The Space Shuttle Challenger Disaster:
When Science and Bureaucracy Collide

Sarah Hollingsworth

Data 605

Final Presentation

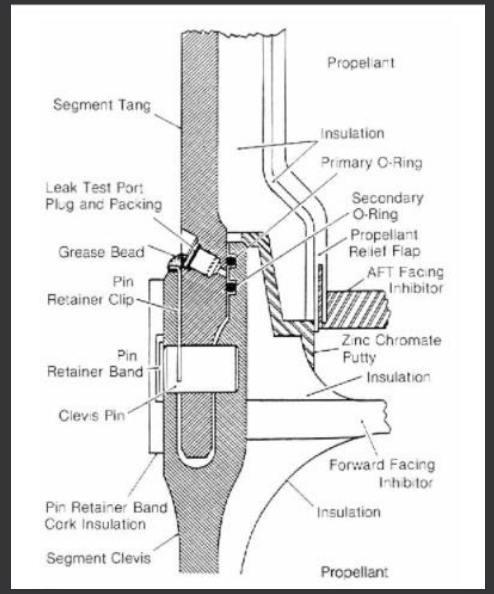
Franklin University

The Space Shuttle Challenger Disaster

- January 28th, 1986
- Astronauts: Francis R. Scobee, Michael J. Smith, Judith A. Resnik, Ellison S. Onizuka, Ronald E. McNair, Gregory B. Jarvis, Sharon Christa McAuliffe
- Primary Cause: Failure of the O-Ring Joint Seal, resulting in the structural failure of the hydrogen tank, ultimately igniting the hydrogen fuel in the tank
- Flight Duration: 73 seconds
- Flight Readiness Review: No mention of the previous O-Ring incidents or the impact temperature had on O-Ring performance were present in the flight readiness review documents
- Launch/No Launch Meeting: Prior to launch Morton-Thiokol engineers expressed their concerns about the O-Ring performance in cold temperatures. However, NASA officials challenged their analysis of the data and asked them to prove the O-Rings would fail, rather than not fail. This caused the engineers to question their conclusions and they could not, with 100% confidence, verify the O-Rings would fail. NASA officials chose to override the concerns of the engineers and went ahead with the launch.

Cause of the Accident: Failure of the O-Ring Joint Seal

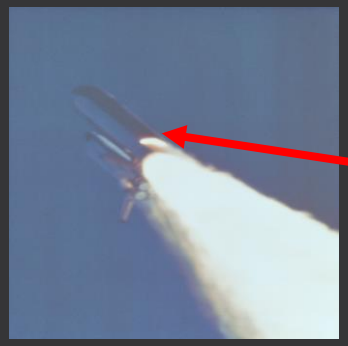
- What is the O-Ring?
  - A circular rubber gasket which seals the Solid Rocket Booster, forcing the propellant out the nozzle of the Solid Rocket Booster
- Timeline
  - At 0.678 seconds into flight, a puff of gray smoke is seen in the vicinity of the aft field joint. Suggesting the grease, joint insulation, and rubber O-Rings in the joint seal were being burned.
  - At 59.262 seconds into flight, a plume appeared on the right Solid Rocket Booster in the area of the aft field joint.
  - At 73.137 seconds into flight, the rotating right Solid Rocket Booster impacted the inner tank structure and the lower part of the liquid oxygen tank, causing both structures to fail.



United States Congress (1986). [Solid Rocket Motor cross section] [Diagram] U.S. G.P.O

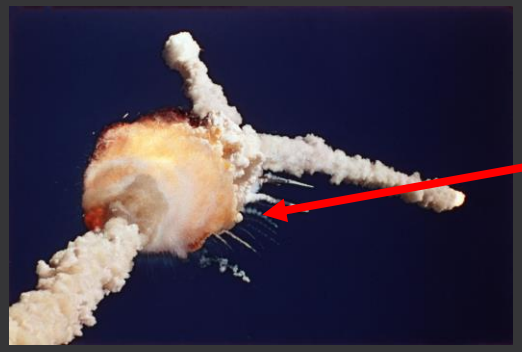
0.678 seconds

NASA Image



59.262 seconds

NASA Image



73.137 seconds

AP File Photo

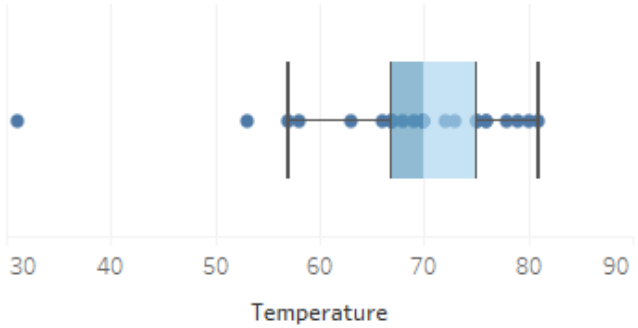
The Space Shuttle Challenger Disaster: When Science and Bureaucracy Collide

