Northeastern Aerospace Budgeting Dashboard

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Abstract

Within an exploratory budget analysis, it is crucial to be able to investigate every piece of your budget in depth, while also being able to get a quick overview of its general spread. A user trying to explore and allocate funds within a budget needs to be able to compare a current proposal to past budgets to be able to identify areas where funds were unnecessarily prepared or unexpectedly needed in the past. They also require the ability to compare budgets split between different departments of an entity, and then draw conclusions about what proportion of their budget makes sense to allocate to each various department.

1 Introduction

There are a few specific tasks which we expect an end user of this visualization to find important. One of the main goals in the creation of this visualization is to support the allocation of future budgets by providing information about past budgeting and spending in an easy to digest way. The extensive tables in which this past information is stored contain the information well, but are not digestible or at all easy to analyze. This visualization is intended to support the user's budget exploration by providing side-by-side details of budgets over time, which allows for easy inspection of trends between budgets and the detection of similarities to a new proposal. Further, it allows for the user to dig into specific areas of the budget for an in-depth breakdown of proposed and actual purchases within a specific subdivision of the budget. Here, a user can investigate the particular usage of each group within their team individually, and make judgements upon past spendings to inform decisions on allowing future spendings.

The end user, specifically for this visualization, is the Treasurer, and other members with budgeting responsibilities within the Northeastern Aerospace club. Should this visualization be generalized to any other club or company, the end user would be their respective users responsible for proposing and allocating funds across the team.

2 Related Work

A first similar case study describes the successful implementation of a high-level financial reporting system at NASA called the Agency Budget Execution Dashboard (ABED) [1]. This dashboard enabled NASA's management to track their finances as well as manage their resources by displaying the variance from expected expenditure. As we are creating a dashboard to aid budgeting and track spending, it would help to take inspiration from the visualizations presented in the paper. Additionally, being able to record expected spending will enable the board of the club to allocate their resources at the start of the term. The actual spending will be recorded as the term progresses and displaying the variance from the planned expenditure will help the board recognize a need for more funds earlier.

Secondly, we have considered a research article which talks about certain design principles with regard to the color palette used in the dashboards [2]. Overuse and misuse of colors can lead to cognitive overload resulting in difficulties to understand the visualizations and delays in decision making. By using contrasting colors (red for negative, green for positive) that are associated with the user's task can enable the user to easily understand the information presented. These color palette choices are

decisions which we consider heavily while designing our visualization.

3 Use case

The NU aerospace club is a Northeastern funded, student-run organization on campus. It is split up into 4 subdivisions: Rockets, Planes, Drones, and Satellites. Within these subdivisions, there exist smaller groups which are focused on specific aspects of the rocket/plane etc. Each semester, the leaders of these subgroups propose a breakdown of funds for their specific needs, and it is then up to the club's Treasurer to allocate funds appropriately where necessary.

The visualization detailed in this report is intended to allow for easy examination of past, or current proposed and actual spending across the various subdivisions and projects. The end user who would most benefit from this project would be the club's treasure, and the visualization would, in theory, allow them to make more informed decisions regarding the allocation of funds by providing an easy-to-digest way to compare what funds are proposed and which are actually used.

With our visualization, the Treasurer could focus into a specific division of the club, specifically Redshift (the rocket division), or Fixed Wing (the plane division) and then investigate past budgets broken down in various ways- by the even smaller project groups within the division, by necessity, by price etc. All of this information would be easy to interpret at a glance. With increased ease of access to this data, all in one place, it would enable the allocation of funds to be easier, and more trustworthy by being backed by real, visible data.

4 Data

Most of our data was collected by, and directly distributed to us by member of the NU Aerospace Club. It is a manually compiled collection of several separate datasets, each specific to one semester's proposed and actual purchases. The proposed budgets contain information as to a purchase's cost, importance, and subgroup within Redshift. The most evident area of bias within this data set is this level of importance. Since it is dictated by those proposing the purchase, and thus inherently desired, it is rare to see "Not necessary" as a level of importance. It would be reasonable to suspect that the importance level of some things could be inflated. This is clear in the fact that many proposed purchases will not end up being recorded. Though, it is also important to note that our actual purchases do not use the entire allocated budget, so it is likely that some purchases were not recorded.

In addition, we were able to obtain a short file containing details of rocket parts broken during launches. This data is often not formally tracked as it occurs, and thus it likely incomplete data, however it is still helpful in noting areas of potentially higher required investment (higher costs due to necessary replacement).

Our data cleaning consisted of several steps, starting with the compilation of our numerous data sets into one standardized Excel file for ease of use. The compiled data [1] did not have a prepopulated column for the designated semester of the budget, so this was added manually as we compiled. We also standardized a few columns to be entirely capital letters, as there was inconsistent capitalization. We also removed disrupted rows from the file which were misaligned or missing crucial data, like the item name or cost/price.

