INM452 Interaction Design 2024-2025

Enhancing The Museum Experience

Group 11

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1. Description

The Imperial War Museum has around 10 million objects in its collections, including artifacts such as tanks, airplanes and rockets (Imperial War Museum, 2019). The objective of this report is to explain how we have explored the opportunity of adding a new interactive technology in one of the objects provided by the museum. Along these lines we will describe in detail our work process and how we used interactive design to create the outcome: a rocket kiosk Constructor and simulator.

Our choice of focalizing in the Imperial War Museum (IWM) was driven by its historical significance, the humane factor and personal preferences. Having visited other 2 museums (NHM and the Design Museum), the chosen museum was the one that evoked the most feelings of empathy. Thus, if we wanted to pay attention to a user-centered process, we believed we ought to empathize with the place and their visitors first. The IWM is successful in bringing complex and emotive topics into life. A place where not only material artifacts are deposited, but emotional engagement is thoroughly throughout most of the visitors' experience - at least of all the ones we interviewed. We believe we could find an opportunity of upbringing these same topics in an interactive experience.

Once the museum was chosen we started putting forth our user research methodology. We decided to create a mixed-methods research, combining qualitative observations, qualitative individual interviews and one “mini” focus group (2 people).

In our user research we identified two main patterns where we believed we could find an opportunity to enhance users' experience; virtual reality and environmental simulations. We decided to choose the latter for two main reasons. 1. Our research findings suggested that learning was a key aspect of the visitors. 2. We believed that the technological progress of the artifacts would give us an opportunity to enhance visitors' learning in a positive manner.

Our initial ideas were to create a sensory experience surrounding war elements. Therefore we had various ideas such as war simulation maps, rocket launch simulation, aircraft pilot simulation aiming to provide users with a deeper understanding of the repercussions of war. Nevertheless we believed we had more opportunity to explain the evolution of the V2 rocket as a symbol of how technology can have a positive impact in the evolution of artifacts.

In summary, we decided to focus on the V2 rocket of the IWM due to historial, emotional and learning factors that we believe would create an opportunity to elevate users' visit.

2. Detailed description of interactive technology

Our interactive technology is a Rocket Kiosk Constructor and Simulator, a multifaceted experience developed to engage visitors in a hands-on sensory experience as well as an educational journey about rockets. Along these lines we aim to explain with detail how the kiosk works, step by step. Each stage is carefully thought to address the brief as each one encourages interaction, fosters creativity and enhances experience.

From our interviews we discovered the need for balance between active and passive engagement. Hence, we identified different user personas whom we were going to build upon the artifact: Curious Carl and Teaching Tom **(Appendix A)**.

We will describe them in detail later in the report, but their key aspects are the following: Curious Carl is an information seeker and a museum hopper, whereas Teaching Tom is a family man who likes to spend his free time taking his kids to museums to enhance their (and his personal) learning. There is a clear distinction between the needs and wants of these, thus we created two main flows – one more engaging and interactive (active) and one more focused on reading (passive). This balance allows visitors to adjust their experience according to personal preferences.

Although our primary personas seemed to have different desires, they had one thing in common: the willingness and ambition to learn. We found a need to extract learnings from their experience interacting with the kiosk. Thus, we decided to enhance the learning experience through storytelling. We believe that storytelling plays a powerful role in our technology, so users don't stand alone throughout the experience. Another factor is that we wanted our users to be able to put “an eyes and a face” to our kiosk. In all, by having a narrator accompanying and teaching the user, we believe to enhance the user journey. To address this, we added a virtual guide in the form of a circular icon at the bottom of the screen **(See Appendix O: Marker 2)**, which provides pop-up facts and instructions throughout the interaction.

The interaction of the kiosk is structured around four main stages, each purposefully designed to add - on the users visit to the museum and take home valuable pieces that create a unique experience. The four stages are the following: 1. Rockets Information and Selection, 2. Rocket Construction, 3. Rocket Launch and sensory experience, 4. Rocket printing and donations.

Stage one: Information about rockets

The initial stage begins with giving the user the option to interact with a touchscreen interface **(See Appendix O: Marker 1)**. The screen features four model rockets from the A (Aggregates) and V (Variant) series. The aggregates were initially experimental rockets that would later turn into the variant models (Military History Fandom, 2014). We used the approach of showing aggregates because we wanted to give the user an overview of the rocket evolution rather than being too specific on the model provided by the museum (The V2 Rocket). This choice was made from an ethical perspective. Whilst we understand that the topic around which we choose to create our artifact is a sensible one, we did not want to refrain from creating something our users suggested they would be interested in engaging. Therefore rather than focusing on the impact and the repercussions of the V2 Rocket, we moved our focus toward the history of the rocket, and the rocket artifacts.

The specificity of which exact artifacts to display on the initial screen was also thought of; the A1 rocket was the first experimental rocket of the series. The A2 rocket was the first successful model rocket. The V1 which was the first operational rocket used in combat. The V2 was the rocket used by the Nazis in WW2 (Military History Fandom, 2014).

To start the interaction, the user is invited to touch any of the rockets. The users has the possibility of touching and exploring the four rockets which allows them to delve deeper into the one they found most intriguing. Simply by touching one of the rockets displayed in the screen, the system offers a brief introduction of the respective rocket specifying information about the artifact such as; date of built, mass, material used, time to built, speed, flight altitude etc. More so, the interface includes an interactive 3D model of the rocket **(See Appendix O : Marker 8)** which the user can engage with, by rotating it with the arrows provided along the side of the artifact. This will enable the user to see the rocket from different actions.

Based on the needs of our personas, we thought to provide this screen to all users, as it is engaging and provides initial learning that we consider will incite the user to keep exploring. This interface incites the user to proceed to the second stage by letting them choose a passive or an active journey.

Stage two: Construct and Learn

To design for the need drawn upon the two personas, we decided to let the user choose how to interact with the rocket; construct the rocket, or read more about the rocket. The second stage.

If the user selects the path of building, the system redirects them to another screen with initial instructions of how to build **(Appendix O : Marker 9)**. The user is invited to virtually construct a rocket using four of its main components: the nose cone, the body (x2), and the fins. The objective is to educate visitors about different parts of the artifacts, and how each plays a crucial role in the science of aerodynamics.

The building screen is presented in a puzzle-format with four drag and drop pieces **(Appendix O : Marker 11)**. They have to figure out the right order to assemble the rocket. As they go on with the pieces, they are presented with relevant engineering facts about this component– for example when they assemble the nose cone of the rocket, they learn a respective fact about it. The facts come from the virtual storyteller at the bottom of the screen in a pop-up format, to make them more interactive. The construction phase is believed to be more hand-on dynamic learning where the user is the center of the evolution of the interaction and design.

Alternatively, for those who prefer not to build, the kiosk also offers a passive interaction offering the users to immerse in the technical information in a reading format. This option is equally relevant to the construct option; providing the user with fun facts, as well as engineering facts. Due to the interest of our users **(Appendix A)** we chose to have variety in the facts to make them appealing to all kinds of visitors regardless of their existing rocket knowledge. Nonetheless, this interface also provides the option of building a rocket or directly ending the flow. We focus our core methods in user-centered design, by providing alternative flows for our users allowing them to have multiple possibilities to choose from.

Stage three: Launch and Feel

The third stage is where we believe we could change the experience of the user from being positive to being unique. Our research suggested focusing on creating real - life simulators. This multi-sensory idea was based on different interviews mentioning how memorable they found respective experiences in other museums e.g. earthquake simulator. Thus, we created an experience that aims to simulate a rocket launch through the sensory experience of feeling the power of the rocket, hearing the launch, and getting a haptic breeze of air **(See Poster)**. The kiosk aims to simulate the vibration and tremors that one would experience when a rocket launches (in a small scale format).

When the user triggers the launch, by pressing the button after the construction interface, the system uses the built-in headphones and handles to make sound and vibrate respectively **(See Appendix O : Marker 13)**. Additionally, the kiosk has an integrated mechanism that deploys a breeze of air throughout the launch to make the experience wholesome. After the unforgettable experience the user is automatically redirected to the last page.

Stage Four: 3D print and Donate

The last page and stage the user comes across the possibility of printing the rocket in a 3D format and taking it back home **(See Appendix O : Marker 14)**. This will enable the user to take the "experience back home". We believe it is a good way to upbring the emotional aspect of the experience, after all the interactive learning. If the user decides to print the rocket constructed, the system will redirect them to the payment flow (screens not provided). The last option given to the user, is the possibility of donating. We wanted to incorporate the donation option because our research found that visitors felt the need to stay connected. The donation allows users to feel they have contributed to the enhancement and support of the museum and its visitors.

3. Description of design process

Our design process was fully focused towards a user-centric approach. This part of the report process explains in depth all the mechanisms, and procedures our group used for the creation and development of our kiosk. We delve deep into the fundamental parts that played a crucial role in the creation of the artifact: user research, conceptual design, detailed design and evaluation.

Visits and museum elections

Museum choice

The first meeting we had was a few hours after knowing the group distributions. We found it crucial to briefly present each other, stating our strengths and weaknesses. After a quick chat, we agreed to visit three museums; The Natural History Museum, the

Design Museum, and the Imperial War Museum (IWM). We decided to “divide and conquer”; pairing up by going to different museums.
“Divide and conquer” has been a strategy that has enabled us to optimize time and strengths along this process. In the following paragraphs you will find how our different working techniques (specifically divide and conquer vs. co-work together) have taught us how to manage ourselves, the process, and the overall project.

On the initial visits to the museums we had one goal in mind: where can we find the best opportunity to create an interactive artifact and enhance museum visits. During the visits we explored various visits, and tried to identify potential ideas on each.

The initial visits enabled us to get a sense of how different types of museums are displayed, and explained. More so, engaging with other museum exhibits and artifacts would help us gather insights into how we were going to structure the user research to determine where our best opportunity lay.

After initial exploration, we gathered together to make a choice. Our museum choice was based on several factors. The most notable one would be that we wanted to create a user - centric approach in a museum where people played a crucial role. Other factors included the numerous artifacts that would help identify opportunity, and personal preferences.

Museum Validation

To validate that we were aligned with the IWM choice and that it was in line with the project brief, a follow up visit was conducted. The objective of the second visit was to identify if we believed we would be able to create an interactive artifact that would stand out from the rest and enhance the visitor's experience. The museum is currently composed of numerous interactive elements that ease the explanation of the war(s), artifact(s) and / or people. This initial observation of seeing people interact with the current artifacts was a game changer, as we hypothesized that by listening to our users' needs, we would be able to create an artifact that would stand out from the rest.

User Research

We structured a user research plan to understand needs, wants, opportunities and pain points from visitors of the IWM. User research was the first part of our design process: empathize with users.

Our research methodology included observational studies, three semi-structured interviews, and one semi-structured mini-focus group (2 people). The structure of the test was carefully thought to ensure we would be able to extract actionable insights whilst following the ethical guideline.

We conducted naturalistic observations in several exhibits, and coded how popular the exhibits were based on people who stopped to view, touch or interact with them. To go beyond observations and understand users' motivations, and preferences we kindly asked around 10-15 visitors to participate in our study. One of our main challenges of the user research was the recruiting process, as people were hesitant to participate in our study. However, we succeeded in getting 7 interviews. The objective of them was to gather user insights and perceptions of the museum. We aimed to understand and identify plausible opportunities that would be engaging within a technological artifact.

The most remarkable insight we identified from the research was that learning plays a key factor in IWM visitors' experience. Thus, we knew our opportunity had to be created with content and storytelling as an approach for the enhancement of learning. Secondary, yet still essential, reasons for visiting included; high interest in the area, and recreational time.

Our user research helped us identify that visitors expressed a desire for immersive experience that deepened their connection to their artifacts. This experience would be enabled in a passive, or an active manner, based on the user's choice.

Upon reflecting on observations, interviews and our personal visits, we decided that the rocket artifact could be a centerpiece of our design. The rocket has such an extensive historical significance, unexplained in the current exhibition. Hence, we saw the opportunity to create a kiosk simulator of a rocket that would aim to reflect on history and manufacturing significance.

Conceptual Design

Affinity & Empathy Mapping

Historical significance with hands- on learning, and interactively exploring, we needed to start putting down our ideas on paper to ensure feasibility. Following through the second stage of the design process: define.

The first part of the conceptual process was an affinity mapping exercise (**Appendix C**). The process helped us figure our common denominators of users behaviors and reaffirmed us the need to have two primary personas. The distinction between the two primary personas, would later demand us to create two different user flows to ensure a user - centric design for all.

User Personas

The creation of two different personas (**Appendix A**) would guide us to identify patterns and themes across visitors. The two fictional personas are depicted as follows.

On one hand we have Curious Carl, a 27-year old Architect with a profound interest in war history, he loves visiting museum's with his partner and deep diving into historic narratives. Curious Carl's needs a balance between passive and interactive engagement, and accuracy in museum visits. He would not be engaged unless he learns something new. Due to his sufficient knowledge in historical artifacts, he believes that war is not properly articulated, thus some exhibits are not worth exploring.

On the other hand we have Teaching Tom; a 40-year-old small business owner with two young children. He values spending quality time with his family in environments that are both educational and fun. He needs interactive hands-on and family friendly technology. Tom's main way is that his kids lose interest in engaging with the artifacts due to the excessive reading material. He likes to engage through fun learning.

Sketching

Using the personas we decided to follow through the ideation process with two brainstorming techniques: "How Might We" and "Point Of View" (**Appendix H**).
After some group discussion on "Worst possible ideas" we started the process of sketching. The third stage of the design thinking process: ideate.
The first part was just scrabbling around with a pen and paper to understand what was in each other's head. Followed by the exercise of the crazy eights (**Appendix I**).
Subsequent to a numerous amount of ink - on - paper and harnessing our creativity, we collaboratively created a low fidelity prototype (**Appendix J**). The initial sketches helped us identify where and how we could create interactive elements that would make each visit unique.

Another important factor that helped us throughout the ideation process was to conduct a competitive benchmark to analyze similar interactive technologies (**Appendix**

K). We found various “build your rocket” games that would later guide us on the design process.

