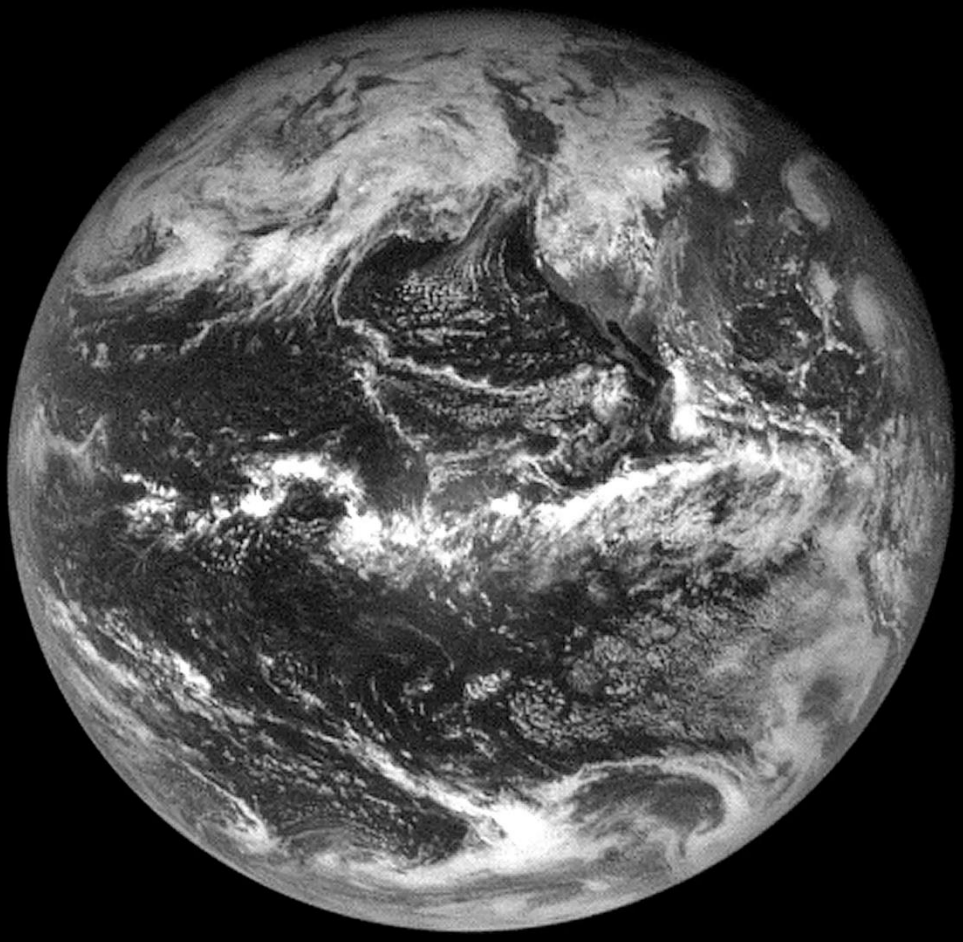


FROM EARTH TO ORBIT

PROCESS BOOK

Adrien Clément
Fletcher Collis
Samuli Näppi

Project Overview

Falcon – Heavy

Falcon Heavy is a heavy-lift launch vehicle developed by SpaceX. First launched in 2018, it is currently one of the most powerful operational rockets in the world. Its successful missions and prominent role in modern commercial spaceflight made it a key source of inspiration for this project.

Description

This project explores the evolution of space exploration from 1957 to 2039 through an interactive website that visualizes global rocket launches and highlights key moments in space history. Using a dataset called "*Historical Space Launches 1957–2039*" from Hugging Face, originally scraped from spacelaunchnow.me, we built a dynamic platform that transforms the data into an engaging, user-friendly narrative.

Motivation

Our motivation came from a desire to present the history of the space race in a way that is both informative and visually immersive. Rather than relying on static charts or timelines, we sought to create a tool that allows users to explore the history of the space race interactively, revealing patterns in launch activity, technological advancement, and geopolitical influence.

Creative process

After discovering the dataset, we saw an opportunity to build something that not only showcases the raw data but also tells the broader story of human ambition in space. The diversity of launch providers, outcomes, and time periods gave us a strong foundation to design a compelling visual experience that educates and inspires.

Evolution of the project

From Concept to Execution

Our development process began with an exploration of compelling space-related visualizations, particularly NASA's asteroid viewer, which initially sparked our interest in 3D space data. We began by pursuing the idea of creating a 3D visualization. However, we quickly encountered significant obstacles: most of the datasets we found were either too complex, requiring specialized software and large amounts of disk space, or had already been thoroughly analysed by the space agencies that published them. This led us to pivot while still staying true to our space-focused theme.