5 Design Process

Prior to creating our final dashboard design, we took the time to brainstorm visual encoding for individual pieces of the data which we hoped to provide to our end user. Below are 3 partial sketches of specific areas of our visualization.

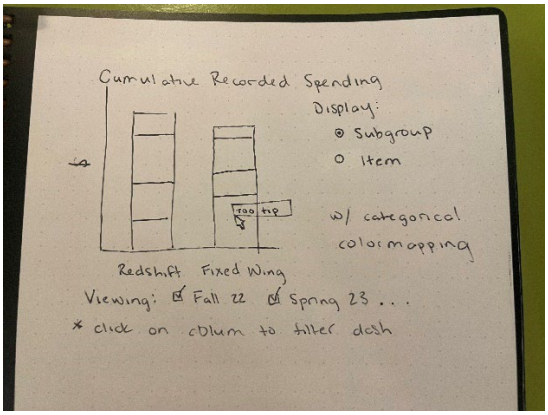

Figure 1: Partial Sketch 1, Budget Overview.

The first sketch we produced is intended to provide a general overview of the budgeting for each of our two considered divisions, rockets and planes. We would provide a segmented bar for each division which has a height representing the total spending for that group. Each segment would initially be shown as a subgroup of that division but would allow for the user to select a item by item breakdown, with zoom capabilities for easier reading, and a tooltip for additional information. The initial overview would be cumulative over the semesters of data, but also allow for filtering by one or multiple semesters. Further, clicking on the rocket or plane column would filter other sections of the dashboard to the respective Aerospace group, or introduce new, division specific tiles if applicable.

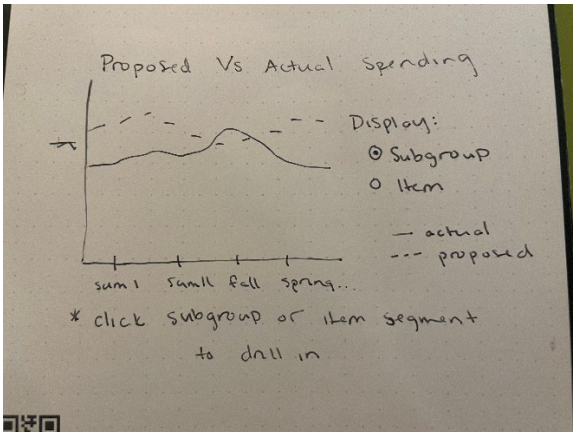

Figure 2: Partial Sketch 2, Actual and Proposed Spending over semesters.

Figure 2, above, depicts a second section of our dashboard which would show a line chart of the proposed vs. actual spending records over time. The dots are markers, similar to the segmented bar chart from Figure 1, which break down the proposed and actual budgets into subgroups. These subgroups are also intended to be drilled into for item-by-item break downs. The same zoom/pan and tooltip capabilities are also intended.

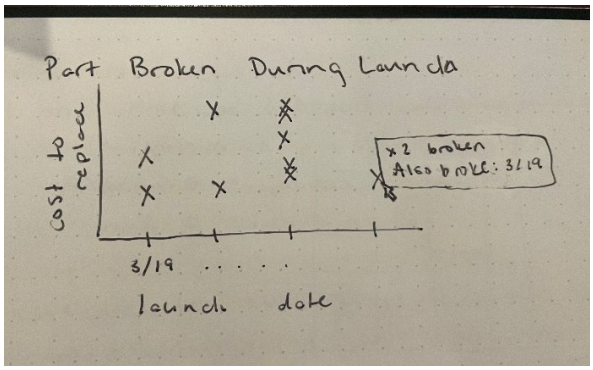

Figure 3: Partial Sketch 3, Redshift Launch Investigation.

The final partial sketch is an additional, Redshift (rocket) focused visualization which provides an additional insight to some potentially unforeseen expenses- damages due to launch. When allocation a budget, it is always important to keep in mind that unpredicted expenses may arise, so having some room within your allocation is crucial. This chart shows some pieces which have broken during a launch, with x-coordinates of launch date, and y-coordinates as average expenses to replace. This gives some incentive to leave room for repair budgeting in distributing funds.

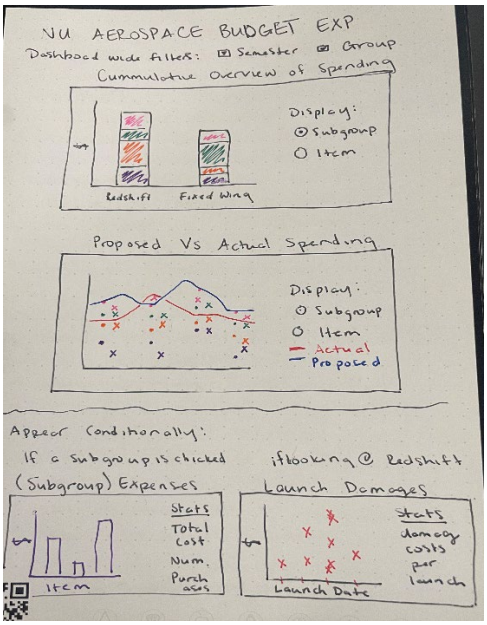

Figure 4: Polished Final Sketch.

