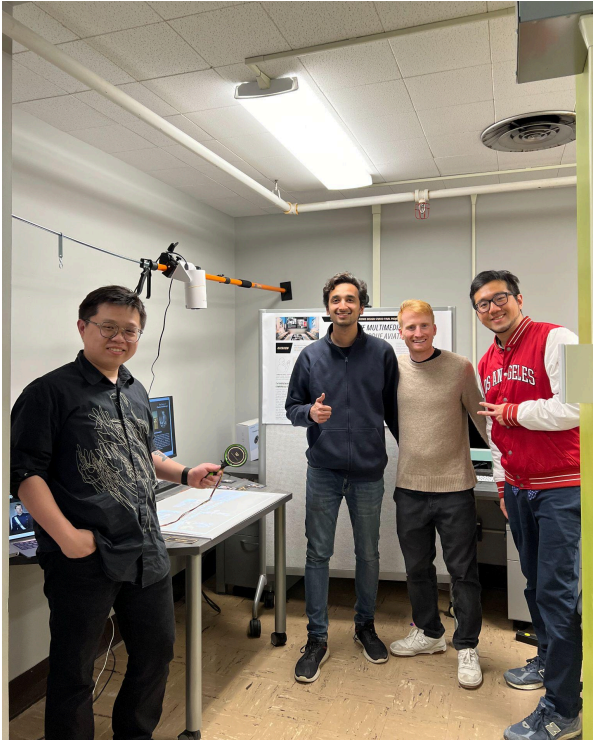




And that's a wrap! Thank you for being with us on this journey.



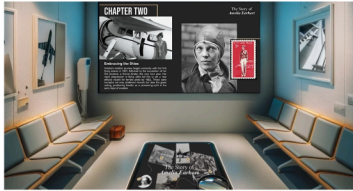
And we hope you enjoyed it as much as we did.



Thank You for Your Mentorship and Instruction, Dr. He.

PROJECT POSTER

View high-quality poster image [here](#).



CROSS-CHANNEL USER EXPERIENCE DESIGN STUDIO FINAL PROJECT • INTERACTION DESIGN

INTERACTIVE MULTIMEDIA EXHIBITION DIVE INTO PURDUE AVIATION HISTORY

OVERVIEW

This physical prototype aims to provide a potential solution to change the current landscape in that media consumption is a single-channel experience. By utilizing image projection, RFID tags, and programmable Arduino kits, we investigate the possibilities of creating an interactive multimedia exhibition piece that introduces the users to the abundance history of Purdue Aviation. Join us in celebrating this heritage in aviation and aerospace technology as we delve into the autobiographies of the Purdue Alumni and celebrities.



Traditional Media Consumption: We aim to change the way we consume media. Normally, people consume media in a single-channel fashion, the only interaction concerned is the browsing phase. Once the information was located, the experience was fairly static.

'24 PURDUE AIRPORT REOPENS FOR COMMERCIAL FLIGHTS

Purdue University is thrilled to announce the return of commercial flights to Purdue Airport in 2024! This exciting development will provide students, faculty, staff, and the entire Lafayette community with easier and faster connections to the world through connection flights via Chicago's O'Hare International Airport (ORD). Soar into new possibilities with Purdue Flies!

Apart from the reactivation, the newly to-be-constructed terminal at Purdue University Airport is unveiled to be named Amelia Earhart Terminal to pay tribute to Amelia Earhart.

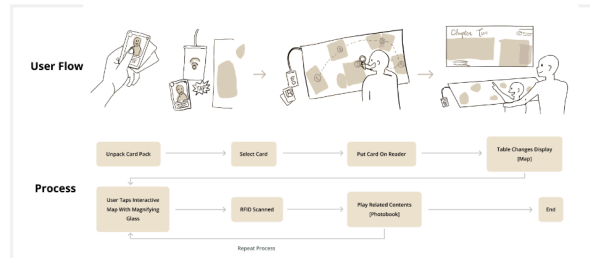
To celebrate these monumental events, we wish to help promote Purdue's connection with aviation history. What's more, this interactive exhibit is the perfect embodiment of fostering the Purdue Spirit. We also provide collectible hero cards that encourage visitors to collect them all.

Our ultimate goal is to create a fun and engaging experience for visitors of all ages. We hope they'll be captivated by the interactive map, enjoy collecting the hero cards, and most importantly, gain a newfound appreciation for Purdue's remarkable contributions to the world of aviation and aerospace

UNVEILING HISTORY THROUGH TECHNOLOGY: COLLECTIBLES, TOUCH-POINTS, AND FUN FACTOR

To help bring Purdue's rich aviation/aerospace history to life, we utilized the interactivity provided by RFID technology and Arduino kits to create an engaging experience that bridges the physical and digital spaces. We designed a wide range of scenarios for the users to experience. For example, visitors will be given an opportunity to delve into the lives of Purdue Heroes such as Amelia Earhart, Sully Sullenberger, and Neil Armstrong. Visitors first select the scenarios by tapping the corresponding RFID Hero Card on the reader to choose the scenario. Once the scenario is set, a short introduction video will be played. Followed by showing a projection of the protagonist's "Life Map." We hid multiple RFID tags underneath the projection. Users use the provided magnifying glass to interact with the touchpoints, which will, in turn, select the chapter to be played on the background moni-

tor. The magnifying glass has been embedded with an RFID reader. By following the aforementioned user flow, a sensation of interacting with the projection will be produced. Further, by moving the magnifying glass, users can peek into different phases of our Purdue Pioneer's life, so to speak. In a sense, we aim to recreate the analog experience of flipping through a picture book or following a map into the digital world. Similar to the general concept and idea of skeuomorphism, this design philosophy has the beneficial effects of: increasing user intuition, enhancing engagement, providing a stronger sense of emotional connection, and building on existing knowledge. We believe this hands-on experience can bring fresh air to the common digital products in our lives. The experience is further accessible to both the young and the elder generations.



Contributors include Graham Allgood, Hassaan Waqar, and Hugo Li — passionate Graduate Students at Purdue University pursuing an M.S. in Computer Graphics Technology. We delved into exhibition design, physical prototyping, and multimedia design through this hands-on investigation and endeavor. This exploration focused on the principles of Human-Computer Interaction (HCI) and interaction design, fueled by the core tenets of user experience (UX) design.

INTERACTION AND VISUAL DESIGN: AN UNIQUE TAKE ON STORY-TELLING METHOD



Card Design: We studied and referenced a number of collectible game cards and basketball trading cards to design our very own Purdue Hero Cards.



Interactive Map (left) and Photo-book Design (right):

The design pays tribute to the tried-and-true treasure-hunt map design to help elicit a sense of exploration on the user's end (left). Once the user tapped the map with the magnifying glass, chapters (right) will be played. Some are embedded with videos to help reduce the mental workload of reading the contents and to provide a more engaging narrative.

CONCLUSION

This development provided a glimpse into the workflow of designing an interactive exhibition piece. We thoroughly enjoyed and learned a great deal during the process. From encountering unforeseen problems to troubleshooting them, it is without a doubt a fruitful experience for us all. And we hope you will enjoy our work as much as we do developing it. Special thanks and recognition to our class instructor, Dr. Liang He, for his guidance.