We eventually discovered a dataset documenting global space launches from 1957 to 2039 on Hugging Face. This presented a unique opportunity to tell a story that merged technological advancement with geopolitical competition.

The dataset contains launch logs including the date of launch, provider name, rocket name, mission status, and launchpad. We initially analysed it to uncover potential patterns and trends: which countries and providers were most active in certain decades, how launch activity evolved over time, and how success rates changed across different eras. From this exploration, it became clear that a temporal and geographic representation would be the most natural and impactful way to present the data.

This insight led us to our core idea: building an interactive world map that could visually represent rocket launches over time.

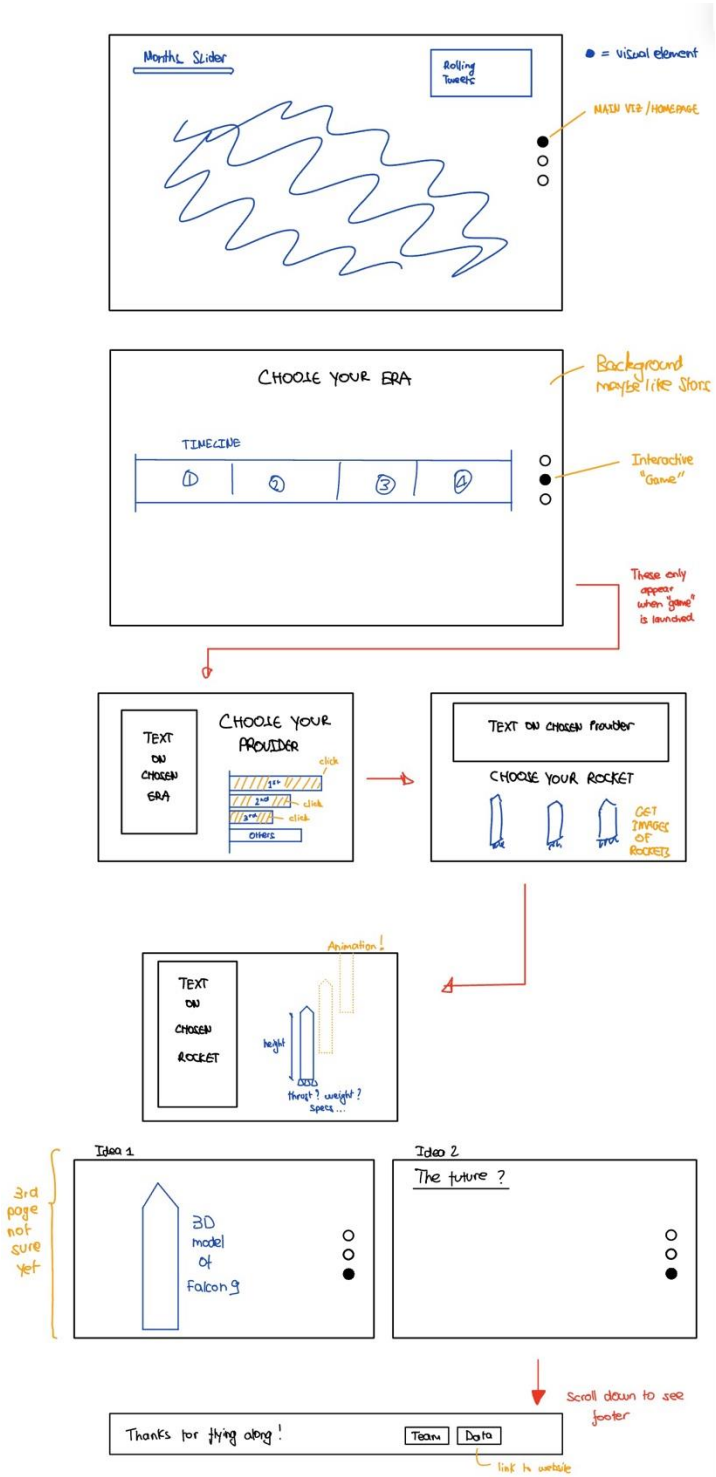
We also wanted to make the experience as engaging as possible, we focused on creating a platform that users could explore freely, allowing them to interact with the data at their own pace and uncover stories based on their curiosity.

STARSHIP

Starship is SpaceX's fully reusable launch vehicle, designed to carry both crew and cargo on long-range missions to destinations like the Moon and Mars. Its bold design and ongoing testing phase made it a fitting reference during the early stages of our project.