The ideation process benefited us as we were able to determine the need of creating a kiosk that would support the idea of a combined rocket constructor and simulator.

To finalize the conceptual design we process aligned on priorities, define our steps and distributed tasks to optimize efficiency. We decided to divide responsibilities, with some team members focusing on the content search and adding value through educational experience, at the same time, others were starting the low fidelity prototype. This “divide and conquer” division allowed us to progress in parallel, yet with the same common goal: find the opportunity to create a unique experience in a IWM visit.

Detailed Design

The first iteration of both the prototype and the research of content were mainly aimed at the impact and the repercussions of the V2 rocket. Focusing on the needs of Curious Carl, we were merely interested in showing the devastating impact the V2 rocket had caused. Although we were aligned on providing context to the user, we kept hesitating as to where it was the right path forward.

A meeting with the coursework professor helped us shift our focus: distancing ourselves from the rocket's impact and repercussions (as we may have been a fine line towards touching ethical considerations). We shifted our focus from solely addressing the V2 rocket, to exploring the broader context, involving other predecessor models and primarily focusing on the progression and evolution of rocket technology. Additionally, we highlighted the distinctive features that make each rocket unique, while emphasizing the critical aspects of the artifact.

The fact that we had to reorient our design, made us adopt a co-design strategy. This second version of the prototype involved all of us to go back to an ideation stage and get our pens out. The co-design meetings provided us with a clear vision of how our technology was going to be valuable. We believe we could teach visitors about a detrimental artifact without having to highlight any negative aspects. We believe we could take something that is thought to be devastating, and turn it into a seamless experience that focuses on learning about rocket history, rocket Material and overall rocket aerodynamics.

Evaluation

The final version of the second prototype was ready to test 10 days prior to the deadline. We wanted to ensure a robust evaluation, hence test our feature via moderated usability test, in person. Each team member was required to gather feedback from a non-class member, this would provide us an unbiased interactive design perspective. In other words, we wanted to evaluate from people who have not studied interaction design in order to be able to generalize user's opinions.

The structure of the evaluation was set to gather main impressions, usability issues to improve and content / design feedback. We found that participants praised the interactiveness of the launch and the learning, yet suggested minor adjustments. Participants in the evaluation suggested changes on the amount of content, specifically in the reading section and the layout of the instructions.

We believe in the need to make these adjustments as they are rapid iterations and listening to users is what makes a user-centric design so special. The implementations were little but powerful: we added visual stimuli to the instructions, we divided the reading section into two parts, and we optimized the grid to ensure users understand they have to drag and drop the parts of the rocket to it.

Following the guidelines of a user-centric design process has taught us how to develop a new opportunity creating an interactive kiosk constructor and simulator. This artifact demonstrates how we can foster creativity and interactive connection amongst people who visit the IWM while enriching their learning and understanding of historical artifacts in a positive perspective.

Ethics

Ethical considerations throughout the whole design process were taken acordingly. The main areas of the process where we wanted to reinforce ethics was the user research and the evaluation, as both directly reflect third-party information.

Our ethical approach for the interviews consisted of creating consent forms, and asking participants to sign them prior to conducting our interviews. We were reassured to express all ethical considerations learned from the coursework material, such as how we will use their information, anonymity, and validity of the answers, amongst others.

Another approach taken throughout both rounds of interviews - user research and evaluation - was to record in video and or audio format.

4. Reflection of strengths weakness: design process

The process of evaluating our prototype was quite personal and fulfilling to the three remaining members. It was the first time for the three of us that we were going to evaluate a piece of interactive technology created by us. Questions were mainly focused towards finding usability issues, gathering first impressions and understanding how (and if) our project could indeed convert to an opportunity.

In short, main strengths include the combination of a learning, interactive and sensory artifact that is deeply focused towards a human-centered aproach. Main weaknesses on the other hand include the simplistic design of the construction, typography and overwhelming content.

Strengths

A key strength that we would reflect upon is the fact that 3/3 participants understood the objective of the artifact right from the start. Based on the kiosk guidelines we read online (Barry, 2024), we were able to determine that it was essential to instruct the user how to navigate along the journey.

A second strength that we extracted is how successful we had been in creating an initial prototype that provided a combination between learning, interaction and sensory experience. This balance ensures that the kiosk would be appealing to all users, fulfilling the needs of the primary personas.

A third strength was to let the user have the possibility to explore all rockets, compare them and observe them from multiple angles was very highly recognized in our evaluation.

Lastly, the approach towards an environmental simulation where the user was able to engage with 4 of the senses was believed to make their experience unique. This aspect strongly stood out as it would help them emotionally connect with the artifact.

Weaknesses

Although we were happy with the strengths, where we really learned from was from the weaknesses that were highlighted, specially the simplicity of the construction and the overwhelming content.

The main weakness was related to the simplicity of the drag and drop features. Users found the fact that they were “forced” to follow the predestined sequence weak. The user not being able to drag and drop as liked, diminishes the interactive experience, and may limit user autonomy.

A second weakness was related to the typography and overwhelming content. Some users found the fonts challenging to read.

Thirdly, the transition from one page to the other was considered a weak point, since it wasn’t perceived as smooth. While these elements were determined by the museum guidelines, the users found them less visually appealing.

Lastly, the design’s simplicity was considered as a drawback due to the lack of impressive visual elements and animations. However this feedback can be attributed to the prototype’s low fidelity nature, which prioritizes functionality and user experience over aesthetics and high-end visuals.

5. Reflection strengths weakness: solutions

Our final objective was to reflect on how each design principle has played a fundamental role throughout this whole project. As expected, our design has some strengths and weaknesses. To conclude this report we aim to explain them based on the principles of 3 authors learned throughout our coursework: Jakob Nielsen, Don Normal and Ben Sheniderman.

Strengths

We conclude that our kiosk resonates strongly with two Nielsen principles: visibility and recognition rather than Recall (Nielsen, 2024), as the system keeps the user informed of what is going on and instructions are visible throughout the flow.

Nielsen, 2024, highlights that user controls and freedom are key components of the interface to provide various options to choose from. We wanted to ensure that users were able to have the freedom to experience more than one journey, with the ability of going back and forth on all screens.

Principles from (Nielsen, 2024) that we endorsed in our feature are; consistency and standards. Our kiosk maintains consistency by using the same colors, typography and design standards according to the museum guidelines (Imperial War Museum, 2019). We also looked at kiosk guidelines to align with the real world (Barry, 2024).

From the design principles of Norman (Batterbee, 2020), our kiosk highlights the subsequent strengths. 1. Discoverability, as our evaluation suggests, users understood the objective from the start (**See Appendix N)**. 2. Mapping, as control and CTAs are similar to other kiosks based on competitive benchmarks (**See Appendix K**). 3. Affordance, as it allows fluid navigation.

Finally, we wanted to reflect on the principles of Sheniderman (Wong, 2021). We agree that our design strives for consistency, universal usability and easy reversal of actions. Users can close dialogs, undo or redo actions, thus supporting flexibility.

Weaknesses

One of our limitations is the lack of feedback upon drawing errors. Norman (Batterbee, 2020) highlights the importance of feedback upon user input allowing the user to understand and process the information. Similarly, Schenierderman (Wong, 2021) emphasises informative feedback to guide users throughout navigation.

Another core weakness is aesthetic and minimalist design from Nielsen (Nielsen, 2024), as the dialogue from the storyteller may sometimes be irrelevant for users, with excessive information. Although we let the user skip and mute, we could have been more minimalistic with the storytellers dialogue.

Lastly, one final weakness is that the kiosk may fail to entirely match within the real world (Nielsen, 2024), as some concepts may not be entirely familiar to the user due to the uncommon topic.

The next iteration of our product could focus upon drawing key principles from the above authors to improve, and enhance the user experience.

The outcome of our kiosk rocket simulator reflects user research as well as key design principles such as consistency, user friendliness and flexibility. Following a user centric approach along the whole process we have been successful in finding an opportunity to create an interactive piece of technology for the IWM that fosters engagement, creativity and connection through an educational and functional approach.

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https://chatgpt.com/ (n.d.). Poster Image Generated using ChatGPT 4o “Prompt used -> “A colorful hand-drawn sketch of a man standing in front of an interactive kiosk in a museum. We want the point of view tobe from the side. The man is wearing headphones, and both of his hands are firmly gripping two large handles attached to the sides of the kiosk, his fingers tightly wrapped around them, demonstrating active engagement. The kiosk screen prominently displays a vivid, dynamic V2 rocket launch scene, with the rocket centere “ Accessed on : 11/12/2024 at 2:30am.

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Statement of Contributions:

Group Members: Naeem Arsiwala (NA), Lucía Lladó (LL), Elena Vergopoulou (EV), Michelle Long (ML)

User research

EV, LL structured the user research path and interview questions and format. NA And ML conducted user interviews and observations. LL and EV conducted the user analysis and defined the key elements that would contribute to the following processes.

Conceptual Design

NA, LL, EV did the initial lo-fi prototypes and. LL and NA created the wireframes in Figma. LL benchmarked the designs by conducted a competitive analysis of other apps.

Detailed Design: NA and LL created the whole design process of the product. NA initialized the wireframes, colour and typography. LL conducted alignment, consistency and design validation. EV contributed to content writing of the product.

Prototyping

NA created the interaction and navigation of the product. EV and LL supervised the flow and navigation. LL, NA, EV contributed to thorough analysis and benchmarking of the prototype.

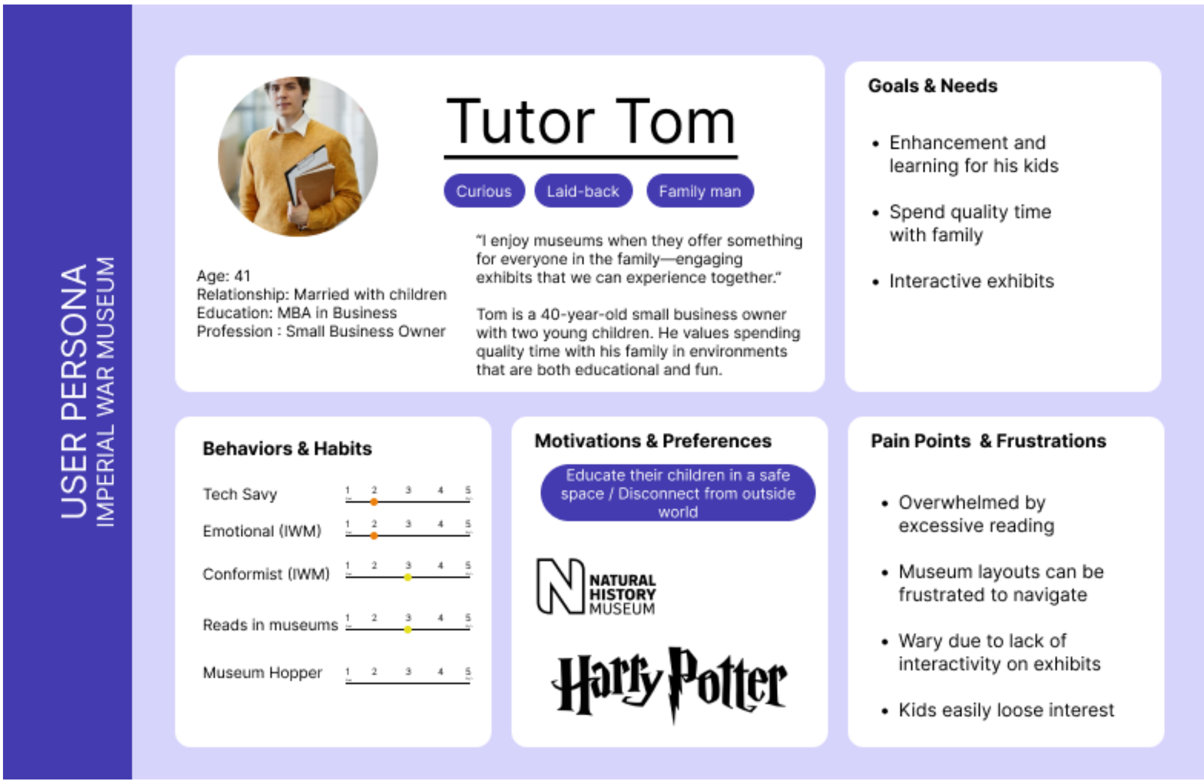
Report writing

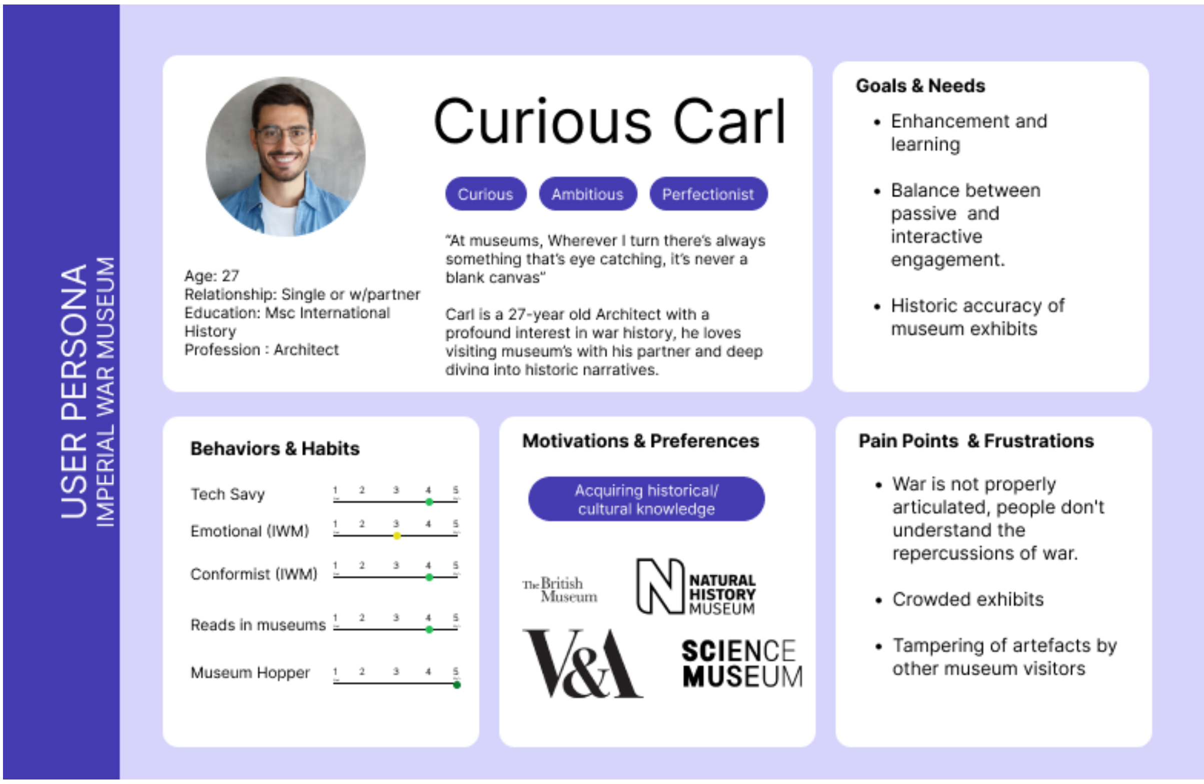
LL wrote majority of the report and made sure it was cohesive and coherent. EV contributed to the content structure as well as parts of the report. NA, LL, EV conducted thorough proofreading of the report to make any final adjustments.