We felt that our initial 3 pieces were strong components for our final dashboard, and so we kept most of our initial sketching, and focused on

then finding ways to connect the pieces in our dashboard-style visualization.

Our visualization makes use of both lines and points as marks. The lines, contained in the overview bar chart, uses length as a channel to represent total costs. Then also use horizontal position to dictate which Aerospace division is being represented, and color to distinguish between separate subgroups of items. The points, in the other subsections of our visualization, as well as the lines in the "Proposed VS Actual" section, make use of horizontal and vertical position to represent dates and costs respectively. These lines will also use color to differentiate the proposed and actual totals, while the points use color to distinguish between groups/items, and shape to distinguish proposed and actual costs.

As for functionality which we have incorporated into our dashboard, all of our individual pieces are designed to include zooming and panning functionality, as well as a tooltip that includes additional information about a subsection or item being hovered over. We also have allotted two dashboard wide filters, one which allows you to filter the entire board down to only Redshift or Fixed Wing focused, and one to select a specific singular or multiple semesters. Additionally, the tool tip for subgroups will suggest clicking for further detail, which will add a new tile to the dashboard showing additional breakdowns and details about purchases requested and made by a this specific subgroup. Lastly, when Redshift is specifically selected, we will also include our Redshift-specific launch data chart. If the planes section is selected, or neither group is selected, the chart will collapse.

6 Final Design

7 Discussion

8 Conclusion

References

[1] P. Putz and H. Finger, "Development and deployment of NASA's Budget Execution Dashboard," 2010 IEEE Aerospace Conference, Big Sky, MT, USA, 2010, pp. 1-7, doi: 10.1109/AERO.2010.5446875.

[2] Palash Bera. 2016. How colors in business dashboards affect users' decision making. Commun. ACM 59, 4 (April 2016), 50–57. https://doi.org/10.1145/2818993

[3] Redshift Rocket Data, Compiled March 2023. https://docs.google.com/spreadsheets/d/1bCLl-Fn6f-2yeBntou9yhGc4JCTuLddlxALZIQmqPOw/edit?usp=sharing

Appendix A: Data Abstraction

Dataset 1, Redshift Proposed Budgets

Items.

Each row corresponds to one proposed purchase for Redshift.

Attributes.

Item: Categorical. The name of an item purchased.

Description: Categorical. A short description of the proposed purpose.

Importance: Categorical. The level of necessity of an item.

Vendor: Categorical. The company which provides the proposed item.

Price: Quantitative, Sequential. The price of 1 unit of an item purchased.

Quantity: Quantitative, Sequential. The number of units purchased of one item.

Cost: Quantitative, Sequential. The total cost of the number of units of an item purchased.

Subgroup: Categorical. The name of the Redshift group which purchased the item.

Group: Categorical. The department of NU Aero which purchased the item.

Semester: Ordinal, Sequential. The Northeastern semester in which the purchase was made.

Dataset 2, Redshift Recorded Expenses

Items.

Each row corresponds to one recorded purchase for Redshift.

Attributes.

Item: Categorical. The name of an item purchased.

Price: Quantitative, Sequential. The price of 1 unit of an item purchased.

Quantity: Quantitative, Sequential. The number of units purchased of one item.

Cost: Quantitative, Sequential. The total cost of the number of units of an item purchased.

Subgroup: Categorical. The name of the Redshift group which purchased the item.

Group: Categorical. The department of NU Aero which purchased the item.

Semester: Ordinal, Sequential. The Northeastern semester in which the purchase was made.

Dataset 3, Redshift Launch Record

Items.

Each row corresponds to one item that was broken during the launch of a Redshift rocket.

Attributes.

Item: Categorical. The name of a part on the rocket launched.

Launch Date: Quantitative, Sequential. The date of the rocket launch in which the given item broke.

Appendix B: Task Abstraction

Domain Task 1

Compare a current proposal to past budgets.

High level action: Consume, Discover. Explore and consider various aspects of past budgets.

Medium level action: Explore. With no specific target or location, observe all aspects of multiple budgets side-by-side.

Low level action: Compare. Observe multiple budgets to locate similar patterns.

Target: Attributes Similarity. Look for similarities and differences between past budgets and whatever budgets you are trying to compare.

Domain Task 2

Examine different departments of the club separately and in depth.

High level action: Consume, Present. Present the user in-depth data of a distinct department.

Medium level action: Browse. Explore within this known section of the visualization (a specific department).

Low level action: Summarize. Display all data for a given department in a simple way.

Targets: Trends, Outliers. Look for distinguishing factors or patterns in the data which could be meaningful, like trends our outliers.