Initial sketch

Our initial layout sketch captured the core concepts for the website. The homepage was designed to prominently feature our main visualization, serving as the focal point of the site. From there, users would navigate to a second page that introduced an interactive "game," allowing them to explore different eras, providers, and rockets in space history. We imagined a third page, with an interactive 3D model of a rocket for example.



Layout evolution

Although we aimed to stay true to our original concept and sketch to preserve a shared vision and streamline collaboration, several key modifications were made throughout development.

Firstly, the originally planned third page, featuring a 3D rocket model or similar element, was replaced. We realized it disrupted the overall flow of the site, so we opted instead for a clean, professional title page to provide a strong introduction to the project.

Secondly, we replaced the planned carousel wheel navigation with a smoother, more intuitive scrolling mechanism to enhance the user experience.

The layout of the interactive game also evolved during development. We added a dedicated title screen that invites users to begin the experience. To retain a 3D element on the site, we incorporated a fully interactive 3D model of an astronaut to this. Additionally, we refined how content is displayed: when users select an option, such as a specific era, the related information now appears immediately within the same section, rather than in the next step, creating a more intuitive and seamless interaction.

Finally, we added a visual component when a rocket is selected, displaying the number of launches and distinguishing between successful and unsuccessful missions, enriching the educational value of the experience.

Visualizations

Main visualization

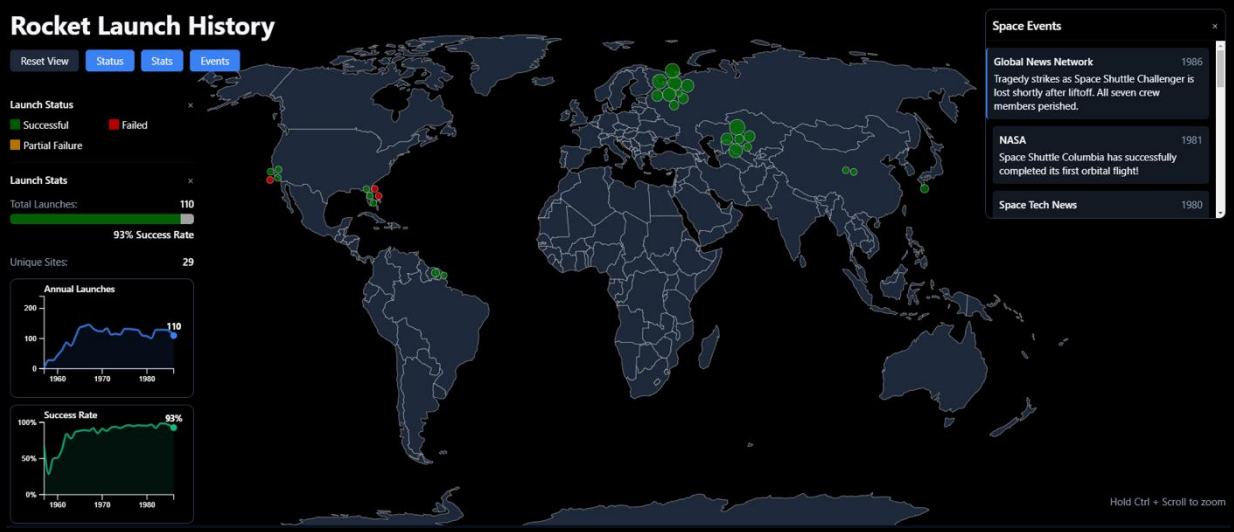
Mapping launch locations over time offered a compelling way to showcase both the temporal and geographic dimensions of our dataset. The dataset included launchpad names but lacked coordinate data, so we used the Google Maps API to geocode each launchpad, verifying and adjusting locations when necessary. Offshore sites for which coordinates couldn't be reliably obtained were excluded from the final map.

Each launchpad was represented by a circle on the map, with size indicating the number of launches and color representing the most common outcome : success, failure, or partial failure. A timeline slider allowed users to filter launches by year and dynamically update the map to reflect changing space activity over time.

To give users more control and responsiveness, we implemented a dual timeline system: one view for yearly data and another for monthly resolution. The monthly scale was especially useful during densely packed periods like the Apollo missions, while the yearly view offered a broader historical overview. We also added speed settings modeled after YouTube's playback interface, allowing users to adjust playback in fine-tuned increments down to 0.05x.

To enrich the visualization with narrative and historical context, we introduced a stream of short, tweet-style messages (limited to 280 characters) that appear in a scrolling window. These messages highlight key events and milestones in space history. Although generated with the help of AI, each was manually fact-checked for accuracy. Additionally, we incorporated text-based annotations on the map to mark different spaceflight eras.