Drawing/Sketching

NA, LL, EV conducted a high-level overview of the storyboard. EV implemented the whole design of the poster & storyboard as well as took lead in all the sketching workshops which led to the initial design ideas of the prototype.

Appendix A: Personas





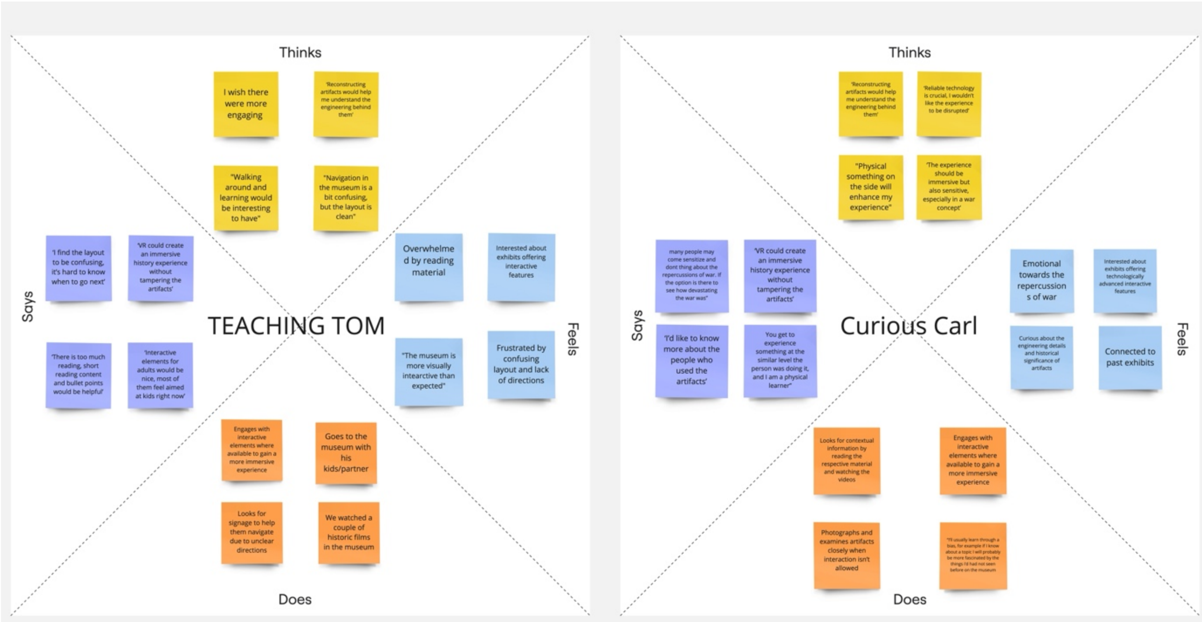
Appendix B: Naturalistic Observation

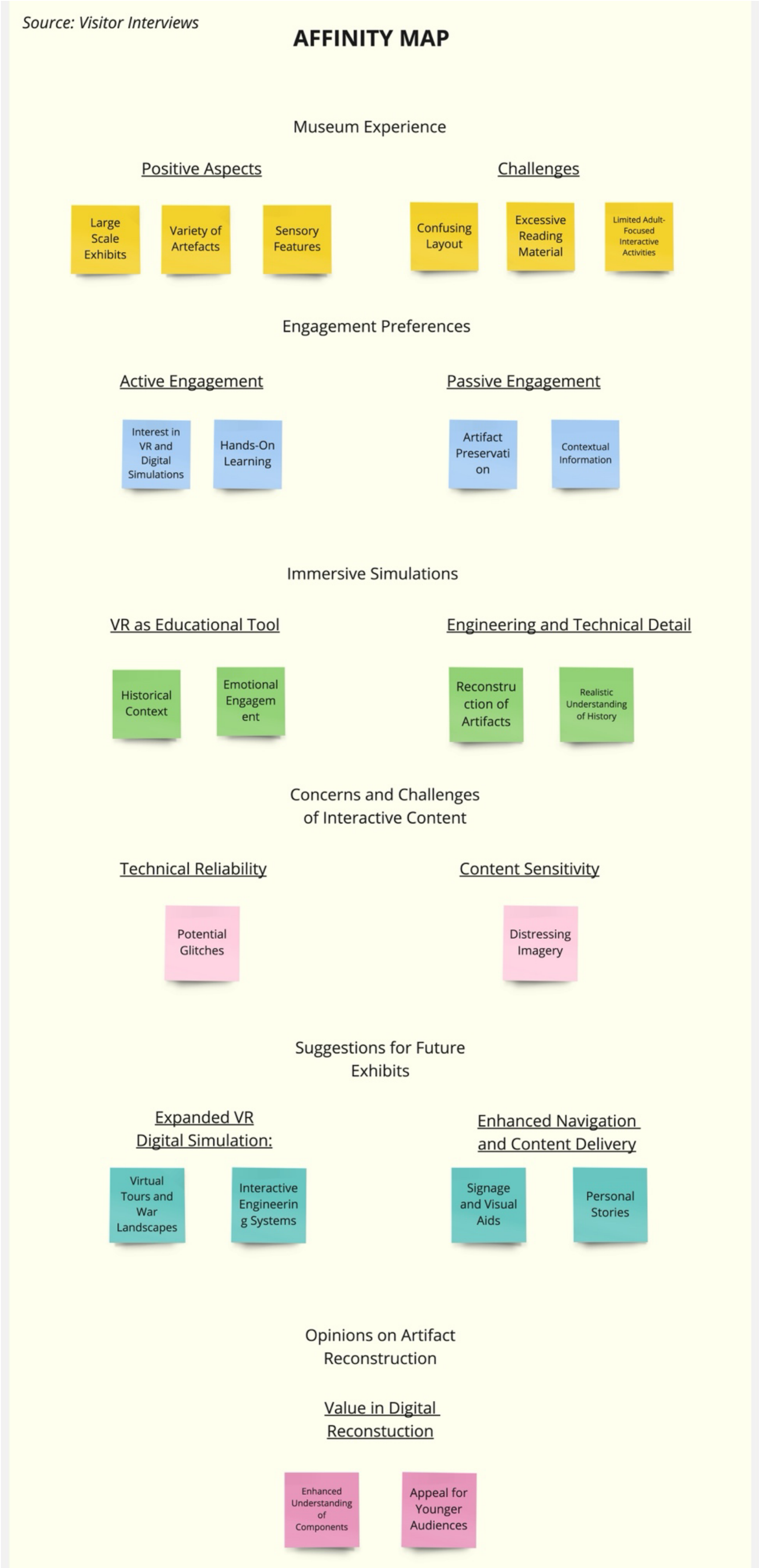
Direct naturalistic observation in the London Imperial War Museum (Framework based on Robson, 2011)

Space	Observations occurred in the 'Witnesses to War' exhibit section on the ground and first floor. The ground floor is the first exhibit area the visitors access when entering the museum. Both areas displayed physical artefacts, mostly vehicles that have been involved in war. On the ceiling of the museum, aeroplanes/jets were displayed.
Actors	Both areas have museum staff (red uniform with badges), couples, families, children on school trips, and people alone.
Objects	Museum artefacts (vehicles/weapons), information screens (interactive technology), display maps, and seats. Actors were carrying personal items (e.g. bags), the museum guidebook, and phones.
Acts/behaviours	• Viewing the artefacts, including walking around the whole of the artefact. • Reading the information available about the artefact, either on information display boards or in the guidebook. • People were discussing the features/history of the artefact with the person they came with. • Taking photos of the artefacts • Looking at maps to navigate the area • Socialising in a group (meet up) Regarding the partial helicopter on the first floor, people were inspecting the parts, tapping and touching the artefact and making predictions on

	how the whole artefact should look like when discussing it with the person they were with.
Time	11:10-11:30AM Some people chose not to spend long at an artefact, instead just taking a photo. While others spent time walking around the artefact and reading the information. People tended to stay longer when touching/watching the interactive information screens.
Goals	During the observation, it appears museum visitors were trying to learn more about the artefacts in the museum and interact with them in multiple ways when possible. Museum visitors also appeared to be trying to navigate to different parts of the museum (likely given the ground floor is the entrance hall). Museum staff appeared to be trying to help visitors and boost museum donations.
Feelings	Museum visitors appeared to be curious, interested, and fascinated. Body language was relaxed when moving around the museum and focused when observing artefacts.

Appendix C: Affinity & Empathy Map




Source: Visitor Interviews
AFFINITY MAP
Museum Experience
Positive Aspects
Large Scale Exhibits
Variety of Artefacts
Sensory Features
Challenges
Confusing Layout
Excessive Reading Material
Limited Adult-Focused Interactive Activities
Engagement Preferences
Active Engagement
Interest in VR and Digital Simulations
Hands-On Learning
Passive Engagement
Artifact Preservati on
Contextual Information
Immersive Simulations
VR as Educational Tool
Historical Context
Emotional Engagem ent
Engineering and Technical Detail
Reconstru ction of Artifacts
Realistic Understanding of History
Concerns and Challenges of Interactive Content
Technical Reliability
Potential Glitches
Content Sensitivity
Distressing Imagery
Suggestions for Future Exhibits
Expanded VR Digital Simulation:
Virtual Tours and War Landscapes
Interactive Engineerin g Systems
Enhanced Navigation and Content Delivery
Signage and Visual Aids
Personal Stories
Opinions on Artifact Reconstruction
Value in Digital Reconstuction
Enhanced Understanding of Components
Appeal for Younger Audiences

Appendix D: Swot Analysis of Interview

Swot Analysis

Strengths	**Weaknesses**
1. High interest in environment simulation 2. Visual and interactive experiences are highly appreciated 3. Technological simulators are familiar to some users (ie., earthquake, F1)	1. Sensitive of war artifacts/elements 2. Artifact simulator not seen in IWM before
Opportunities	Threats
1. Learning as a key factor incites to use provide a user-centric approach with strong story telling and use of context 2. Balance between reading & visual approach	1. Accessibility issues 2. Inaccuracy of feature as participants are not sure what to expect

Appendix E: Deck Research

Deck Research (For content & Learning use)

Museums with interactive transportation artifacts

- London Transport Museum
  - Driving a bus simulation
  - Operating Tube train
- New York Transit Museum
  - Operate signal tower & learn about train dispatching
- National Railway Museum in York
  - Experience the sensation of driving a high-speed train through simulators
- Petersen Automotive Museum
  - Test driving skills in virtual tracks using realistic racing simulators
  - AR to explore inner workings of vehicles
- National Air and Space Museum Washington DC
  - Flight Simulators
  - Interactive Cockpits

Rocket and Plane Simulators

- Kerbal Space Program
  - Players can design, build and launch rockets
  - Realisitic mechanics
- Spaceflight Simulator
  - Construct custom rockets
  - Accurate physics
- Orbiter Space Flight Simulator
  - Includes historical rockets
  - Accurate physics
- Launch Visualizer
  - Simulate rocket launches
  - Flight dynamics and performance
  - Bad design
- Flight Club
  - Simulations of rocket launches and orbital trajectories
  - Mostly for professionals
- Microsoft Flight Simulator 2024
- X-Plane 12
- GeoFS
- FlightGear
- Prepar3D

Appendix F: Interview Analsysis

Interview Analysis

Park 2 Interviews

Key notes

1. Engagement Preferences:
- Visitors tend to prefer experiencing historical artifacts **passively** without physical immersive interaction as they believe this is the best way to **preserve their integrity** and **reduce the risk of tampering.**
- However there is a willingness to consider elements that **do not directly impact the authenticity** of the artifacts. For instance **digital features** (e.g. videos, simulations) that imitate experiences without requiring physical interaction.
1. Suggestions and Opinions on Immersive Simulations:
- Both visitors appreciate **immersive experiences**, such as virtual reality, which could make them feel more involved in a historical setting. They think that these simulations could **improve comprehension by placing artifacts in context**. They suggest this is particularly useful in war-related exhibits where the **emotional aspect can enhance learning** by making visitors less desensitized to the topic.
1. Concerns and Challenges of Interactive Content:
- There's an concern regarding the **reliability of technical elements** (e.g. potential glitches) that might impact the experience.
- One participant brings up concerns about the **sensitivity of interactive content**, mainly in a war-related context, where **intense imagery or flashing elements could be triggering**, especially for visitors with epilepsy etc.
1. Design Suggestions for Future Exhibits:
- One suggestion is a **virtual reality** setup, where users could experience different **war landscapes** (e.g., a WWI battlefield or a Gulf War desert) as 360° images or moving frames. They think such immersive experiences can bring historical scenarios closer to life.
- Another suggestion is a **war vehicle immersive simulation** (e.g. tank driving experience). The visitor underlines that the driving factor isn't mandatory, just the **experience of being inside the vehicle.**

Park 1 Interview

Key Notes

1. Personal Museum Experience:
- The participant mentions that the museum **layout can be confusing**, with certain sections being confusing due to the **lack of direction signs**. They feel that a navigational improvement using visual guides and clear pathways will improve the flow and create a better experience.
- They appreciate some **signs that indicate a synopsis of the content** and mention the need for adding **'highlights' tables**.
- While navigation clarity is valued, the participant also appreciates the **discovery aspect**. They suggest a balance between clear guidance and the thrill of exploring.
1. Engagement Preferences:
- The visitor highlighted a preference for **a blend of visual and interactive experiences** rather than only passive experiences. They **appreciated elements that broke up the museum experience** such as films and display panels, especially for visitors who do not prefer reading elements.
- For active engagement, they found value in features that allowed visitors to pick up information as they moved through the museum, allowing them to engage at their own pace. **Interactive technology**, like simulations, was considered an interesting concept that could **get the visitor more involved and help them gain a better understanding.** However, they expressed **concerns** of overuse, mentioning that **extensive interactivity could be overwhelming**.
1. Suggestions and Opinions on Immersive Simulations:
- The visitor appreciates immersive setups, especially ones that allowed a **physically intact experience.** They praised similar artifacts in other museums such as an earthquake simulator, as they provided a deeper connection to the subject matter. In this museum, the visitor found that the **larger displays** in the main hall **created an immersive effect** due to their scale and visual appeal.
- The idea of **recreating or simulating historical transportation** seemed interesting as a concept that would allow visitors to piece together **a more realistic understanding of history**. They also saw potential in exhibits that **include the stories of the people involved**, believing this factor could make the experience more relatable and impactful.