Shuttle
All

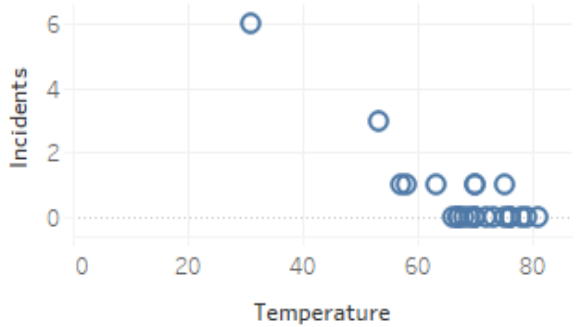
Year

Measure Names
Additional Delay
Time on Pad

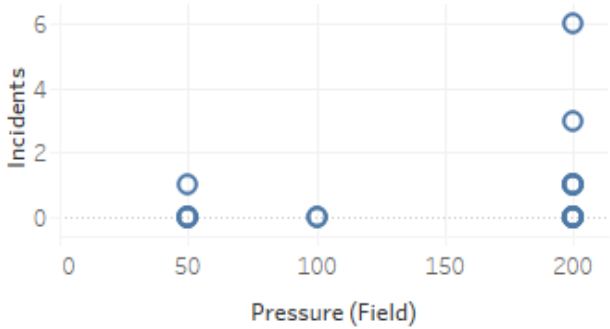
Temperature at Launch



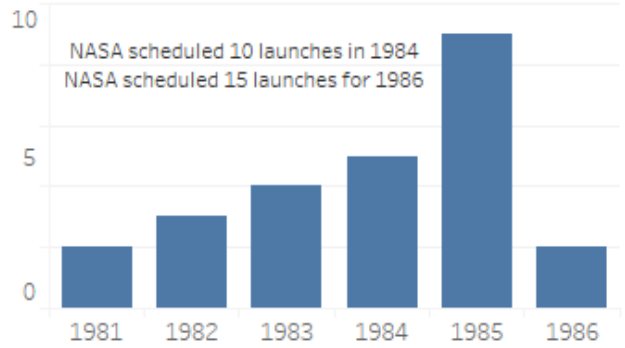
Temperature vs O-Ring Erosion Incidents



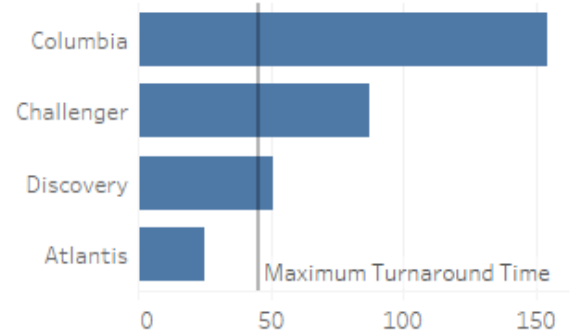
Pressure vs O-Ring Erosion Incidents



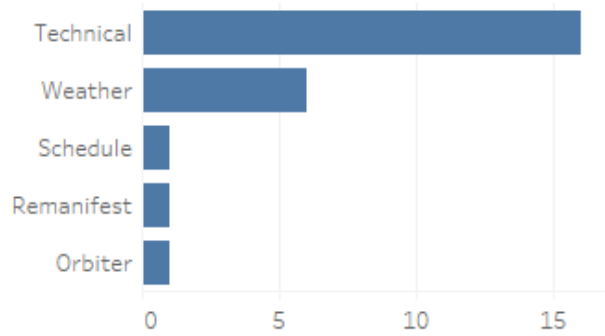
Launches by Year



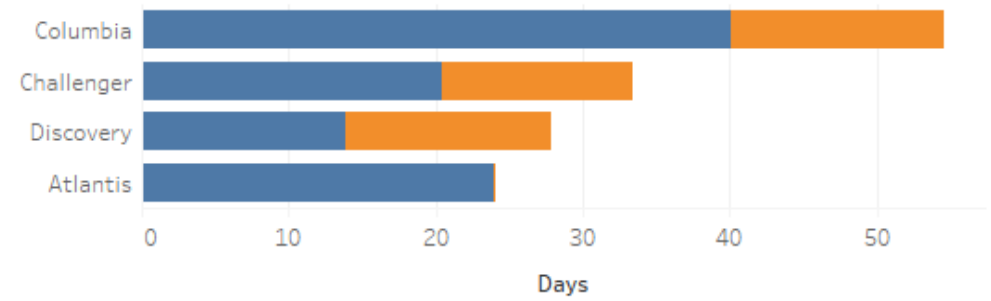
Average Turnaround Time (In Days)



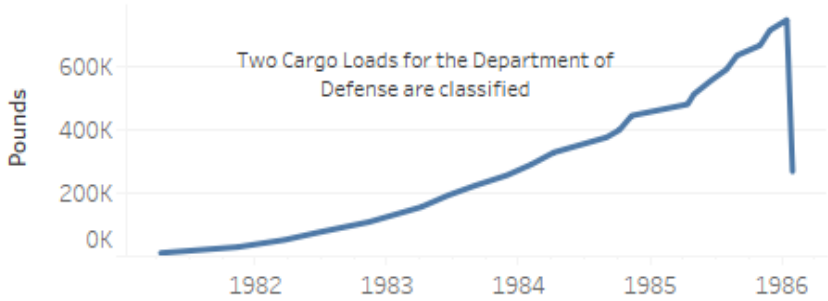
Total Delays (1981 - 1986)