Finally, to make use of the relatively empty Pacific Ocean area, we displayed summary charts there. These visualized broader trends such as Cold War-era launch growth, post-war slowdowns, and the boom in commercial launches after 2000. We also illustrated how mission success rates improved steadily, eventually stabilizing around 90%.



Main visualization - Challenges

A major challenge was managing overlapping launchpads in dense areas like Cape Canaveral. Grouping them into complexes led to visual inconsistencies, so we instead used a force simulation to gently separate overlapping circles. While this preserved interactivity, it caused the positions to shift slightly between years, an issue that became noticeable during animated timeline playback.

We considered fixing each launchpad's position, but this would have required planning for worst-case density, resulting in awkward empty areas during quieter periods. Ultimately, we chose visual clarity over strict positional consistency.

Due to time constraints, we had to forget features like a heat map for visualizing launch density and a zoomable interface for exploring clusters. Both would have improved the experience but required moving beyond our SVG-based system to more complex mapping tools.

Despite these trade-offs, the final visualization met its goals: providing a clear, engaging, and historically grounded view of global space activity.

Interactive experience

Once the main visualization was well underway, we began thinking about how to make the website more immersive for users. During a team brainstorming session, we developed the concept of an interactive "game" like experience.

This part of the website allows users to explore space activity by era, actor, and rocket model through an intuitive, staged interface.

Era Selector: Users begin by selecting one of four major space eras. Hovering reveals a brief description of each era's significance.

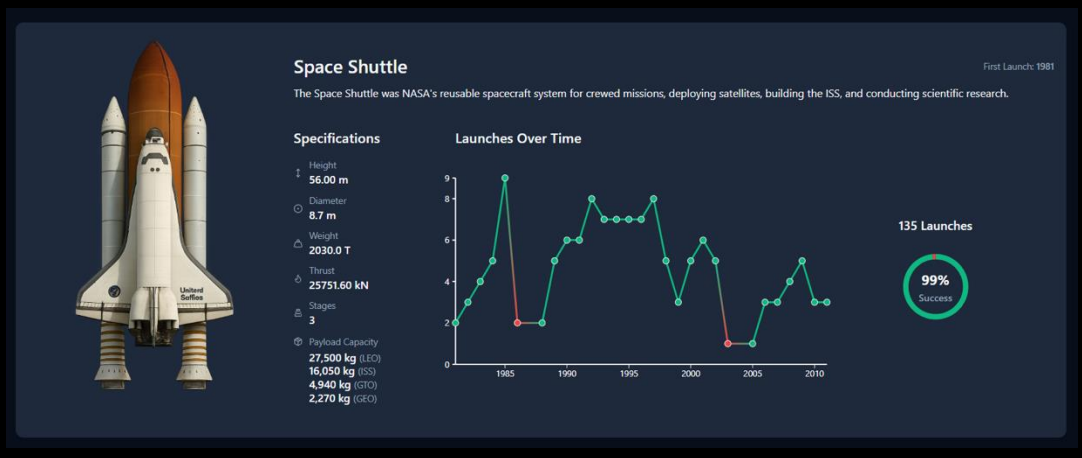
Actor Selector: Once an era is chosen, users can see a bar chart of the main space actors from that period. Instead of using raw provider names from the dataset, which often listed subdivisions of larger governmental agencies, we created a mapping system that groups related providers under unified actor names (e.g., combining NASA sub-agencies or various Russian entities).

PROTON

The Proton rocket family has served as Russia's heavy-lift launch system, placing large payloads into orbit including interplanetary missions and modules of the ISS. Proton's legacy of carrying weighty missions made it a symbolic parallel to the demands and scope of our own main visualization.

To maintain clarity and relevance, we only display actors who together represented 97% of the launches during the selected era. This threshold ensured the chart remained focused while still representative.

Rocket Selector: Selecting an actor reveals its top three rockets, based on usage. Clicking a rocket opens a detailed card displaying its specifications and launch history. We also added responsive design features like hover effects to improve user experience.



Interactive experience – Challenges

One key challenge was balancing user choice with manageable complexity. Every new selectable actor or rocket expanded the visualization's branching paths, increasing both development load and cognitive load for the user. To keep it streamlined, we limited each era to its top 3 actors, and each actor to 3 main rockets.

Another challenge was the dataset's limited contextual information. It provided raw launch data but lacked details about eras, space agencies, and rocket specs. We supplemented this with extensive manual research to build a meaningful narrative.