IWM 1 Interview

Key notes

1. Personal Museum Experience:
- The visitors **appreciated the engineering, the scale and size of certain artifacts** (e.g. the V2 rocket). They found the information to be **well laid out** and liked the **range** of exhibits.
- They **didn't have any interactive experience** themselves but they do consider them as good **opportunities to get connected to the exhibits and the past.** They were particularly interested in features that could explain the **engineering and historical context behind the objects** on display, e.g. details about how these technologies were developed, engineered, and they served historically.
1. Engagement preferences:
- The visitor seem to lean towards an **active engagement experience** because of the **learning opportunities** it has to offer e.g. experience scientific principles firsthand.
1. Suggestions and Opinions on Immersive Simulations:
- Visitors showed interest in **VR as a tool to simulate historical settings.** They think a digital experience using **VR cameras and headsets** could be beneficial for understanding complex **engineering and historical contexts**, noting that it could help visualize aspects like propulsion systems or construction methods. They suggest that such simulations, focusing on technical aspects would be particularly engaging for visitors with a technical interest.

IWM 2 Interview

Key notes:

1. Personal Museum Experience:
- The visitor **appreciates the structure, lay out and sensory aspects of the museum.** They found it generally informative and **easy to comprehend**. They find features like **small films and interactive visuals** valuable, as they enhance a holistic and **sensory experience** and provide a feeling of being in the moment.
- They suggested the **use of bullet points** for an even better structure of the information.
- They seemed to have **issues with the navigation** and they reported that there was **not a clear natural path to follow.**
- They also mentioned to have a strong personal connection to WWII, which enhanced their engagement, suggesting that such **personal experience adds depth to the visit.**
1. Engagement Preferences:
- The visitor shows interest in enhancing engagement through **immersive, digital technology** as they found the **reading material to be excessive** and saw potential for the addition of **more interactive elements**. They see value in **VR and simulations for their ability to create immersive historical contexts**, which may be especially interesting to younger audiences.
1. Suggestions and Opinions on Immersive Simulations:
- They suggested the **use of VR glasses** used to watch the **recreation of historical battles.**
- They did **not show interest in hands-on activities such as reconstruction of artifacts.** They indicated that they would **not be prepared for such an activity when visiting this museum** and that it would probably be more interesting and suitable for **younger audiences.**

IWM 3 Interview

1. Personal Museum Experience:
- The visitor has an interest in **WWII artifacts, especially guns and knifes**. They enjoy observing them, learning how they were used for fighting back, war tactics etc.
- They mention that whenever they are presented with **an opportunity to interact with an artifact** e.g. **touch** it, they use it otherwise they mostly take photos.
- They find the current layout satisfactory but feel that **adding audio guides** or other auditory elements would allow them to listen to information while exploring the exhibits at the same time. This suggestion comes from previous exhibitions they attended.
1. Engagement Preferences:
- The visitor leans toward **immersive experiences** that allow them to **learn actively while observing** instead of first reading the information and then interacting with the artifacts.
- While they did notice **interactive games** in the museum, they feel that these are **mainly targeted at younger audiences**. They were open towards interactive elements designed for adults, though they don't give specifics.
1. Suggestions and Opinions on Immersive Simulations:
- While they **struggle to visualize specifics for these simulations**, when presented the idea of digitally recreating a rocket/plane, they do find interest in the idea. They find value in such simulations because **they allow the user to have a better understanding of its components**.

General conclusions

1. Museum Experience
- Visitors mostly found the museum **layout confusing,** especially considering navigation, with a **lack of clear direction signs,** making navigation difficult and detracting from the experience. (IWM 1, Park 1)
- Many visitors appreciated the **variety of artifacts and especially the large-scale exhibits**. (IWM 1, IWM 2)
- Some visitors noted that the amount of **reading material felt excessive**, preferring shorter summaries or visual aids to make information more accessible. (IWM 2, Park 2)
- Visitors suggested that **interactive games and activities were more suitable for younger audiences,** lacking respective adult options. (IWM 3, Park 1)
1. Engagement Preferences:
- Visitors seem to generally appreciate opportunities for **active engagement**, especially when it **enhances learning** and provides interactive experiences. (IWM 1, IWM 3)
- There were **passive engagement preferences** but they were **mainly associated with preserving historical artifacts integrity**. Non-invasive digital elements, like simulations, were considered ideal. (Park 2)
- There is a recurring theme across interviews that **digital interactions,** such as VR, offer an ideal balance—**allowing engagement without risking condition of artifacts**. (IWM 2, Park 1)
3. Interest in Immersive Simulations:
- There is a strong general interest in **immersive digital experiences**, especially VR, to **simulate historical contexts**. (IWM 2, IWM 3, Park 2)
- VR was suggested by many visitors as a good way of **contextualizing artifacts**, such as simulating war landscapes, historical battles, or engineering setups like propulsion systems. (IWM 3, Park 2)
- Immersive simulations were considered a way to **enhance emotional connection**, particularly in war-related exhibits where realistic environments can help visitors become more **sensitive in human history** and **get connected to the exhibits and the past.** (IWM 3, Park 2)
1. Concerns and Challenges of Interactive Content:
- Concerns around technical reliability and the potential for **digital malfunctions** (e.g VR glitches) were raised. (Park 2)
- A visitor expressed sensitivity around i**nteractive content in war-related contexts** concerning **intense or graphic simulations** which may be **distressing for certain audiences**, suggesting a need for content design that takes varying audience comfort levels into account. (Park 2)
1. Visitors Suggestions for future exhibits:
- **VR and digital simulations** are frequently suggested, with specific ideas including virtual tours of **war landscapes**, interactive **explorations of engineering systems**, and immersive experiences within **war vehicles**. (IWM 3, Park 2)
- Integrating **auditory or visual aids** to improve navigation and content delivery. (IWM 2, Park 1)
- **Including the stories of the people involved**, believing this factor could make the experience more relatable and impactful. (Park 1, Park 2)
1. Opinions on reconstruction of an artifact:
- Sometimes there was **struggle** on behalf of the visitors to **visualize the idea.** (IWM 3)
- They generally found value in such a simulation because **they allow the user to have a better understanding of the artifacts components and engineering,** mentioning ****that it could help visualize aspects like propulsion systems or construction methods. (IWM 1, IWM 3)
- The idea of **recreating or simulating historical transportation** seemed generally interesting as it would provide **a more realistic understanding of history.** (Park 1, Park 2, IWM 1)
- One visitor mentioned that they **wouldn't be prepared for such an activity** when visiting the museum and that it would probably be more interesting and suitable for **younger audiences**. (IWM 2)

In depth analysis Interviews

⚠️Distinction between male and female.

Female > Male willingness to interact.

Male > female learning habits?

Reasons for visit

- Enjoyment of "museum hoping" is essential, and the reason for the participants meeting
- Learning as a key factor for users visit

🎮 Interactiveness

- Non - first times
- touch (trench'?) would be interesting as historical artifacts
- Lighting is a disadvantage for users
- "Where you turn there is always on your eye-line, never a blank canvas" - contrast of eyes
- User mentioned the attractiveness of an astronaut simulation "You get to experience something at the similar level the person was doing it, and I am a physical learner"

📖Learning

- Learning is based on bias
  - "I'll usually learn through a bias, for example if I know about a topic I will probably be more fascinated by the things i'd had not seen before on the museum"

🛋️ Experiences

(2/2 interest in AT)

- Male participant prefers not immersive "there are a lot of people who would want to face, and just looking at things is appropriate" however when asked him about simulating senses he was interested.
- Woman participant would not mind a "physical something on the side" would enhance her experience

💚Preferences

- Educational will enhance learning "If I feel more in it I am going to take things more away"
- High interest in simulation environment in IWM as "many people may come sensitize and don't thing about the repercussions of war. If the option is there to see how devastating the war was"

💪Challenges

- Personal triggers (epilepsy)

🦄Uniqueness

- VR room with 360 images of different war environments
  - Still images are preferred over moving images

P2. Park 1

Reasons for visit

- Sons half term and enhancement of learning
- First time in museum
- Impressed by galleries and "more visually interactive then expected"
-

🎮 Interactiveness

- Watched a couple of films (WWI - choose bit of films)
- Display panels were interesting

📖Learning

- Improve engagement by diminishing abundant reading material

🛋️ Experiences

- Engaged by earthquake simulator

💚Preferences

- Interesting as a concept
- Context is essential
  - Why is there, what is it used to, what was it
- Reading = Interactive

🦄Uniqueness

- Found layouts interesting
- Navigation somewhat confusing

P3. IWM1

🤦‍♀️it seems these participants have a great deal of knowledge on the wars

⁉️Reasons for visit

- Retired colleagues, trying spend time
- First timers
- V2 rocket preference

🎮 Interactiveness

- First look at the information displayed
- Astonished by the amount of engineering used in rockets
- "Well laid out, very clean"

🛋️ Experiences

- Interactive experiences increase interaction

💚Preferences

- have an interactive tool in order to deep dive into the museum
- Features like a digital experience like the VR headsets for a simulation

💪Challenges

- Create different scenarios and understand how users would react

P4. IWM2

👩Woman with son

⁉️Reasons for visit

- Interest in WWII
- Non-first timers

🎮 Interactiveness

- Easy to understand information, expressions, films

📖Learning

- "Watching the films is like being there in a way"

💚Preferences

- User does not seem interested in interactive simulation
- "For me it would not enhance the experience but for children, for my 10 YO boy it would be interesting"

P5. IWM3

Reasons for visit

- Interest in War (2>1)
  - artifacts and learning of WW2
- Non first timer
- General interest and basic knowledge

🎮 Interactiveness

- Interested in having more "adult-games"

🛋️ Experiences

- "F1 exhibition they used to have the headphones that you could press the button and walk around while learning would be interesting to have something like that"
- Walk around and looking at things while you take in some information is key

💚Preferences

- Guns and knives how they were formed
  - how they were used
- Feel them > taking pictures
- Interested in interactive simulation but "very hard question to answer because he is finding difficulties picturing how that would be"

Appendix G: Research On Rockets

Research on V rockets - Elena

Timeline of V and A series rockets

A series were experimental prototypes for aerodynamics, propulsion, and guidance systems

They were not used for military purposes but laid the groundwork for the **V rockets**, which were operational and destructive weapons

1. Aggregat-1 (A1) – 1933

- **Speed**: Not applicable; exploded on launch.
- **Explosive Impact**: None (experimental prototype).
- **Fuel Type**: Liquid oxygen (oxidizer) and ethanol (fuel).
- **Material**: Steel body with fiberglass insulation.

- **Length**: ~1.4 meters.
- **Weight**: ~150 kg.
- **Designer**: Wernher von Braun and the German Army Rocket Research Group.
- **Manufacturer**: German Army Research Facility, Kummersdorf.
- **Hours to Construct**: Not standardized (prototype).
- **Where and When Made**: Kummersdorf, Germany; 1933.
- **Significance**:
    - The A1 was the first liquid-fueled rocket design in the Aggregat series.
    - Although it failed during its only launch attempt, it provided foundational knowledge for subsequent designs, particularly in stabilizing rockets and

fuel system integration.

2. Aggregat-2 (A2) – 1934

- **Speed**: Reached altitudes of 2.2–3.5 km in successful test flights.
- **Explosive Impact**: None (experimental prototype).
- **Fuel Type**: Liquid oxygen and ethanol.
- **Material**: Steel.
- **Length**: ~1.6 meters.
- **Weight**: ~180 kg.
- **Designer**: Wernher von Braun and the German Army Rocket Research Group.
- **Manufacturer**: Kummersdorf Rocket Research Facility.
- **Hours to Construct**: Not standardized (prototype).
- **Where and When Made**: Kummersdorf, Germany; 1934.
- **Significance**:
    - First successful liquid-fueled rocket test flights in Germany.
    - Demonstrated the viability of liquid-fueled rockets for higher altitudes and validated design concepts that were improved in later models.

3. Aggregat-3 (A3) – 1937

- **Speed**: Designed to reach altitudes of 18 km.
- **Explosive Impact**: None (test model).
- **Fuel Type**: Liquid oxygen and ethanol.
- **Material**: Steel and aluminum components.
- **Length**: ~6.7 meters.
- **Weight**: ~750 kg.
- **Designer**: Wernher von Braun and Walter Dornberger.
- **Manufacturer**: Peenemünde Research Facility.