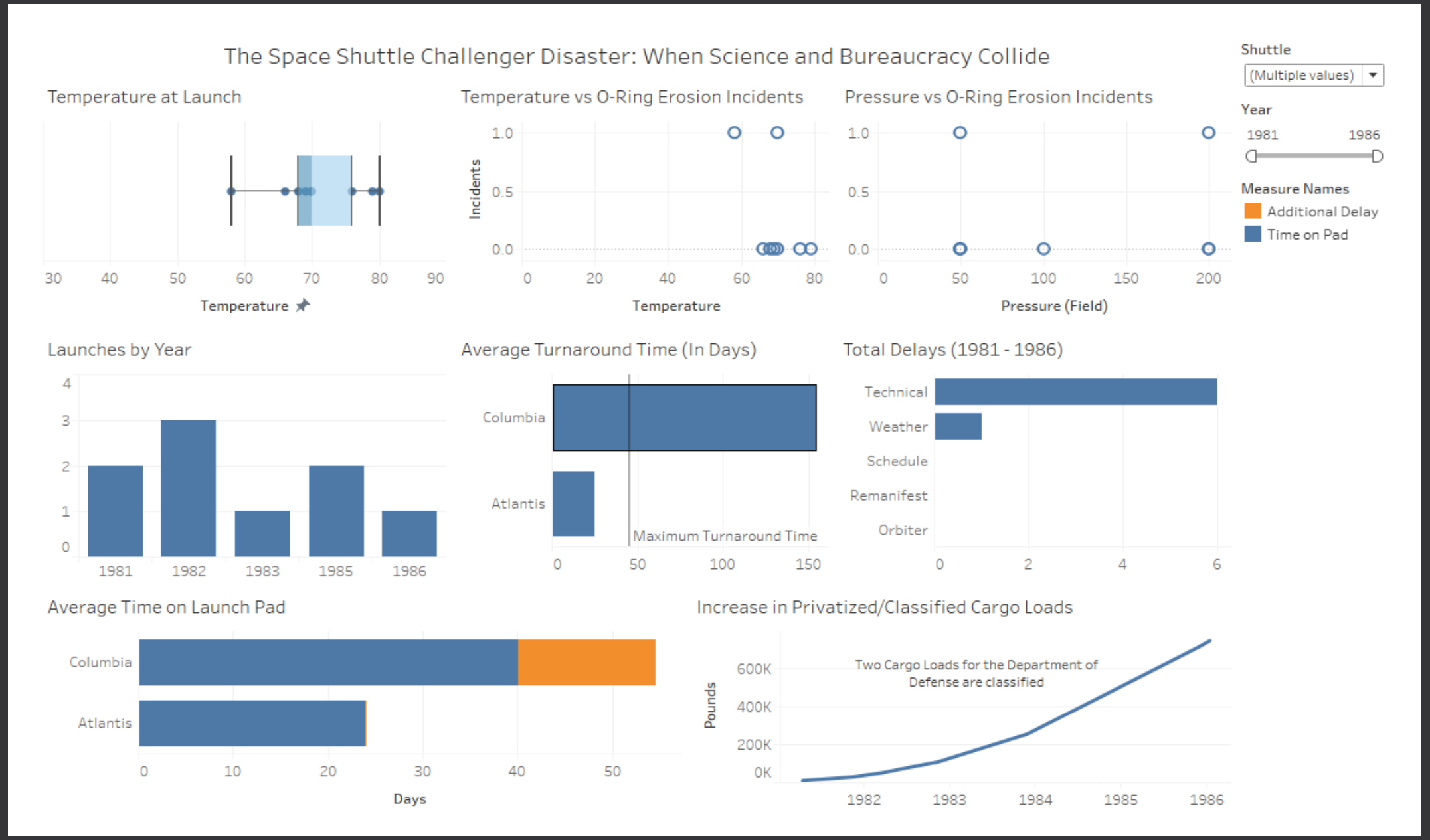
Average Time on Launch Pad



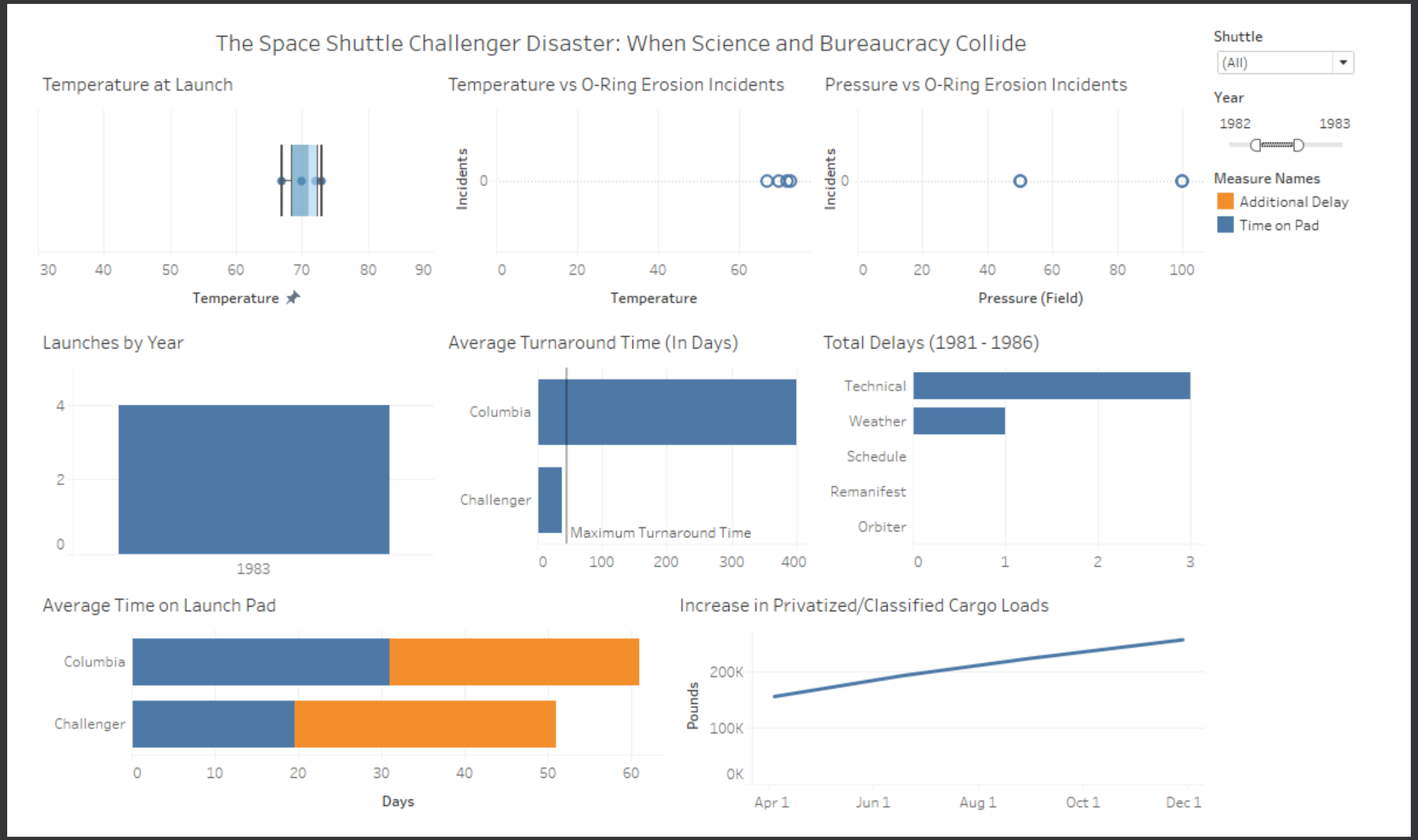
Increase in Privatized/Classified Cargo Loads



