Visualizing Victory

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***Abstract*—During WWII, the United States built over 3,000 merchant ships to keep the Allied war effort fed and supplied. These vessels were produced at unprecedented scale using innovative technology. The historical records for many of these ships are remarkably complete, presenting an excellent subject for data exploration and visualization. The work in this paper sought to develop an interactive visualization, in a data-journalistic style, which tells the story of these ships in an engaging, meaningful way.**

I. Introduction

As of the writing of this paper, the United States is witnessing one of the most miraculous scientific, manufacturing, and logistical triumphs in living memory. Less than 18 months into the global COVID-19 Pandemic, nearly half of all US adults are fully vaccinated against SARS-CoV-2, [1] an accomplishment that should not be overlooked, even as we continue the necessary reckoning over many other facets of our COVID response. Inspired by this vaccination saga, I wanted to tell the story of a similar but overlooked feat from America's past: the construction of nearly 3,400 Liberty and Victory transport ships during the Second World War.

Produced by shipyards across the country, in numbers far greater than the Axis Powers could possibly sink, these vessels initially denied Nazi Germany the ability to starve the United Kingdom into surrender and formed the backbone of Allied supply networks throughout the war. Thanks to assiduous record-keeping and painstaking curatorial work [2–4], the individual histories of many of these ships is known with great detail. This story is both immense in scale and rich in intricacies. To tell it properly requires a visualization design that presents both the grand narrative arc and all the thousands of fascinating details on equal footing. Furthermore, I wanted to create a visualization which is both valuable and effective for a diverse audience. In terms of value, I want the visualization to be interesting and educational for both people who've never heard of these ships and for those who are quite familiar with the story. Likewise, I want this project to be effective and easy to use for those who are less experienced with interactive visualizations without being too boring or rudimentary for more savvy users to enjoy. I want this product to be something my grandparents can use and my sister, a high school art teacher, can enjoy looking at. Doing so is not a small undertaking, but this is a story worth telling.

II. Related Work

By far the most valuable source of information I came across on on this topic is the report *'Liberty' Cargo Ship* by James Davies [2]. This incredible work of curation contains nearly all of the data used in this project for the Liberty Ships. Although this report contains some basic graphs and images, it is primarily a textual document, not a visual one. Mark Biegert, of the *Math Encounters Blog* took the data from this report and parsed and organized it into a very clean Excel workbook [5]. He did the same for the Wikipedia data on Victory Ships, which is less detailed. Again, Biegert's work contained a few graphics but was not primarily visual in nature. The Excel workbooks did contain a small degree of interactivity, through the ability to sort the data along different axes. Although Wikipedia is not generally thought of as a reliable source for academic work, the crowd-sourced nature of it's content is well-suited to a topic of this scope. The Wikipedia articles pertaining to this story are well written and organized [6, 7], and I find them to be the best gateway into this topic.

III. Methods and Results

Building off of the excellent works cited above, I set out to create a visualization which tells this story at all scales of time and detail. As an interactive, web-based visualization, the interactivity is implemented in Javascript and makes heavy use of D3 [8]. Inspired by Gregor Aisch's work, *In Defense of Interactive Graphics*, I operated on the design principle that an interactive visualization should tell a complete story at first pass and only require extensive interaction to layer richness atop the base narrative. Working from this constraint, I arrived at a two-component design which neatly dichotomizes the visualization into two narrative levels. The first component is a so-called scrollytelling piece which paints the story of the Liberty and Victory ships in broad strokes, accompanying each section of text with a relevant image. The scrollytelling feature is powered by Scrollama [9]. The text scrolls smoothly along the side while the accompanying visuals and captions cycle in-place as their corresponding text flows in and out of view. To give a smooth and responsive feel, the images changeover instantaneously, without any sort of animated transition, and the text changes from a low-contrast color to stark black to indicate which piece of text corresponds to the image being displayed.