- **Hours to Construct**: Not standardized (prototype).
- **Where and When Made**: Peenemünde, Germany; 1936–1937.
- **Significance**:
    - Same as A1 (dimensions and engine) but with separate propellant tanks
    - Achieved two successful test flights

4. Aggregat-5 (A5) – 1938

- **Speed**: Subscale tests for supersonic speeds.
- **Explosive Impact**: None (experimental testbed).
- **Fuel Type**: Liquid oxygen and ethanol.
- **Material**: Steel with improved aerodynamics.
- **Length**: ~5.8 meters.
- **Weight**: ~900 kg.
- **Designer**: Wernher von Braun and Walter Dornberger.
- **Manufacturer**: Peenemünde Research Facility.
- **Hours to Construct**: Not standardized (prototype).
- **Where and When Made**: Peenemünde, Germany; 1938–1942.
- **Significance**:
    - The A5 successfully tested the stabilization systems and aerodynamics intended for the A4.
    - All flights were successful, confirming the reliability of these systems and building confidence for scaling up the design.

5. Aggregat-4 (A4) / V-2 Rocket – 1942

- **Speed**: ~5,760 km/h (3,580 mph).
- **Explosive Impact**: 1-ton Amatol warhead.
- **Fuel Type**: Liquid oxygen and ethanol-water mixture.

- **Material**: Steel alloy body, aluminum fins.
- **Length**: ~14 meters.
- **Weight**: ~12,500 kg.
- **Designer**: Wernher von Braun.
- **Manufacturer**: Mittelwerk Factory (using forced labor).
- **Hours to Construct**: ~10,000 worker-hours.
- **Where and When Made**: Designed at Peenemünde; first deployed in 1944.
- **Significance**:
    - The first long-range guided ballistic missile.
    - A technological breakthrough with liquid-fuel engines, gyroscopic guidance, and advanced aerodynamics.
    - Deployed operationally during WWII, the V-2 was the first human-made object to reach the edge of space, influencing the U.S. (Redstone program) and Soviet (R-1 missile) rocket programs.

6. V-1 Flying Bomb – 1944

- **Speed**: ~640 km/h (400 mph).
- **Explosive Impact**: 850 kg warhead.
- **Fuel Type**: 80-octane gasoline.
- **Material**: Steel fuselage, plywood wings.
- **Length**: ~8.3 meters.
- **Weight**: ~2,150 kg.
- **Designer**: Robert Lusser (Fieseler Aircraft Company).
- **Manufacturer**: Various German facilities, including Volkswagen.
- **Hours to Construct**: ~350 worker-hours.

- **Where and When Made**: Developed at Peenemünde; deployed June 1944.
- **Significance**:
    - The first operational cruise missile and precursor to modern drones.

7. Aggregat-9 (A9) – 1944

- **Speed**: Designed for supersonic speeds.
- **Explosive Impact**: Intended for payload delivery (conceptual).
- **Fuel Type**: Liquid oxygen and ethanol.
- **Material**: Steel and lightweight alloys, with wings for extended range.
- **Length**: ~14 meters.
- **Weight**: ~16,000 kg.
- **Designer**: Wernher von Braun.
- **Manufacturer**: Peenemünde Research Facility.
- **Hours to Construct**: Limited prototypes only.
- **Where and When Made**: Concept tested in 1944.
- **Significance**:
    - Early design for intercontinental missions, precursor to modern ICBMs.
    - Designed to attack the US from Europe.

8. Aggregat-10 (A10) – 1944 Concept - not implemented

9. V-3 Cannon (High-Pressure Pump) – 1944

- **Speed**: Projectiles reached ~1,600 km/h (1,000 mph).
- **Explosive Impact**: 140 kg warhead per shell.
- **Fuel Type**: Explosive charges.
- **Material**: High-strength steel.
- **Length**: Barrel ~130 meters.

- **Weight**: N/A (artillery system).
- **Designer**: August Cönders.
- **Manufacturer**: Mimoyecques Facility, France.
- **Hours to Construct**: ~15,000 worker-hours.
- **Where and When Made**: Mimoyecques, France; 1943–1944.
- **Significance**:
    - Used to bombard Luxembourg and aimed to bombard London but never used for this purpose due to allied attacks on the launch facilities

10. V-4 Rheinbote – 1944

- **Speed**: ~5,500 km/h (3,420 mph).
- **Explosive Impact**: 40 kg warhead.
- **Fuel Type**: Solid fuel.
- **Material**: Steel and lightweight alloys.
- **Length**: ~11 meters.
- **Weight**: ~1,700 kg.
- **Designer**: Heinrich Loeffler.
- **Manufacturer**: Rheinmetall-Borsig AG.
- **Hours to Construct**: ~1,500–2,000 worker-hours.
- **Where and When Made**: Germany; 1944.
- **Significance**:
    - Demonstrated the potential of tactical solid-fuel rockets for military use.

References:

Aggregate-1

https://en.wikipedia.org/wiki/Aggregat?utm_source=chatgpt.com

https://www.britannica.com/technology/V-2-rocket?utm_source=chatgpt.com

https://en.wikipedia.org/wiki/V-weapons

https://military-history.fandom.com/wiki/Aggregate_(rocket_family)

https://www.wehrmacht-history.com/heer/missiles/v-2-rocket.html

https://www.nevingtonwarmuseum.com/aggregate-rocket-family.html

https://www.daviddarling.info/encyclopedia/A/A_series.html

4 models to present

- V2 - obvious reasons
- V1 - first operational model
- A9 - its technologies were later used in space programs
- A2 - first successful model

V2 fun facts:

- The V-2 consumed a third of Germany's fuel alcohol production and major portions of other critical technologies: to distil the fuel alcohol for one V-2 launch required 30 tones of potatoes at a time when food was becoming scarce. (V-2 rocket - Wikipedia)
- V2 was the first human-made object to cross the Kármán line (100 km above sea level), the recognized boundary of space.
- The V-2's nose cone was meticulously engineered to house a 750 kg Amatol explosive charge. This design was crucial for the rocket's aerodynamic stability and effectiveness as a weapon. '

V-2

Nose Cone - During World War II, the nose cone held a German warhead containing almost a ton of explosives. At White Sands, the Army invited government agencies and universities to use the nose cone's 20 cubic feet of space for scientific research, up to 2,000 pounds of scientific equipment, such as cameras, sensors, and on-board experiments, were carried aloft on each flight.

Control Section - This section contained gyroscopes for guiding the rocket in flight and the bottles of nitrogen gas that powered them. The gyroscopes produced electrical signals in the form of voltage proportional to the amount of correction needed to maintain a preset trajectory. The corrective signals were transmitted through an integrating computing element to steering vanes in the tail assembly.

Midsection - The propellant used in the V-2 consisted of alcohol and liquid oxygen, propellant tanks and associated valves and piping were located in the rocket's midsection. Glass wool insulated the rocket from the extreme cold of the liquid oxygen.

Thrust Frame - The thrust frame held the propulsion unit, which consisted of a turbopump, steam-generating plant, heat exchanger, combustion unit, and associated piping. The turbopump was powered by steam generated from combining hydrogen peroxide and sodium permanganate, both of which were stored in tanks in this section and forced into the pump by compressed air.

Tail Assembly - The tail served to stabilize flight and steer the rocket, and consisted of the tail faring, four stabilizing fins with steering vanes, vane motors, and antennas.

Research into V2 rockets- Michelle

An IMW Blog (10 Oct 2024): 80 years on: the V weapon attacks on Britain (https://www.iwm.org.uk/blog/research/2024/10/80-years-on-the-v-weapon-attacks-on-britain)

Summary extracts:

- V2s were launched **in September 1944**; these were silent, and there was no warning before they'd land. Over **10,000 lives were lost in Britain, and many more in the camps where the bombs were built using forced labour.** Hundreds of thousands of homes, mainly in London and the south-east, were also damaged or destroyed.
- Churchill described the psychological impact as being worse than during the Blitz: "Suspense and strain were more prolonged. Dawn brought no relief and cloud no comfort." While the death and destruction has not always been commemorated, localities such as **Chiswick**, **Tottenham**and **Deptford** have ensured the memory lives on.
- The impact of the rockets grew outside of these attacks, with their influence becoming integral to **the space race** between the United States and the Soviet Union through the latter half of the twentieth century.
- On **September 8th the first V2 rocket was fired at the UK**, landing in Chiswick.
- Due to their speed and trajectory, **V2s could not be shot down by anti-aircraft guns or fighter planes**, and instead the Allies' only option was capturing the launch sites during their advance through north-western Europe.
- While the rocket technology was advanced, the V2s **were vastly expensive and inaccurate**, and civilian morale remained steady despite the heavy losses suffered.
- At 12:25pm on **Saturday 25 November 1944, a V2 rocket landed on the Woolworths shop on New Cross Road in Deptford.** 168 people were killed, and many more were injured. On the day the rocket landed, only a month before Christmas, the shop was particularly busy – a queue was leading all the way out the shop as people waited to enter. Pat Grant, who lived five minutes away, recalled "after the sudden fright of everything around your home being shaken violently... there was an eerie silence". For

Vera Pearl, it was the concentrated smell of brick dust and blood that stayed with her. Over 100 members of the Civil Defence arrived at the site to help those injured, clear rubble and move bodies.

- To read more about this particular V2 attack and the aftermath on the community, **Rations and rubble : remembering Woolworths**can be accessed in the **IWM Research Room**.
- The lead scientist behind the V2 rocket, **Wernher von Braun, was recruited by the United States, later helping NASA develop the rockets which took astronauts to the moon**. Von Braun's complex, even contradictory, legacy is explored by the photographer, writer and researcher Lewis Bush in **Depravity's rainbow**.
- One particularly visible legacy of the V-weapons for visitors to IWM London is the **giant V2 rocket displayed in the atrium, and a V1 is suspended at IWM London between the Second World War Galleries and the Holocaust Galleries**. On the 80th anniversary of their first use, the legacy of the V-weapons attacks is memorialised through their presence at the Museum.

The woolworths V2 attack links:

- https://sites.gold.ac.uk/goldsmithshistory/the-v2-woolworths-rocket-bomb-disaster-25th-november-1944/
- https://heritagecalling.com/2019/11/25/devastating-v2-rocket-attack-on-woolworths-new-cross-london/
- https://www.woolworthsmuseum.co.uk/1940s-remembernewcross.htm

first British v2 attack in Chiswick links:

- https://www.londonremembers.com/subjects/first-v2-attack-chiswick?memorial_id=9934
- https://alondoninheritance.com/out-of-london/launch-and-landing-sites-of-the-first-v-2-on-london/
- https://brentfordandchiswicklhs.org.uk/local-history/war/commemorating-the-chiswick-v2/

IWM catalogue:

https://www.iwm.org.uk/collections/search?query=V2+rocket&pageSize=&media-records=records-with-media

This catalogue has loads of images regarding the v2 rockets.

Examples found in the catalogue:

DAMAGE CAUSED BY V2 ROCKET ATTACKS IN BRITAIN, 1945 (https://www.iwm.org.uk/collections/item/object/205022153): Ruined flats in Limehouse, East London. Hughes Mansions, Vallance Road, following the explosion of the last German V2 rocket to fall on London, 27 March 1945.

V1 AND V2 DAMAGE, 1944-45 (https://www.iwm.org.uk/collections/item/object/205070209): Extensive damage caused by mystery explosion in Southern England.' The photograph actually shows the site of the first V2 rocket impact on Britain, Staveley Road, Chiswick. Photograph taken 9 September 1944.

Interview with British gunner (George Gwyn Evans) served with 104th Z Bty, Royal Artillery in Birkenhead, GB, 1940-1942; NCO served with 538th (Mixed) Heavy Anti-Aircraft Regt, Royal Artillery in London, GB, 1942-1945. (https://www.iwm.org.uk/collections/search?query=V2+rocket&pageSize=&media-records=records-with-media): Reel 4: sight of V2 Rocket hits on area; attempt to work out the sounds made by V2 Rockets; sight of V2 Rocket in flight over south London; civilian morale; damage to London at end of Second World War; V2 Rocket hit on his site.

Wernher von Braun (https://www.nasa.gov/people/wernher-von-braun/)

Summary extracts:

- German-American **rocket scientist**
- Wernher von Braun (1912–1977) was one of the most important rocket developers and champions of space exploration in the twentieth century.
- The **V-2 ballistic missile** was the primary brainchild of von Braun's rocket team. After 1937 they worked at a secret laboratory at Peenemünde on the Baltic coast.
- A **liquid propellant missile** 46 feet in length and weighing 29,000 pounds, the V-2 flew at speeds in excess of 3,500 miles per hour and delivered a 2,200-pound warhead to a target 200 miles away. **First successfully launched in October 1942**, it was employed against targets in Western Europe, including London, Paris, and Antwerp, beginning in September 1944.
- Following Royal Air Force bombing of Peenemünde on the night of 17–18 August 1943, the Nazi leadership made the decision to move production to a new underground facility. This **V-2 assembly plant, called the Mittelwerk**, was in central Germany near

Nordhausen, utilized enslaved labor from the **attached Mittelbau-Dora concentration camp**. Outfitting the underground facilities began in 1943 with production beginning late 1944. **Brutal conditions in the underground facility** led to a high mortality rate among the laborers.

- Though he remined at the test facility at Peenemünde almost to the end of the war, von Braun later testified (1969) to have traveled to the Nordhausen area around 15 times between the late 1943 and February 1945. These typically one-day visits involved trips to the Mittelwerk to communicate changes in V-2 design and final acceptance criteria resulting from continued testing at Peenemünde.
- **Von Braun was well aware of the terrible conditions** and was involved in decision-making about the use of slave labor. The camp was liberated by American forces in April 1945.
- He surrendered to the Americans in the Austrian Alps, along with other key team leaders. For 15 years after World War II**, Von Braun worked with the U.S. Army in the development of guided missiles**. As part of a military operation called Project Paperclip, he and an initial group of about 125 were sent to America where they were installed at Fort Bliss, Texas. There they worked on rockets for the U.S. Army and assisted in V-2 launches at White Sands Proving Ground, New Mexico.