Dashboard with Shuttle Filters Applied



Dashboard with Date Filters Applied

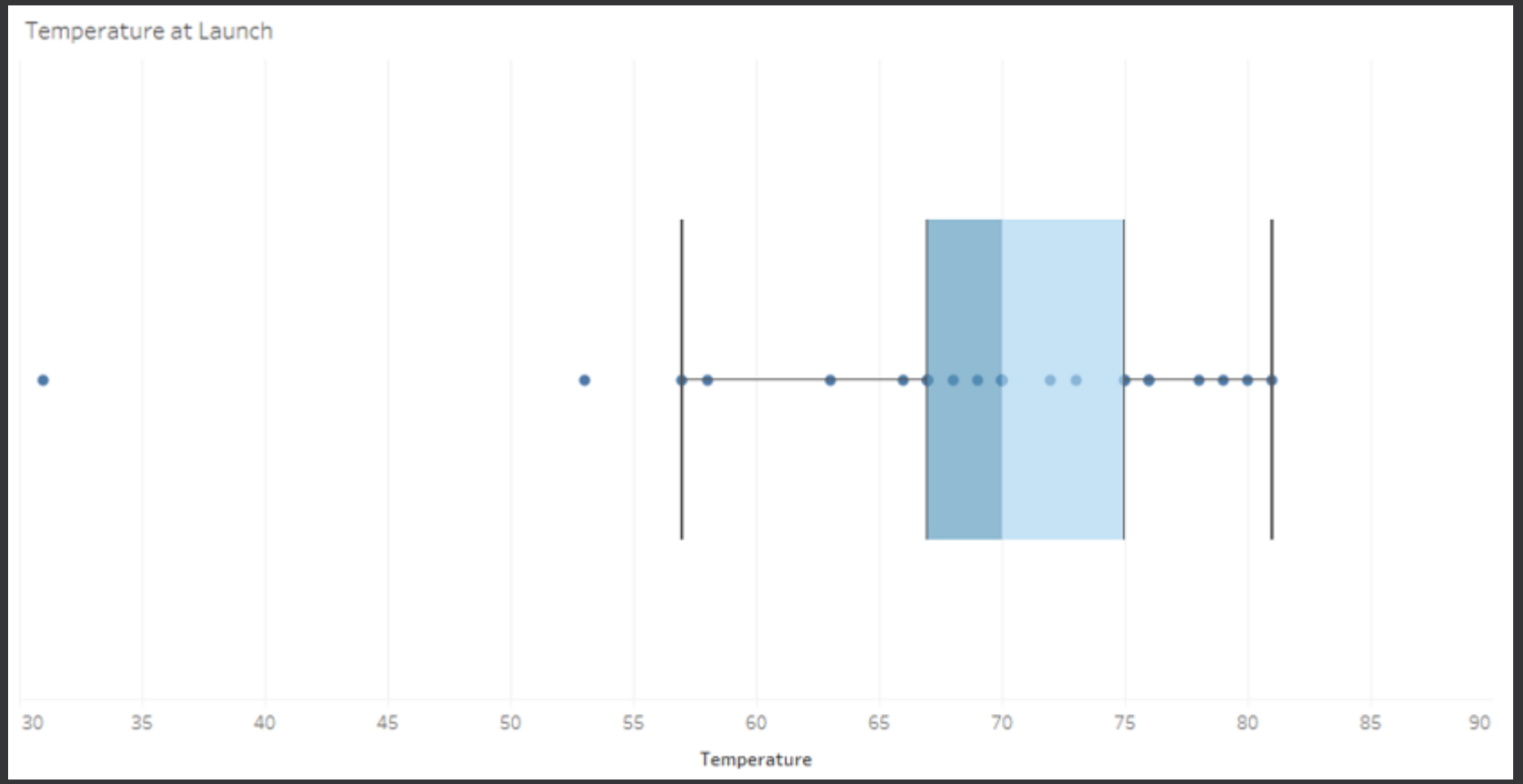


Key Charts

- Temperature Box Plot
- Temperature vs O-Ring Erosion Incidents
- Pressure vs O-Ring Erosion Incidents
- Launches by Year
- Average Turnaround Time
- Total Delays
- Average Time on Launch Pad
- Increase in Privatized/Classified
- Filter by Shuttle
- Filter by Year
- Legend