Below the scrollytelling section is a highly interactive, full-screen visualization of all the data I could find on these

ships and the yards that built them. When first viewed, the visualization is mostly blank, with only a map of the US, an empty bar chart, a timeline of WWII, two labeled ship glyphs, and and a search bar with several buttons. The map of the US is adorned with small dots, each indicating the location of a shipyard involved in this story. Of the four buttons next to the search bar, three are clearly inactive, leaving only a large button, labeled "Play", to be clicked. Upon clicking the play button, the progress bar on the timeline begins tracking through time and a corresponding date at the top of the screen appears in large font and begins to evolve forward in time. Simultaneously, small ship glyphs begin appearing above the shipyard markers before smoothly moving into a growing grid of such glyphs above the map. This grid is a unit visualization in which each glyph represents a single liberty or victory ship, color-coded by type. Hovering over a ship highlights it and the shipyard that built it and prompts basic information about the ship to be displayed above the unit visualization. Clicking on a ship populates a region to the right of the visualization with all of the available data on that vessel. As the unit visualization is populated, the initially empty bar graph below it begins to fill out, with the length of each bar encoding the number of ships built by a single shipyard. Hovering over a bar highlights the corresponding shipyard on the map, and vice versa; basic data about the shipyard is displayed at the top of the page in either case, and clicking presents more information, as with the ships.

When the animation finishes, the buttons next to the search bar become active, and the user is free to search for ships which contain any keyword or term in their "Fate" data-field (although available data is currently limited to Liberty Ships). Any ships matching a search will be highlighted in red until either the "Clear" button is clicked or another term is searched. A button labeled "Try Suggested Search" will automatically populate the search bar with something interesting and launch the search. The user can also drag around the progress marker on the timeline to fix the visualization to a certain date. Ships built after that date have their opacity lowered and the bar graph is altered to reflect totals only up to that date. This interactivity is very fluid and responsive for reasons discussed below.

Most of the interactivity discussed here was implemented through extensive and layered use of D3.js data operations. The animation is implemented through a set of nested loops and timeouts which also create the glyphs and bind them to the data. As stated above, the implementation of the timeline scrubbing is worthy of note because of the fluidity which results. The key insight was to move as much of the code required to update the visualization, including determining which elements need updating, outside of the "on('input')" call bound to the slider through D3. Instead, a small function which makes any necessary changes to the visualization, based on the state of the timeline, is called every 30 milliseconds. This effectively sets a frame rate for the visualization regardless of how erratically the slider is manipulated, leading to responsive but smooth behavior.

IV. Discussion

It is my belief that I've succeeded in my goal of creating a visualization which provides educational value in an effective and engaging way. Feedback from initial readers indicates that the scrollytelling component is effective at providing the necessary background information, and the full-screen interactive has received overwhelmingly positive feedback. Multiple readers reported being shocked by the sheer number of vessels represented in the visualization. Reading that there were 3,400 cargo ships built in 4 years is one thing, but animating the creation of the unit visualization presents the story of the ships' construction in a visceral way. It is impossible not to recognize the enormity of this historical undertaking as literally thousands of glyphs fly across the screen, representing the completion of multiple ships per day by mid-war. In fact one reader was skeptical of the 3,400 number until explorint the visualization and coming to terms with the quality of the data.

More personally, through researching this project, the story of these ships is one I've come to care about a great deal, and I feel that I've done it justice.

V. Future Work

As mentioned above, the available body of data for Liberty Ships is far more complete than that for Victory Ships, so the "Fate" data-field is currently blank for those vessels. James Davies' report on the Liberty ships is a treasure, and I hope that somebody with similar talents is able to curate an analogous document for the Victory Ships. Incorporating this data into the visualization would make it feel more complete.

Another way to augment the utility of this visualization would be to add a feature which allowed the user to highlight all of the ships built by a certain shipyard at once. I think the most intuitive way to do this would be to add a dropdown list of all the shipyards next to the search bar and otherwise use the same interface.

Finally, although it is beyond the scope of this work, it would be exciting to see a data visualization which focuses on the individuals who built and crewed these ships, particularly focusing attention on the gender and racial integration spurred by crisis.

References

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