Dora-Mittelbau: Overview (https://encyclopedia.ushmm.org/content/en/article/dora-mittelbau-overview)

- Prisoners from Buchenwald were sent to the area in 1943 to begin construction of a large industrial complex. **In October 1944, the SS made Dora-Mittelbau an independent concentration camp** with more than 30 subcamps of its own.
- In 1943, prisoners at Dora-Mittelbau began construction of large underground factories and development facilities for the V-2 missile program and other experimental weapons. These so-called Weapons of Retaliation (Vergeltungswaffen), as the Germans called them, were constructed and stored in the underground facilities and bomb-proof shafts.
- Until the spring of 1944**, prisoners were kept mostly underground,** deprived of daylight and fresh air, and enclosed in unstable tunnels. The **mortality rate was higher** than at most other concentration camps. Prisoners too weak or ill to work were sent to Auschwitz-Birkenauor Mauthausen to be killed. In 1944, a compound to house

forced laborers was built above ground level south of the main factory area. Once full production of the missiles began in the fall of 1944, Dora-Mittelbau had a **standing prisoner population of at least 12,000**.

- Dora-Mittelbau had **a prisoner resistance organization**, which sought mainly to **delay production of the Weapons of Retaliation and to sabotage the rockets that were produced.** Prisoners suspected of sabotage were usually killed; more than 200 were publicly hanged for sabotaging production.
- In early April 1945, the Nazis began to evacuate the prisoners from Dora-Mittelbau. Within days, most of the remaining prisoners were sent to Bergen-Belsenin northern Germany. **Thousands were killed during death marches under horrendous conditions.** When American forces liberated Dora-Mittelbau in April 1945, only a few prisoners were still in the camp.

The V2 missile: (https://airandspace.si.edu/stories/editorial/vengeance-weapon-2-70th-anniversary-v-2-campaign)

- Vergeltungswaffe 2, "Vengeance Weapon 2" or V-2
- A **liquid-fuel rocket 14 meters** (46 feet) tall and **weighing almost 13 metric tons** (over 28,000 lbs) at launch, it traveled nearly **300 kilometers (200 miles) in five minutes.**
- Thanks to that velocity, the noise of it rushing through the air came after the sound of the explosion—if you were lucky enough to not be at the point of impact.
- Despite having a highly sophisticated and pioneering inertial guidance system using gyroscopes and an analog computer, the V-2 could barely hit a giant urban area part of the time, as the technology was not sufficiently advanced. It was an extraordinarily expensive way to drop a one-ton bomb on a city
- **10-20,000 concentration-camp prisoners who died in the SS camps connected to V-2 manufacturing**. That makes it a rare and peculiar weapon—more **than twice as many people died as the result of making it than did being hit by it**.
- he United States, the Soviet Union, Britain, and France were the real beneficiaries of Germany's vast and wasteful expenditure on rocket technology, and they did so by taking personnel as well as documents, missiles, and equipment, to their countries. Notably, the U.S., which got the military and engineering leaders of the V-2 program, Gen. **Walter Dornberger and Dr. Wernher von Braun, deliberately ignored or**

obscured their involvement with concentration-camp labor, as the Germans were too useful for the new missile arms race that ensued during the Cold War.

- The space launch vehicles and the intercontinental ballistic missiles of the world virtually all trace their origin, one way or another, to this rocket. It was the **first human-built object to reach space, during German test launches in 1943/44, and again in U.S. and Soviet firings after the war**.

Appendix H: How might we & POV statements

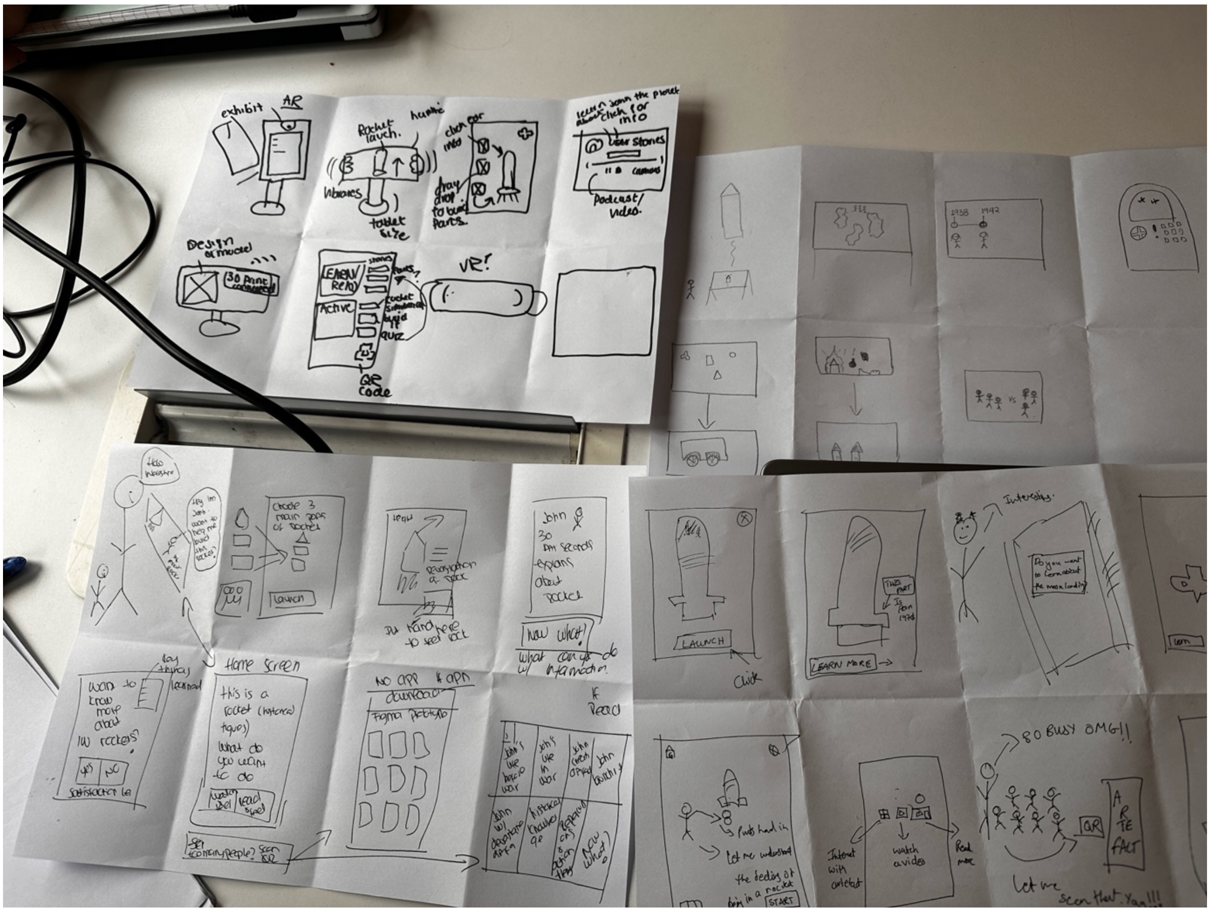
POV Statements

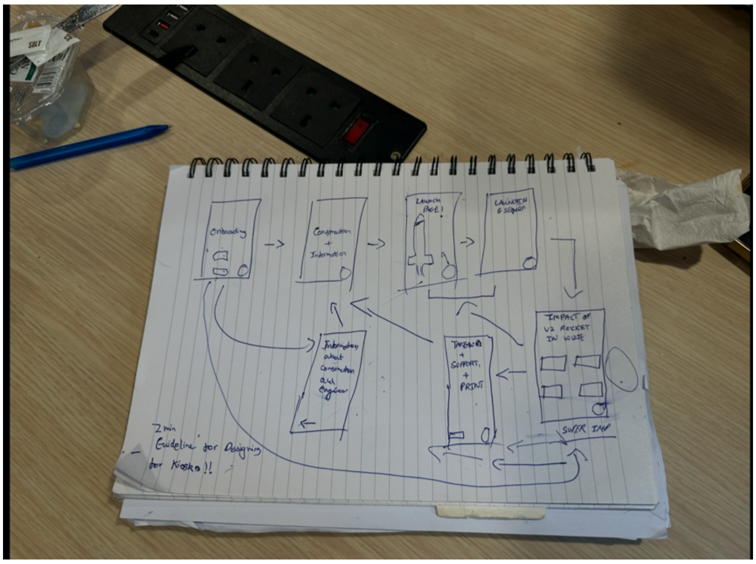
- Carl needs interactive elements that go beyond surface-level information because he is curious about in-depth **historical narratives**.
- Carl needs hands-on **learning opportunities** about the engineering behind artefacts because is interested in the technical aspects of historical designs.
- Tom needs **clear navigation** and signage in exhibits because he becomes **frustrated** when the layout is confusing, which detracts from his overall experience.
- Tom needs exhibits to be visually engaging because excessive text is **overwhelming** , especially for children

How Might We Statements

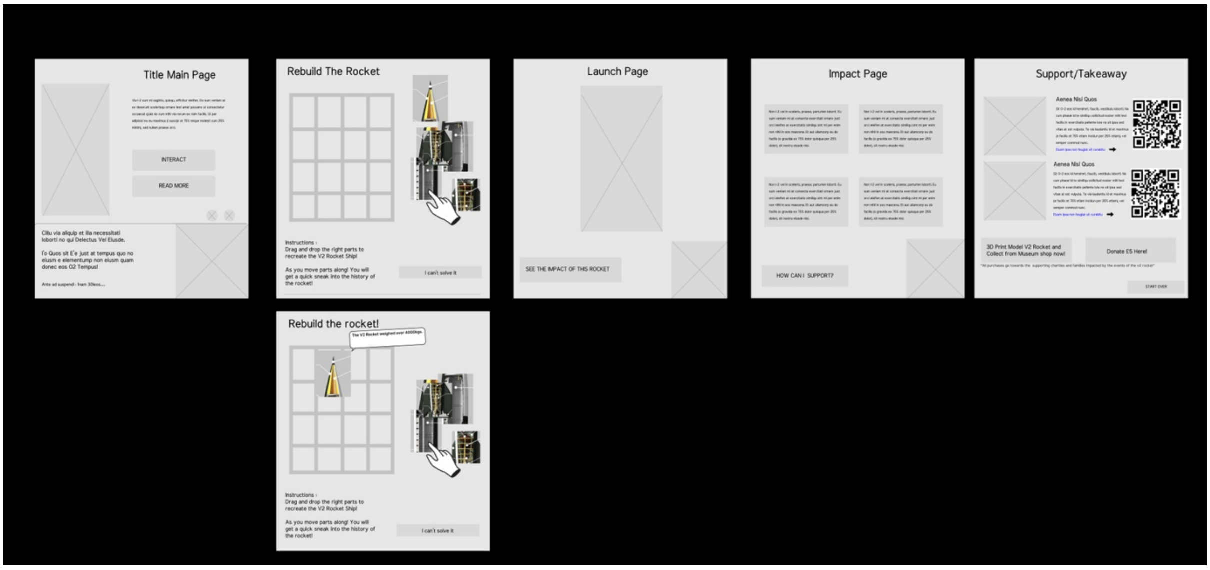
- HMW make exhibit information concise and visually engaging so visitors wont feel overwhelmed by reading?
- HMW create a right balance between **passive and interactive engagement**, suited for different learning preferences of the visitors
- HMW depict the **emotional and historical** impact of war in order to make visitors resonate with it?
- HMW use real stories and persons to enhance historical understanding so that visitors become more aware and connect deeper with the past?