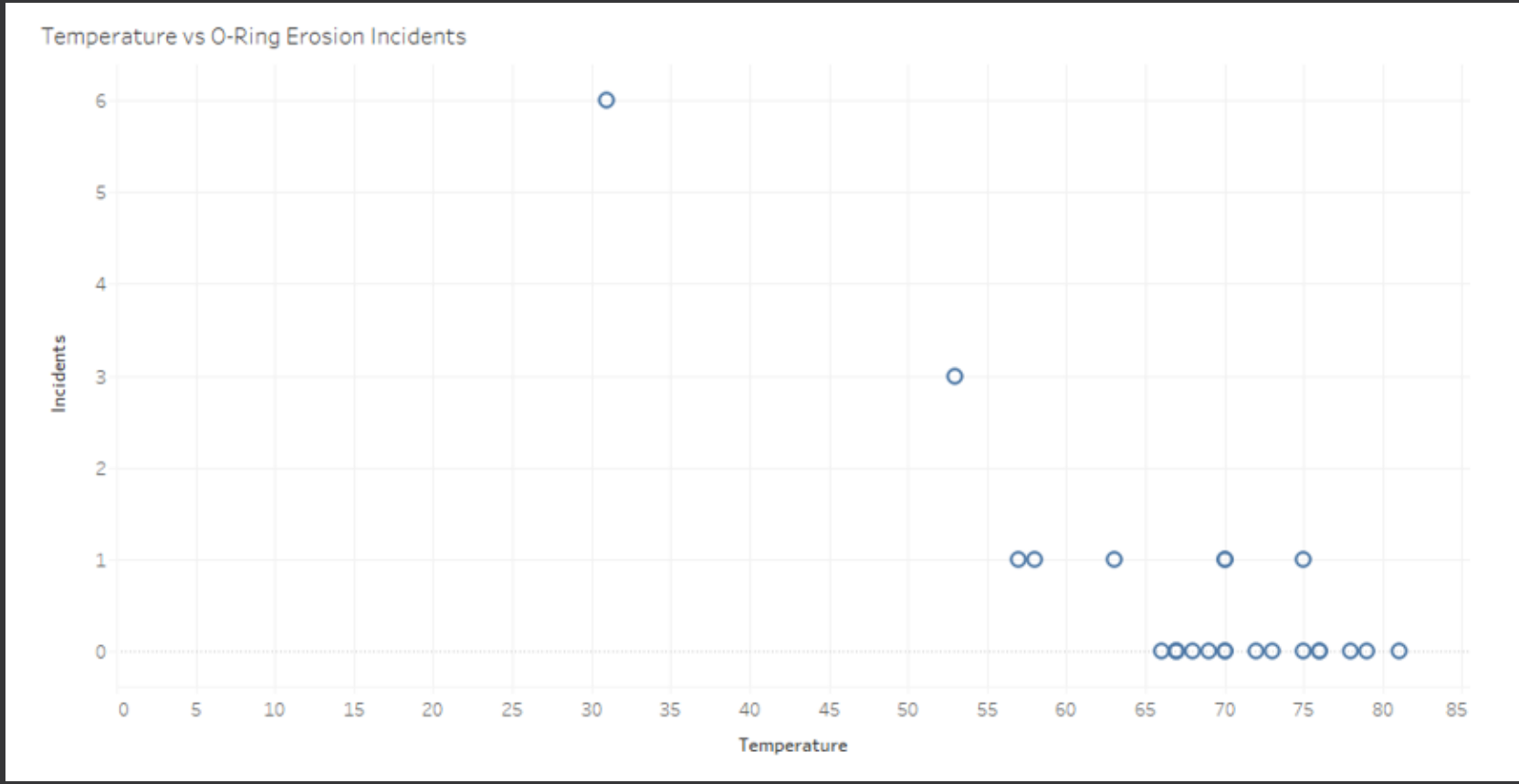
Temperature Box Plot

- O-Ring Temperature at Launch



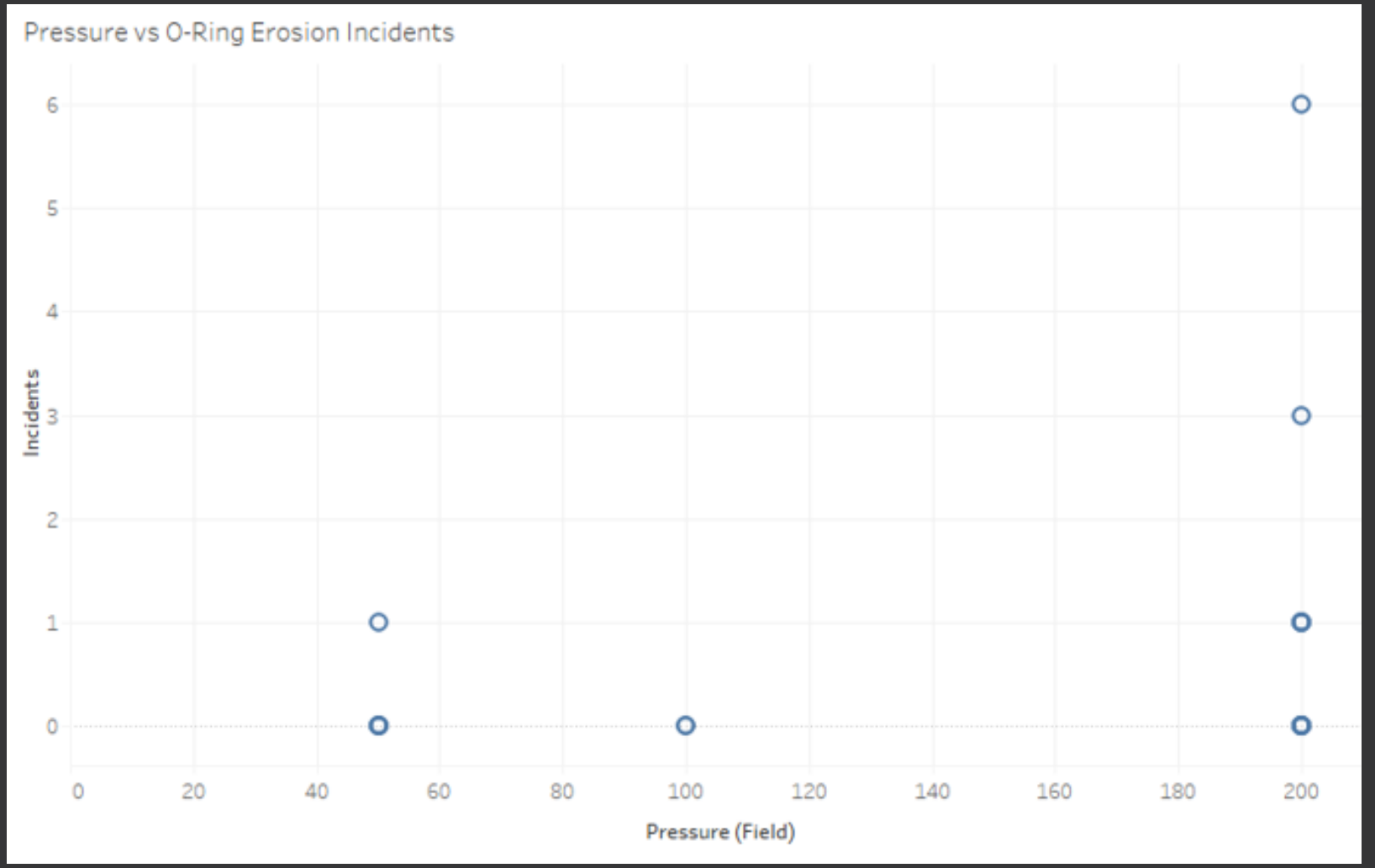
O-Ring Temperature vs O-Ring Erosion Incidents

- Correlation Analysis of O-Ring Temperature to O-Ring Erosion Incidents



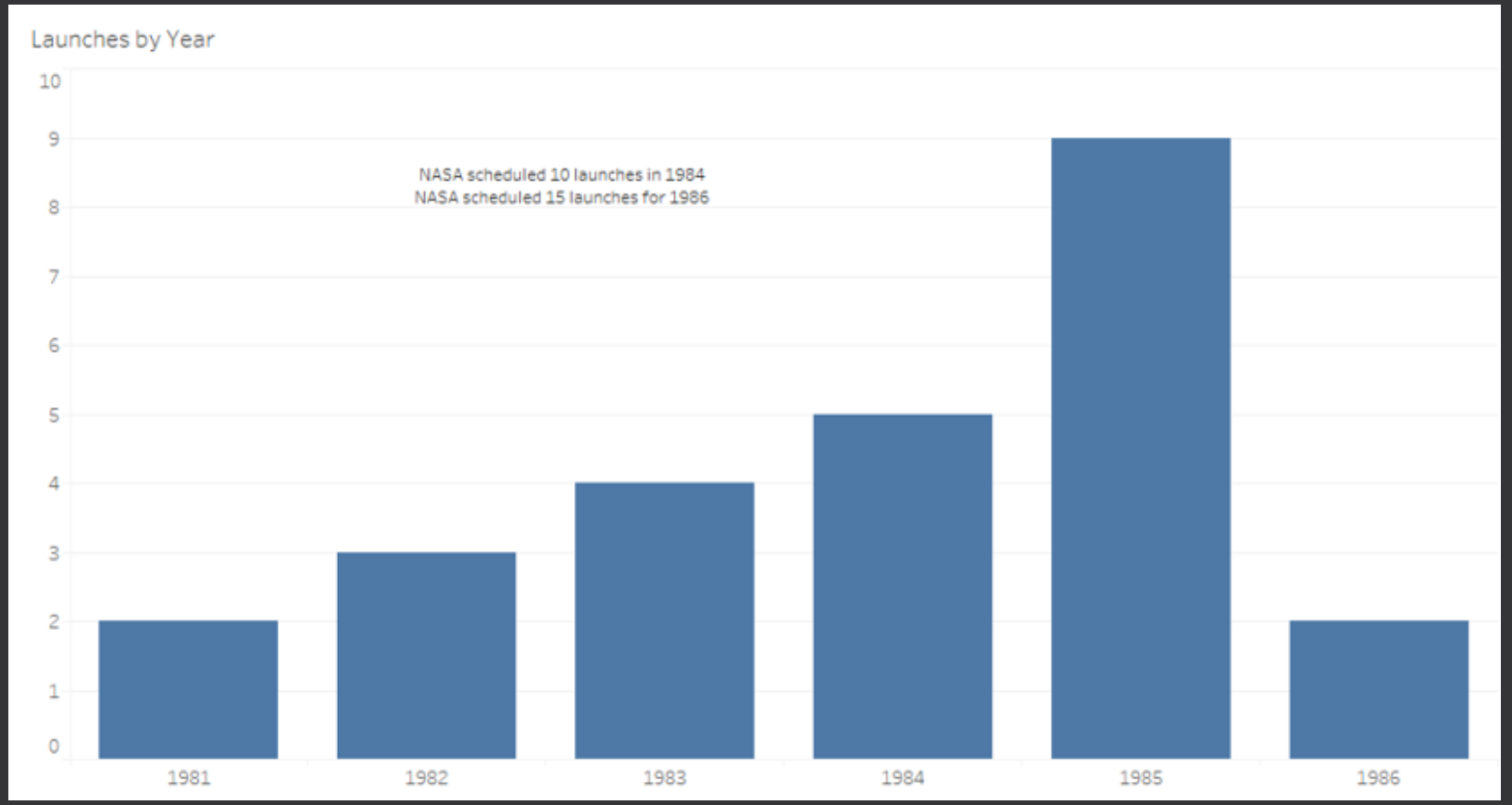
O-Ring Pressure (PSI) vs O-Ring Erosion Incidents