To give each rocket a consistent visual identity, we generated images using AI-based image generation. While helpful, this method was labor intensive and had drawbacks: generated visuals sometimes included unwanted elements like text or flags, leading to inconsistencies in image quality we couldn't always resolve.

Contributions

Throughout the project, our team prioritized open and effective communication to ensure we remained aligned with our goals and shared vision for the website. We held numerous in-depth meetings and discussions that helped clarify objectives and support collaborative decision-making. Each member contributed their unique strengths, whether in design, coding, content development, or testing, allowing us to divide tasks efficiently and support one another throughout the process. This strong teamwork enabled us to adapt quickly to challenges and changes, ultimately resulting in a cohesive and polished final product that reflects our collective effort and creativity, **a project we are truly proud of !**

Team Members

Each team member contributed equally to the project, bringing their own unique strengths to the table.

Adrien Clément

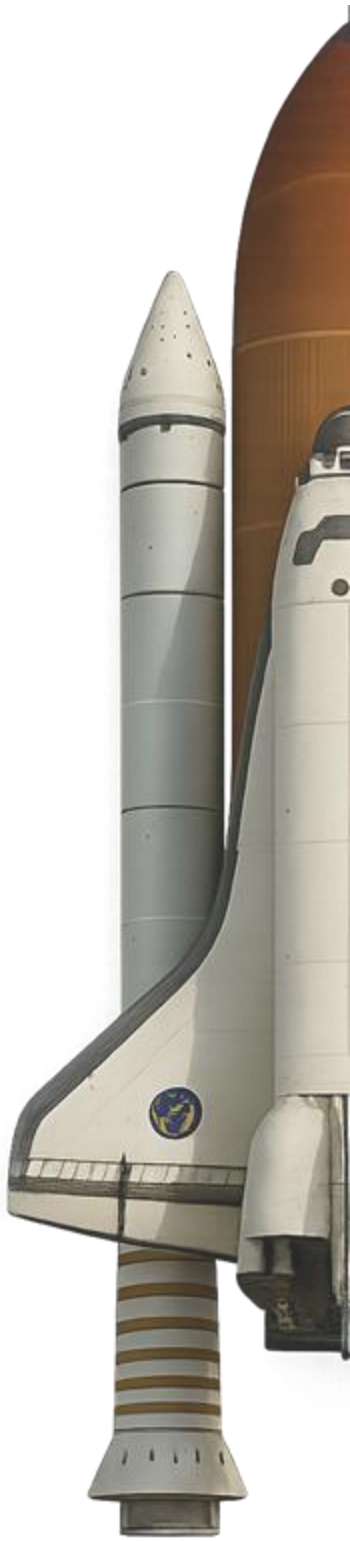
I led the data exploration that shaped our visual and interactive logic, defined the mapping strategy, and contributed to the barplot design. I was also in charge of the rockets section—researching specs, hardcoding data, and helping integrate it into the site. Additionally, I built the title page and curated all rocket visuals using AI-generated images to ensure visual consistency.

Fletcher Collis

I led the initial dataset exploration, helping shape the project's direction and vision. I was central to the concept and design of the interactive game, created the final game layout and rocket details page, and hardcoded all data on eras and providers, a time intensive task. I also integrated the 3D astronaut model to enhance immersion. Additionally, I contributed significantly to this report, both in visual design and writing much of the content.

Samuli Näppi

I served as the primary developer and built the core technical architecture of the application using React and TailwindCSS for responsive design across mobile and desktop devices. I implemented the context providers for state management and created the progressive disclosure system that guides users through data exploration. I designed and built the main visualization encompassing the D3.js world map with force simulation positioned launch sites, interactive tooltips, dynamic statistics panel, space events feed, and timeline slider with animated playback controls. Additionally, I worked on the chart components and geocoded all launchpad locations using Google Maps API.



Space Shuttle

The Space Shuttle serves not only as a technological milestone in space exploration but also as a powerful symbol of collaboration. Operated by NASA from 1981 to 2011, it supported a wide range of missions—from deploying satellites to assembling the International Space Station—many of which required cooperation between nations, agencies, and scientific communities.

Acknowledgments

We acknowledge the use of ChatGPT for enhancing the clarity and precision of the text in this paper, our website and for translation support. It was also used to help with code debugging and image generation. However, ChatGPT was not involved in data analysis or in deriving the project's conclusions.

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Title page image :

NASA's OSIRIS-REx Snaps Pictures of Earth and the Moon

Data used :

Historical Space Launches 1957–2039 – HuggingFace

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