Appendix I: Sketching

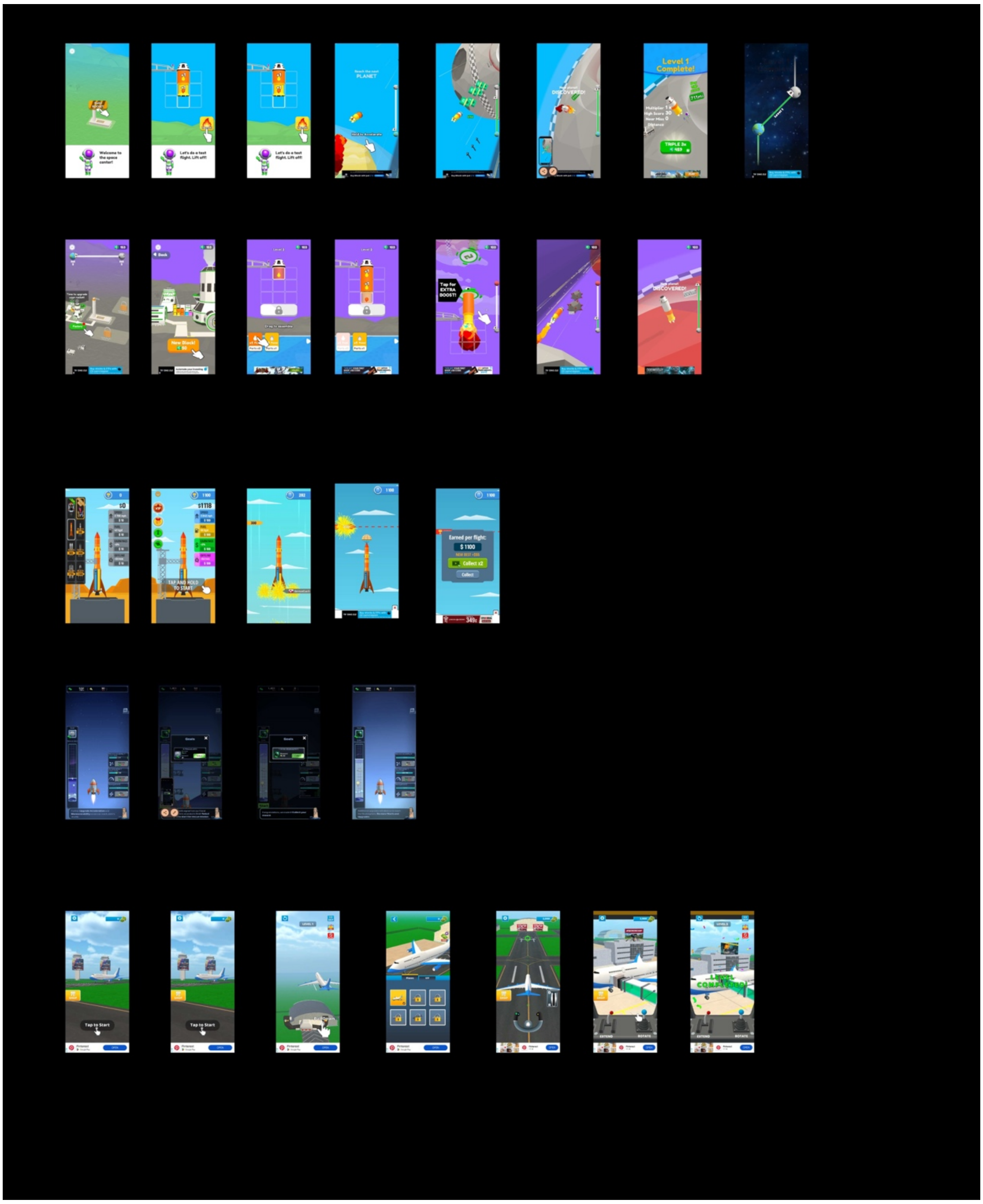




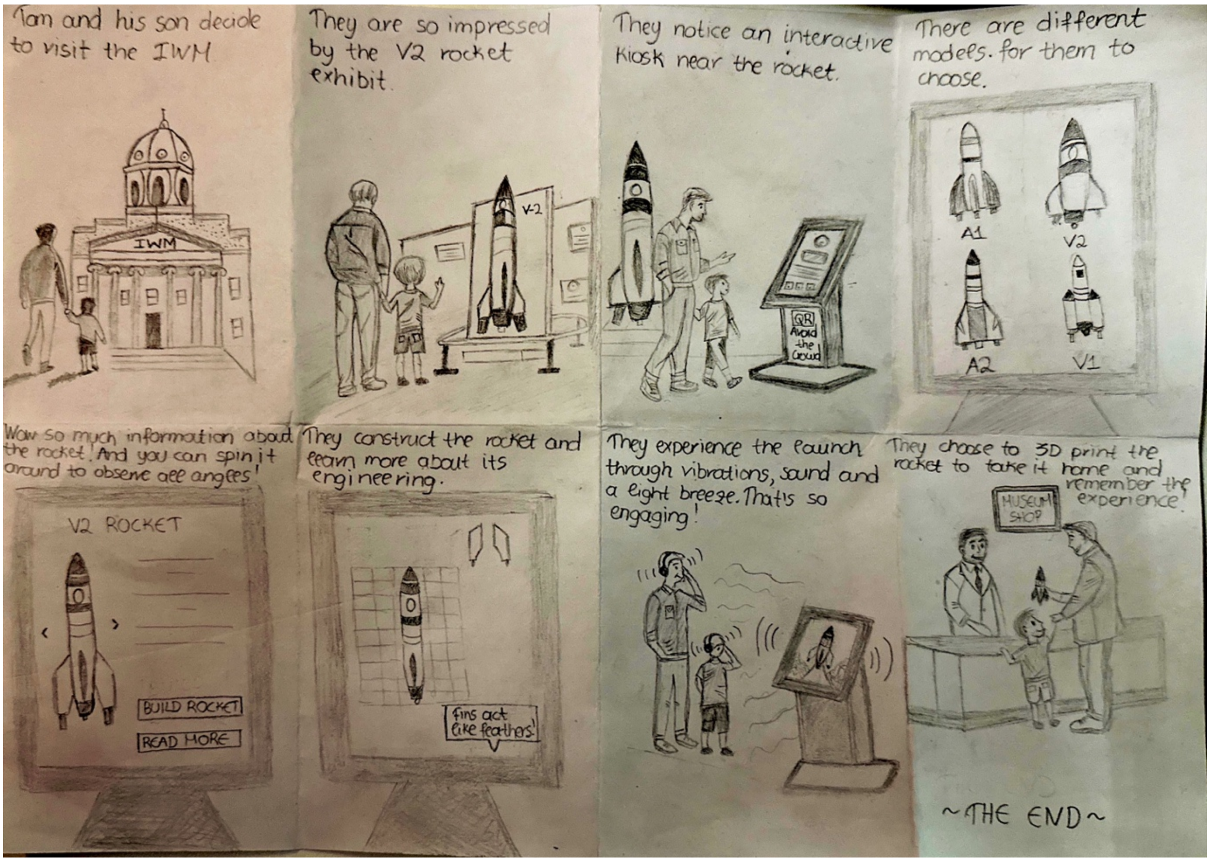
Appendix J: Lo-fi-Wireframes



Appendix K: Competitive benchmark



Appendix L: Storyboard



Appendix M: Icons, Colours, Typography

Colours

Typography

Font used on IWM : Identikal Sans

Font we can use that is the same Family : Meera Inimai

Official Logo

Iconography : Simple Design Sytem

Appendix N: Evaluation Analysis

Evaluation Analysis

Part 1

Overall design was positive, content was engaging but overwhelming. Instructions were clear but unintuitive. Experience would be positive but we must highlight more the sensory part.

🚶 NEXT STEPS

- Enlarge CTA's, specially the one that incites the user to build
- Content must be summarized, specially the information about the rocket and the reading part
- Drag and drop must be available with all parts
- Create a fully functional prototype (with possibility of skip, and add, etc)
- Enlarge the instructions (for building and for interacting)
- Change the format of the grid to help participants understand they must build there (ie., a grid shaped like a rocket)
- Break reading section into two
- Break donation part into two
- Highlight sensory experience more!

😮First Impressions

- Participant enjoyed the layout but content was too overwhelming
- He understood the objective of the rocket
    - "To get knowledge about rocket and built knowledge through interactions"

- He was unsure were to click to start building, stating at the CTAs were too smalls
- The drag and drop was interesting but little interactive as participant was not able to drag as his choice
- Participant did not understand the that there was a reading flow. Once explained he recommended it dividing it into two parts in order to ease the focus of the user.

🧨Experience (Usability & Interaction)

- The main feature participant kept insisting that we can optimize to make it more engaging is the content
- The design of the letters was intuitive and unattractive
- The grid is difficult for him to comprehend
    - "Is not really intuitive that you need to build the rocket with the grid"

🎨Content and Design

- Participant enjoyed the fact that we provide information of the rocket, and appeals however it is too hard for him to digest
    - Overall information because he is interested in the mass
- Instructions of deploy are clear but easy to miss
- He initially did not read the instructions of deploy, once reading them he was highly surprised and believed it would definitely change his experience in a positive manner
- Participant got confused with the last screen. Suggesting we shoudl split the screens into two as for him - printing a 3d model and donating to charity are very different concepts.
- Test in the reading section was too much

First Impressions:

- Participant found the idea very interesting - liked the fact that you can choose from 4 different rockets
- Found reading content a bit overwhelming
- Found design simplistic
- Excited about the building idea - found instructions clear and helpful

Part 2 & 3

First Impressions:

- Participant found the idea very interesting - liked the fact that you can choose from 4 different rockets
- Found reading content a bit overwhelming
- Found design simplistic
- Excited about the building idea - found instructions clear and helpful

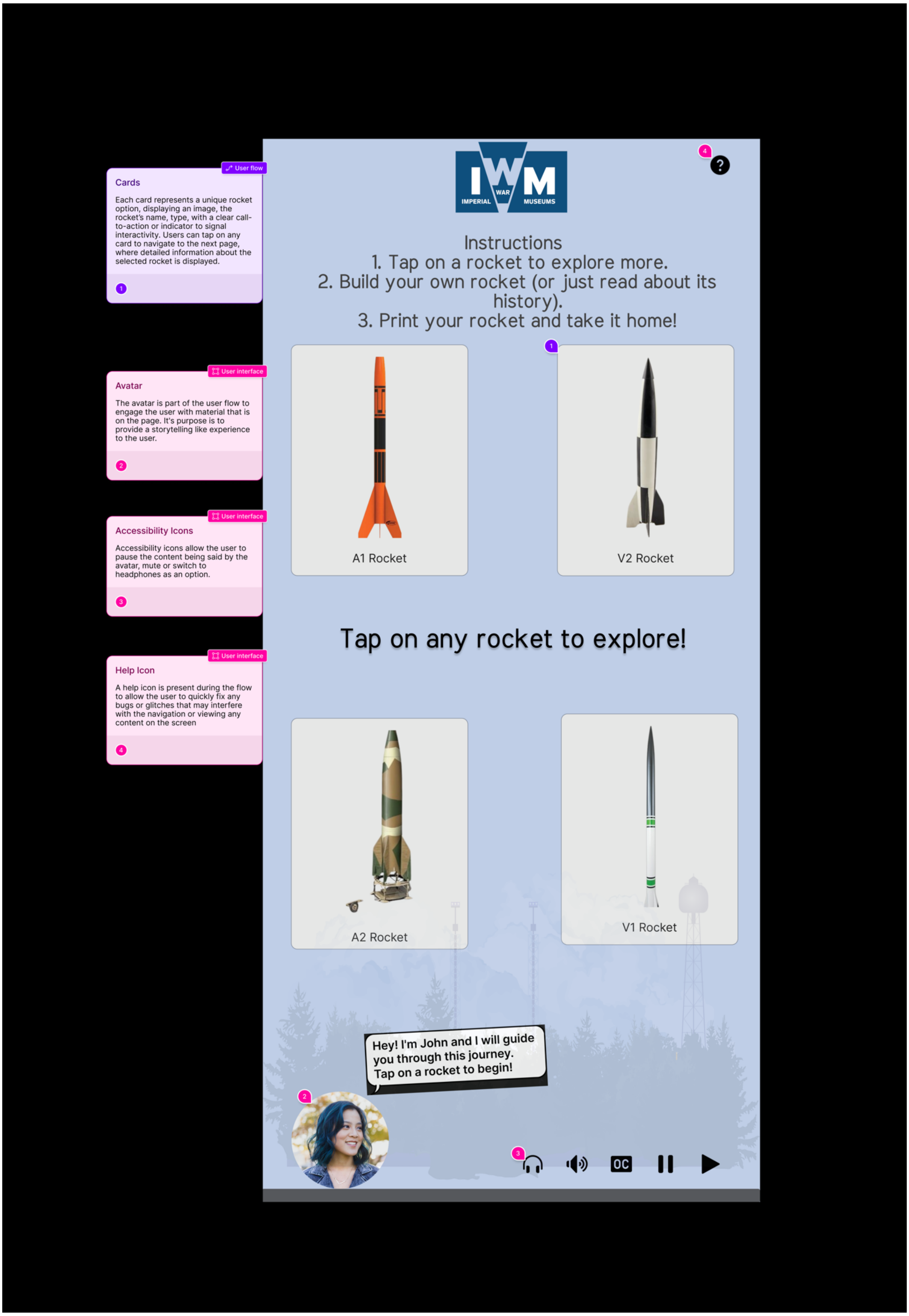
Experience

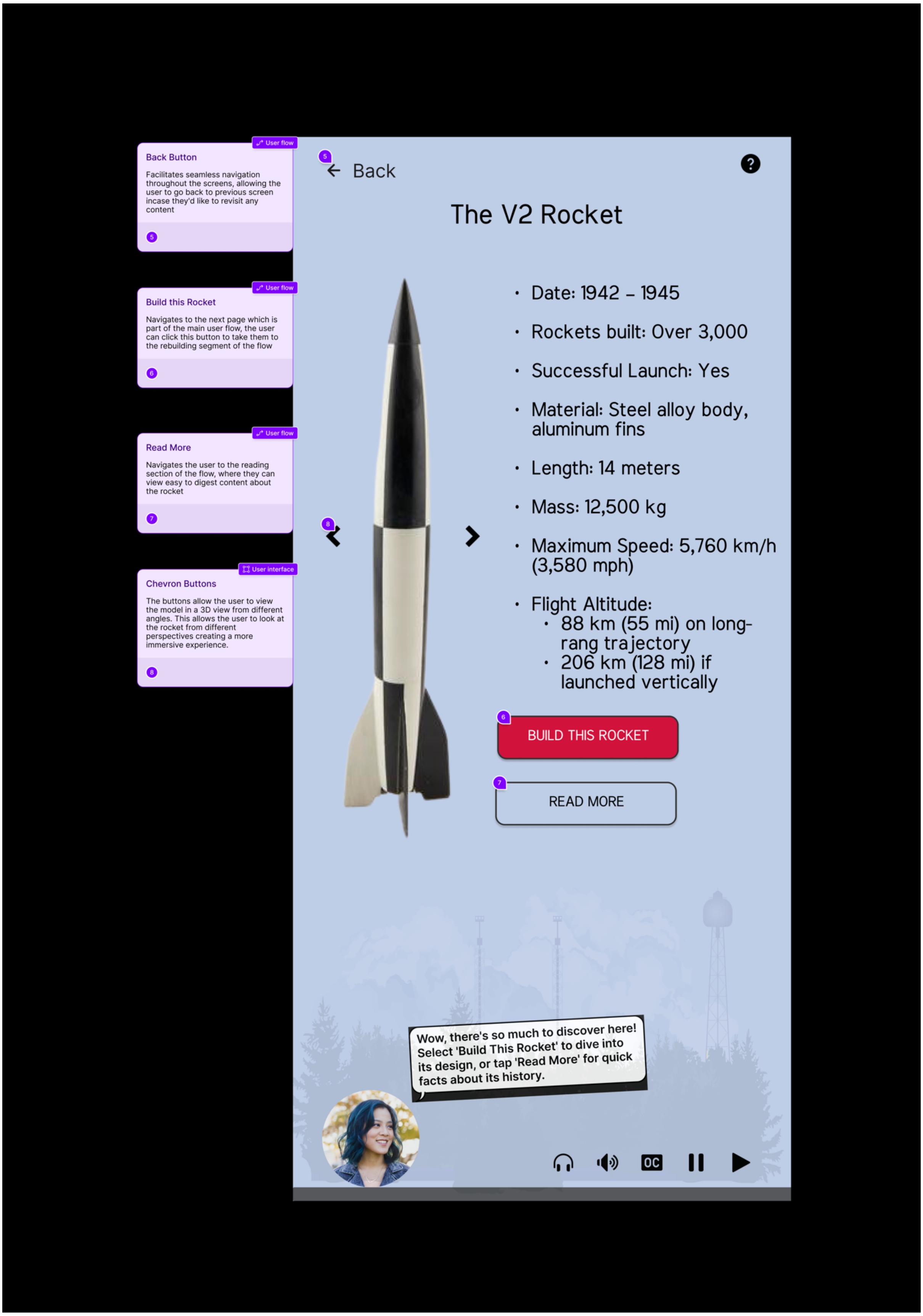
- When he went to read more and then back he expected the back to lead to the main rocket not the first page - by instinct he wouldn't go to the building page through the reading page
- He tries to start the construction before the pieces appear
- He said that pieces are in order so its easy
- Arrangement of information on the reading page
- Skip button didn't work
- Start - construct button
- Dragging the parts seems very smooth - liked the drag and drop
- Add skip button in the middle of construction