- Correlation Analysis of O-Ring Pressure (PSI) to O-Ring Erosion Incidents



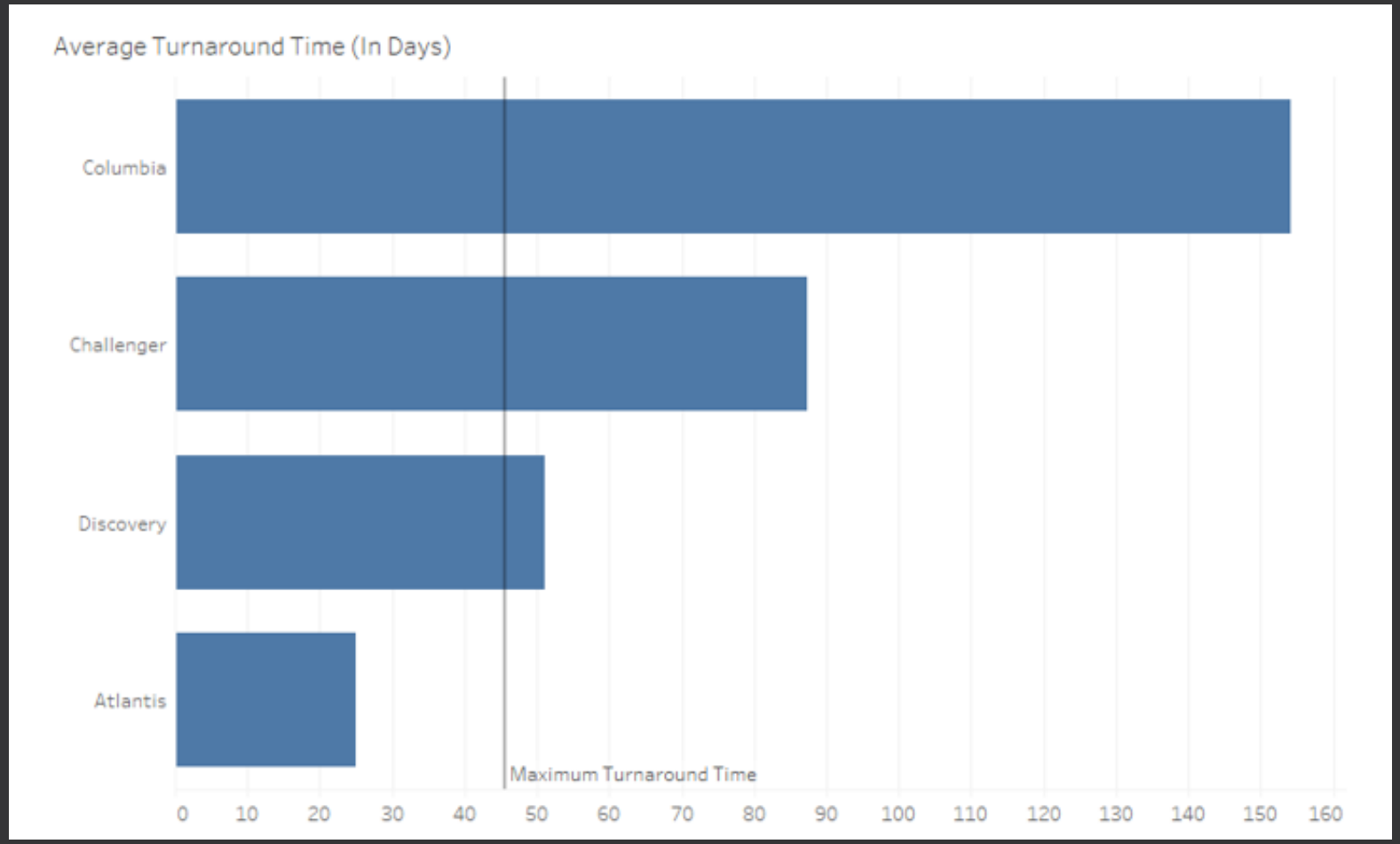
Launches by Year

- Number of Launches by Year, including the scheduled number of flights for 1984 and 1986



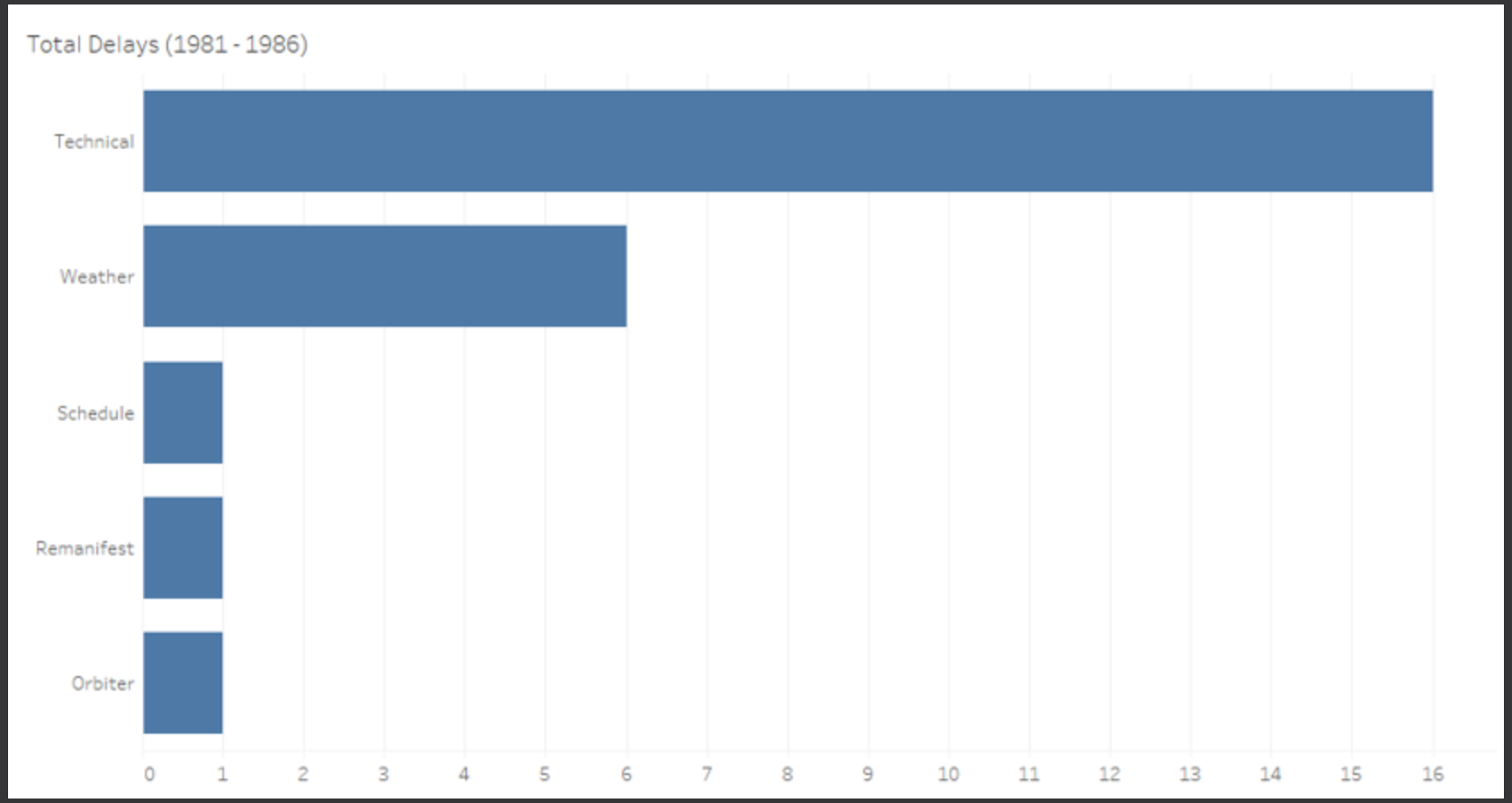
Average Turnaround Time (In Days)

- Average time from landing to the next scheduled flight date for each shuttle, with the maximum turnaround time to meet schedule



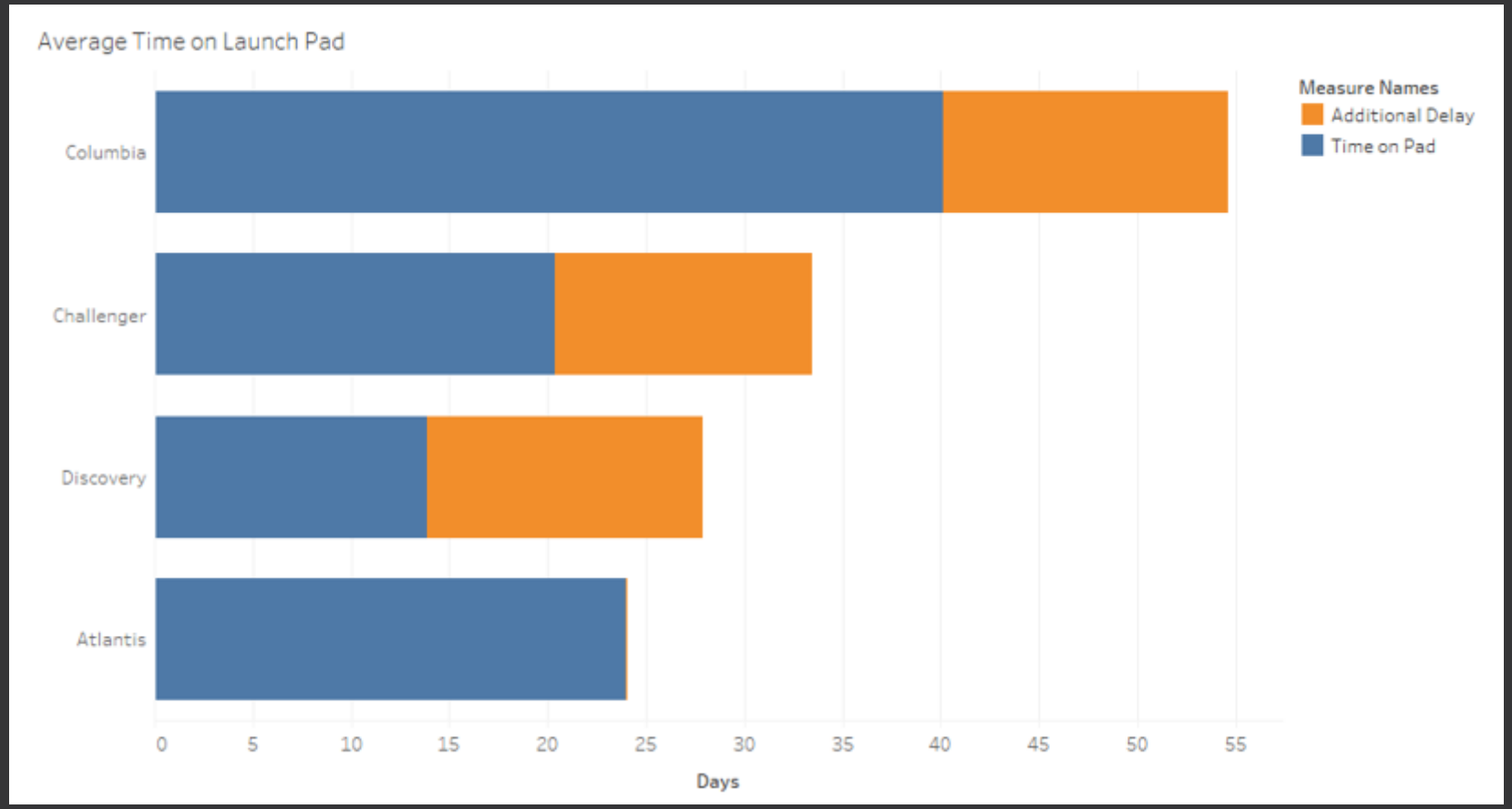
Total Delays (1981 – 1986)