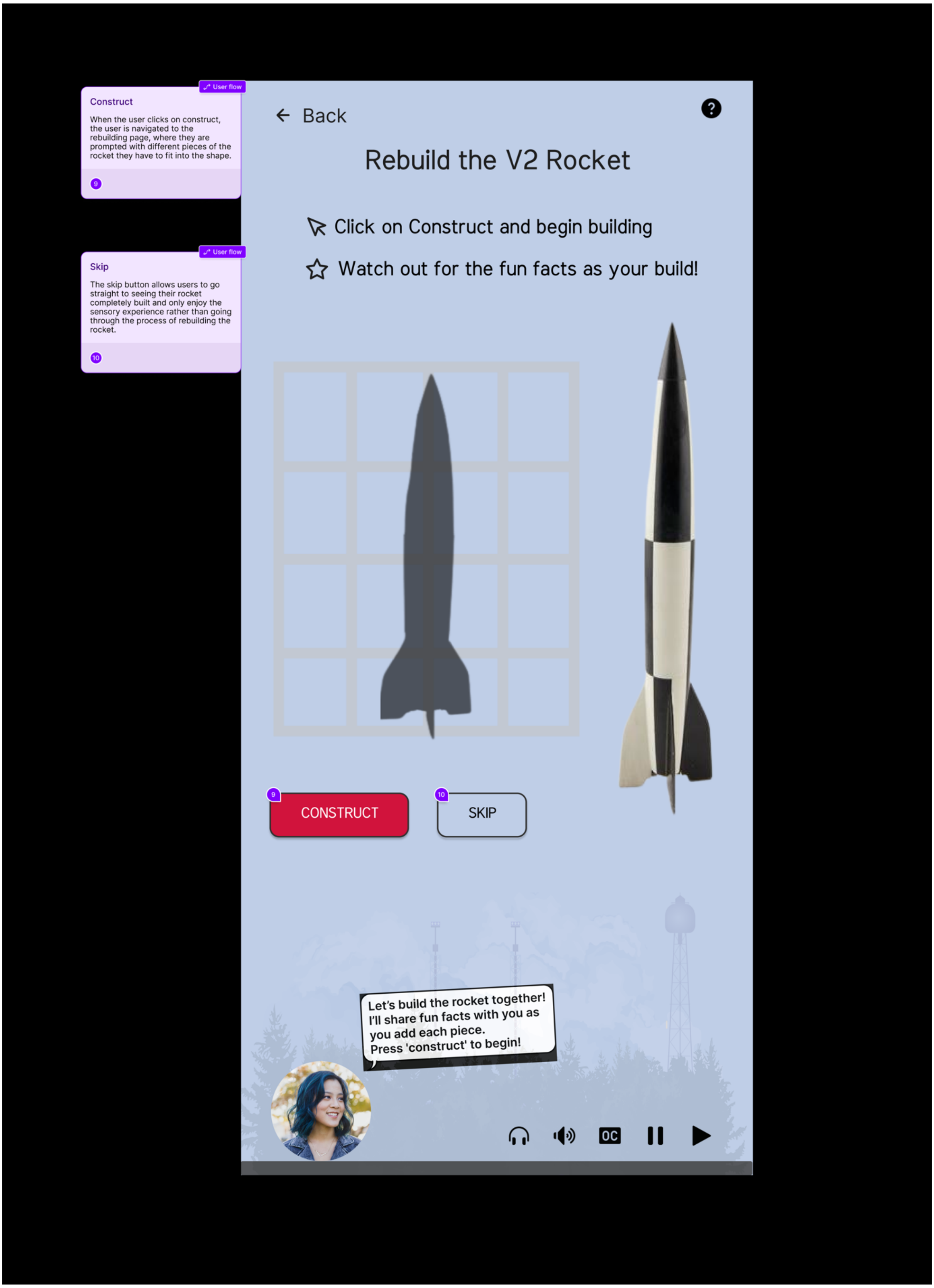
Content and Design

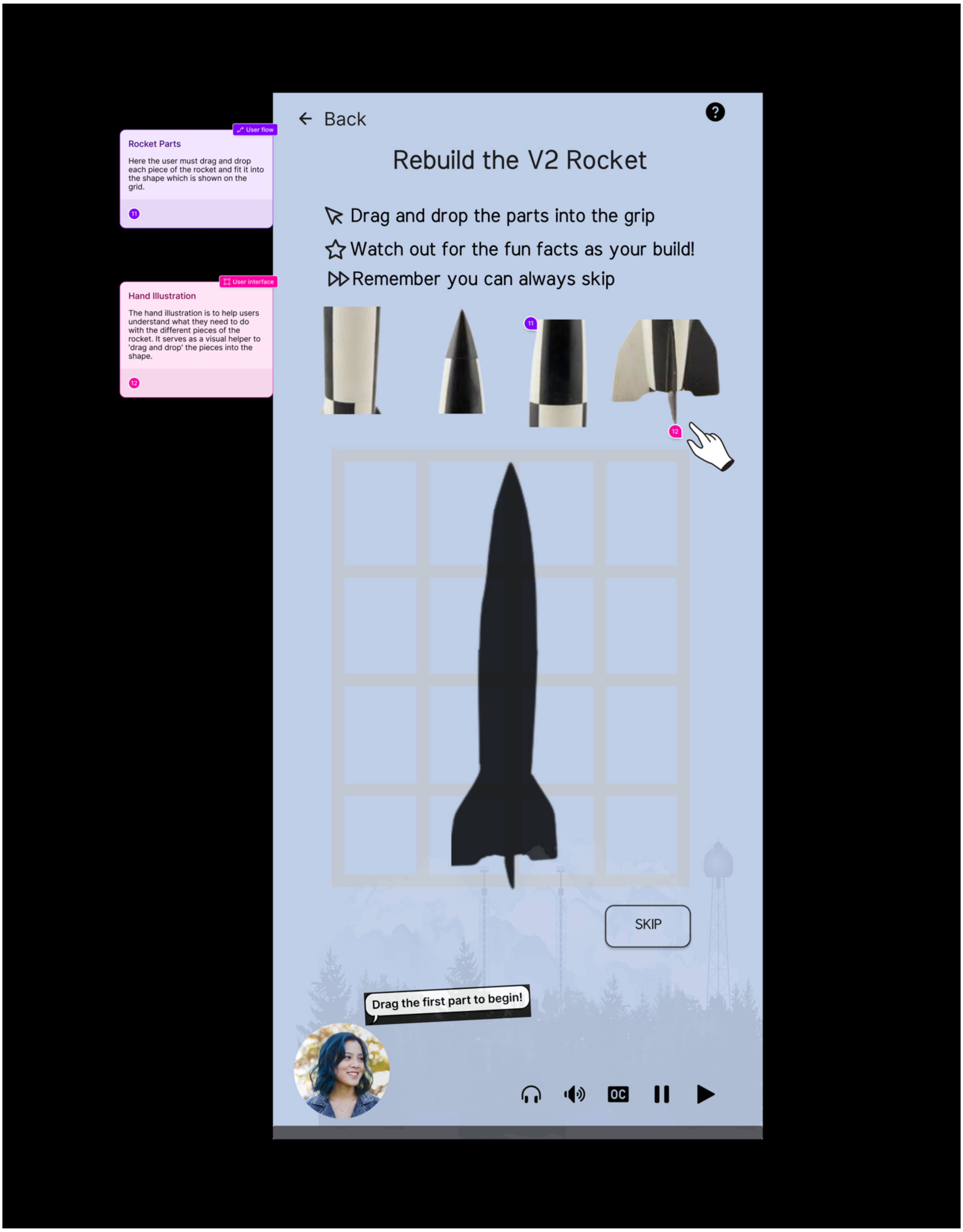
- Would like to see and learn internal parts of the rocket - where the engine is positioned etc
- Would like to see a combination of fun facts and engineering facts in the interactive flow
- Liked all the information and enhanced knowledge of rockets
- He would like to press on information boxes and to enlarge them because he couldn't focus - more things to pop up
- He would like smoother transition between the screens
- He is interested of the 360 view of the rocket (arrow view - examine from different points)

Appendix O: Annotated Wireframes




User flow
Back Button
Facilitates seamless navigation throughout the screens, allowing the user to go back to previous screen incase they'd like to revisit any content
5
User flow
Build this Rocket
Navigates to the next page which is part of the main user flow, the user can click this button to take them to the rebuilding segment of the flow
6
User flow
Read More
Navigates the user to the reading section of the flow, where they can view easy to digest content about the rocket
7
User interface
Chevron Buttons
The buttons allow the user to view the model in a 3D view from different angles. This allows the user to look at the rocket from different perspectives creating a more immersive experience.
8
Back
The V2 Rocket
Date: 1942 – 1945
Rockets built: Over 3,000
Successful Launch: Yes
Material: Steel alloy body, aluminum fins
Length: 14 meters
Mass: 12,500 kg
Maximum Speed: 5,760 km/h (3,580 mph)
Flight Altitude:
88 km (55 mi) on long-rang trajectory
206 km (128 mi) if launched vertically
BUILD THIS ROCKET
READ MORE
Wow, there's so much to discover here! Select 'Build This Rocket' to dive into its design, or tap 'Read More' for quick facts about its history.
CC


User flow
Construct
When the user clicks on construct, the user is navigated to the rebuilding page, where they are prompted with different pieces of the rocket they have to fit into the shape.
9
User flow
Skip
The skip button allows users to go straight to seeing their rocket completely built and only enjoy the sensory experience rather than going through the process of rebuilding the rocket.
10
Back
Rebuild the V2 Rocket
Click on Construct and begin building
Watch out for the fun facts as your build!
9
CONSTRUCT
10
SKIP
Let's build the rocket together! I'll share fun facts with you as you add each piece. Press 'construct' to begin!
CC


User flow
Rocket Parts
Here the user must drag and drop each piece of the rocket and fit it into the shape which is shown on the grid.
11
User interface
Hand Illustration
The hand illustration is to help users understand what they need to do with the different pieces of the rocket. It serves as a visual helper to 'drag and drop' the pieces into the shape.
12
Back
Rebuild the V2 Rocket
Drag and drop the parts into the grip
Watch out for the fun facts as your build!
Remember you can always skip
SKIP
Drag the first part to begin!
CC

User flow

Deploy

Upon clicking deploy the user will navigate to the next screen where they will experience the sensory/ visual experience of the rocket launching.

13

← Back

?

Congratulations! Ready to Deploy your Rocket?

Follow the instructions to get the full experience

1. Put on headphones to hear the sounds
2. Grab the handle below to feel
3. Relax and enjoy the immersive experience

*Be aware that you will feel a light burst of air coming out during simulation.

13

DEPLOY

Amazing work! You're about to experience the thrill of launching a rocket.
Grab the handle and headphones and let's launch!

CC


User flow
End of the flow
This is the end of the user flow, where the user can order a 3D print of the model rocket they created or choose to donate to the museum via scanning the QR code.
14
User flow
Start over/ Automatic Reset
The start over button allows the user to go back to the starting screen and restart the entire flow.
Additionally This screen automatically resets after 10s to allow the next user to enjoy the immersive experiences. We've set this timer according to Kiosk Guidelines at museums.
15
Back
TAKE YOUR 3D ROCKET HOME
Print your 3D model and pickup from the museum shop right away!
ORDER
SUPPORT THE MUSEUM
Scan the QR Code to donate
Charity 1
Charity 2
START OVER

User flow

Keep reading

Navigates the user to the next page with more engineering based facts that the user can read through

16

← Back

?

General Facts

V2 was the first human-made object to cross the Kármán line (100 km above sea level), the recognized boundary of space.

The V-2's nose cone, housing a 750 kg Amatol explosive charge, was crucial for its aerodynamic stability and effectiveness as a weapon.

The V-2's test rockets had a black and white cherboard pattern for engineers to track roll and spin during flight!

To distill the necessary fuel alcohol for a single V-2 launch, 30 tonnes of potatoes were required, straining wartime resources significantly.

BUILD THIS ROCKET

16

KEEP READING

These facts are interesting why don't you try building this rocket?

OC

Appendix P: Clickable Prototype Link

https://www.figma.com/proto/oWSwQuIvFipFkyHK5xRpPf/IXD-Final-Submission?page-id=0%3A1&node-id=4-3694&node-type=canvas&viewport=948%2C752%2C0.04&t=u2PGyxaw0rMmXLUv-1&scaling=scale-down&content-scaling=fixed

Appendix Q: OneDrive Folder -> Interview Recordings & Transcripts

Submission Raw Data File