- Number of delays by category for all launches



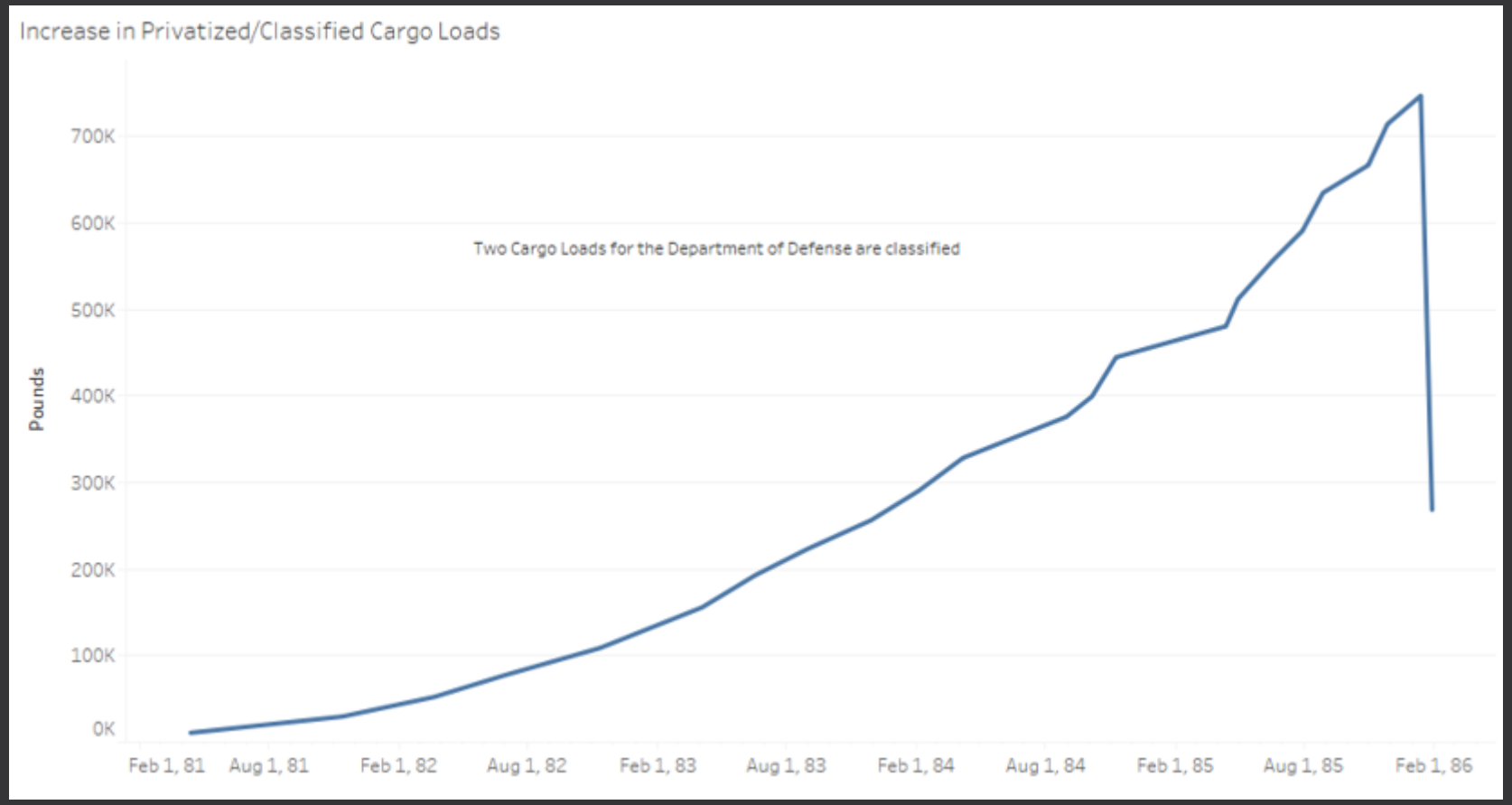
Average Time on Launch Pad

- Average amount of time each shuttle spent on the launch pad, categorized by the scheduled amount of time on the launch pad and additional time caused by delay



Increase in Privatized/Classified Cargo Loads

- Cargo load by shuttle mission date, with notation of the two classified cargo loads which were not available



Challenges

- Disparate Data
  - Problem Statement: There was no single source for the Challenger data, most data sources only focused on the temperature and O-Ring damage data. Other sources had shuttle mission data, which focused mostly on delays, cargo details, and other key mission details, but not on temperature or O-Ring damage.
  - Solution: Consulted multiple references including the Rogers Commission Report and NASA documents, cross referenced data points to confirm the data was consistent across all sources, when not able to confirm, the data was excluded
- Different Formats or Not Formatted
  - Problem Statement: The data files which were available were in different formats, which included both text and csv file formats. Some sources did not contain a data file, rather it was a pdf file with shuttle mission details. Similarly, there was no complete data file available in Tableau or SAS Viya
  - Solution: Required to create my own excel file, which I was only able to upload in Tableau, as the upload option was disabled in SAS Viya. While time consuming, this also allowed for the data to be explored in ways not previously attempted.
- Missing Data, Including Classified Information
  - Problem Statement: In some instances the data was missing or classified due to the nature of the missions, consulted multiple sources including official NASA records and libraries.
  - Solution: When not able to confirm with multiple sources this data was excluded. For classified information it was notated on the final visualization which missing data was excluded due to it being classified.
- Over Analyzed
  - Problem Statement: While conducting research, I encountered multiple articles and visualizations for the Challenger Disaster. This was unexpected when the subject matter was chosen, which presented the unique challenge of attempting to interpret existing data in a new way.
  - Solution: While one of the charts included was present in previous work, the focus for this dashboard was to show contributing factors which, when considered, would have persuaded decision makers to come to a different conclusion.

References

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